



# nviron 2015

**Institute of Technology, Sligo**

**April 8<sup>th</sup> to 10<sup>th</sup> 2015**

[www.environ2015.org](http://www.environ2015.org)

**The 25<sup>th</sup> Environmental Researchers' Colloquium (ENVIRON 2015)**  
**a partnership between the Environmental Sciences Association of Ireland**

**and**

**Institute of Technology, Sligo**

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**CONTENTS**

Welcome to ENVIRON 2015	2
ESAI Welcome to ENVIRON 2015 Delegates	4
Delegate Information	10
ENVIRON 2015 Programme Outline	13
Biographies: Questions & Answers, Plenary Session	15
Oral and Poster Presentation Schedule	23
Oral Presentation Abstracts	33
Poster Presentation Abstracts	149
ESAI Annual Review 2014	233

## Welcome to ENVIRON 2015

Dear Delegate,

The ENVIRON 2015 Organising Committee welcomes you to the 25th Irish Environmental Researchers' Colloquium (ENVIRON 2015) at the Institute of Technology, Sligo. The very first Environmental Colloquium was held here in January 1991 and we at IT Sligo are very proud to be Environ hosts for the fourth time on its silver anniversary.

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. During ENVIRON2015, there is a great opportunity to network with 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.

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 is reflected in the theme of this 25<sup>th</sup> colloquium, 'Environ 25: Sustainability and Opportunities for Change'. The colloquium theme addresses the need to review environmental change since 1991. These shifts will be reflected upon during the plenary session, by Dr Richard Thorn, emeritus President of IT Sligo and the very first Environ convenor. Although technologies and knowledge transfer systems have developed exponentially in the new millennium, the major challenges to global sustainability have also evolved. Is current Irish environmental research optimising research to deliver management and policy recommendations towards sustainability? The colloquium will investigate current sustainability actions while addressing opportunities for positive changes in engagement.

The conference will begin on Wednesday April 8<sup>th</sup> with two workshops on: 'Introduction of the use of R in Environmental Statistics' (Dr C  il  n Minto, GMT) and 'Communications in Science' (Dr Cara Augustenborg, Impact Research Management and Mr. David Dodd, DEHLG)). Environ 25 will open to the public on the evening of Wednesday April 8th with a question and answers style panel debate on the popular topic of 'Paying for our water: quality and quantity matter'. The panel will comprise Jerry Grant (Head of Asset Management, Irish Water), Fiona Regan (Director of DCU Water Institute), Michael Ewing (Environmental Pillar Co-ordinator) and Michael Fitzmaurice (Independent TD for Roscommon-South Leitrim).

The colloquium will be 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 M  che  l    Cinn  ide (EPA Director), Marianne Kettunen (Senior Policy Analyst, Institute for European Environmental Policy) and Dr Brian Motherway (CEO, Sustainable Energy Authority of Ireland).

Four concurrent sessions will follow lasting one and half days and spanning 15 topic areas. For the first time in the Environ series, we have 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. 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.

I hope you will find Environ stimulating for your own research and that you will also enjoy the various social activities you undertake in the beautiful surroundings of Sligo.

Fáilte roimh go léir go Sligeach agus bain sult as ENVIRON 2015!

Dr Frances Lucy,

ENVIRON 2015 Colloquium Convenor,

On behalf of the ENVIRON2015 Organising Committees

### ESAI Welcome to ENVIRON 2015 Delegates

On behalf of the Environmental Sciences Association of Ireland (ESAI), the ESAI Council extends to you a warm welcome to the 25th Irish Environmental Researchers colloquium (ENVIRON) at Institute of Technology Sligo (IT Sligo).

We are delighted that the ENVIRON Colloquium should be held in IT Sligo and is coming back to its first home on its significant silver jubilee. It also coincides with some significant recent developments in IT Sligo with the opening of the new Science building and the launch of the Centre for Environmental Research Innovation and Sustainability (CERIS). It is not surprising that there has been a record level of abstracts submitted to ENVIRON this year as it is a good reflection of the esteem in which the Department of Environmental Science at IT Sligo is held among environmental researchers across Ireland. We are also cognisant of the significant involvement of IT Sligo in the Connacht-Ulster Alliance and the ambition of a move towards Technological University status.

ENVIRON provides a platform for researchers to present to a wide audience and also gives an opportunity to engage with the general public. Environmental news is now mainstream with topics such as climate change, waste management and water pricing featuring regularly on both social media and on traditional platforms. For the last number of years, the colloquium has been open to the public on the first evening of the event in the form of a Questions & Answers debate. This time, the Q&A is on the hot topic of water, the management of which is undergoing a significant transformational change at the moment. Another new outreach activity this year is the invitation to secondary school students to view the research posters.

I would like to highlight some other initiatives that we have developed in ESAI for the benefit of our members. We are welcoming on board an ESAI Liaison in each college. We are also offering free membership to all undergraduates in relevant courses in each college. On the back page of this book, please read details of the ESAI Postgraduate Researcher of the Year competition and a new ESAI/EPA Workshop Support initiative.

The ESAI wishes to sincerely thank Dr Frances Lucy (Director of CERIS) and the IT Sligo committee for hosting ENVIRON and for assembling a very comprehensive programme. We also wish to thank Ms Sinead Macken for providing excellent administrative support to the event as always.

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

Dr Tom Curran  
ESAI Chairperson

The current ESAI Council Members are

Dr Cara Augustenborg	Dr Martina Prendergast	Dr Frances Lucy
Dr Paul Bolger	Mr Kevin Ryan	Dr David Bourke
Ms Emer Cosgrove	Ms Aoife Delaney	Mr Alan Berry
Mr Mark Nolan	Ms Dorothy Stewart	Dr Tom Curran
Ms Elizabeth O Reilly	Ms Rebecca Mooney	

**ENVIRON 2015 ORGANISING COMMITTEE****Conference Convenor**

Dr Frances Lucy CERIS Director, Department of Environmental Science, IT Sligo

**Institute of Technology, Sligo Planning Committee**

Mr. Daniel Doherty	Dr Mary Heneghan
Mr. Declan Feeney	Dr John Bartlett
Dr Anne O' Donohue	Dr Billy Fitzgerald
Dr Nicolas Touzet	Dr Bill Crowe
Dr Cian Taylor	Ms Cait Coyle
Ms Maria Keeney	Ms Margaret Savage
Dr Caroline Sullivan	Dr Suresh Pillai
Dr Tomás O' Flaherty	Dr Brian McCann
Mr. David Doyle	Ms Aideen Considine
Dr Eoin Gillespie	Mr Paul Hamilton
Mr. Steve Tonry	Ms Lil Rudden
Dr James Moran	Dr Michael Broaders
Dr Ann-Marie Duddy	Ms Edel Costello
Mr. Ossian Geraghty	Mr Guy Marsden

**Environmental Sciences Association of Ireland (ESAI)**

Ms Sinead Macken ESAI Administrator

Dr Tom Curran ESAI Chairperson

ESAI Council

**On the Ground Assistance at IT Sligo**

A special thank you to:

IT Sligo Postgraduate Research Students and Environmental Science Undergraduate Students

Estates at IT Sligo Ms Breege Fahy, School of Science

IT Services at IT Sligo O'Hehirs' Food Court

Dr Monica Sullivan, Environmental Services Ireland

## Thanks to ENVIRON 2015 Sponsors & Exhibitors

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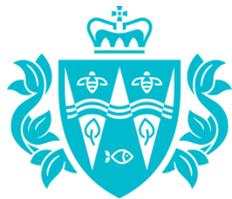
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UNIVERSITY  
OF DUBLIN**



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**DELEGATE INFORMATION**

**REGISTRATION**

The ENVIRON 2015 Registration Desk will be open at the following times

Wednesday April 8 <sup>th</sup>	1pm -8pm
Thursday April 9 <sup>th</sup>	8am- 6pm
Friday April 10 <sup>th</sup>	8.30am-1pm

All enquiries regarding the colloquium (including meals, finance, accommodation and social events) can be made at the Registration Desk. Check the registration area for notices and updates about events.

**Follow @environ2015 on Twitter for #ENVIRON2015 updates**

**DELEGATE BADGES**

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

**LOCATIONS**

Registration	Reception Area
Debate	A006
Conference Sessions	A004, A005, A006, E0011
Poster sessions and Exhibitors	Food Court
Tea/Coffee/Lunch	Food Court
Introduction to R Workshop	E 0028
Communications Workshop	B1201 (next to Food Court)

**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 is in the lower section of the Food Court. When you arrive at the registration desk please indicate that you have a poster for presentation we will direct you to the poster area.

Posters can be erected on Wednesday April 8<sup>th</sup> (13.00-17.00) or on Thursday morning, April 9<sup>th</sup> (8.00-11.00). All posters should be in place by 11.00 on Thursday, April 9<sup>th</sup>. Please do not remove posters until the end of the final poster session on Friday 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 in the Delegate Handbook). Your poster should be mounted on the poster board assigned to your ID. You are welcome to bring some A4 handouts of your poster to give away.

### **WIFI**

IT Sligo has Eduroam for those from other colleges. There will also be a temporary log-on available during Environ. This will be provided for you on signs in the conference zone.

### **TEA/COFFEE/LUNCH**

Teas/coffees at all breaks and lunch on Thursday and Friday will be available in the Food Court. Thursday lunch will be soup and sandwiches. On Friday, a brown-bag lunch will be available for all, which you can eat in IT Sligo or later when travelling.

### **ATM**

There is an ATM on campus situated on the main concourse close to the Food Court.

### **PARKING**

Free parking is available in the main car parks on campus. There are also two pay car parks, one on the main campus and one on the Clarion Road, close to the hotel.

### **LOCAL TRANSPORT**

There is a bus service downtown every 30 minutes from 7.40 am to 6.10pm.

Taxi services include:

John's Taxi	087 791 7480	McCarthy's Taxi	086 3888333
Starcabs	087 914 7777	Sligo Taxi Centre	087 914 8888
Sligo Taxis	086 1219111	The Fours Taxi	087 914 4444
Emerald Taxis	071 9148888	Feehily's Taxis	071 9143000

 <b>Environ 2015 Programme, Wednesday April 8<sup>th</sup></b> 	
<b>1:00 PM - 8:00 PM</b>	<b>Registration – Main Reception Area IT Sligo</b>
<b>Workshops</b>	
<b>2:00 PM – 5:00 PM</b>	<b>Introduction to the use of R in Environmental Statistics.</b> Facilitator: Dr. Coilin Minto, GMIT
<b>2:00 PM – 5:00 PM</b>	<b>Communicating Research.</b> Facilitators: Dr. Cara Augustenborg, Impact Research Management and Mr. David Dodd, DEHLG
<b>7:00 PM – 8:00 PM</b>	<b>Reception – Main Reception Area IT Sligo</b>
<b>8:00 PM – 10:00 PM</b>	<b>Panel Discussion: ‘Paying for our water: quality and quantity matter’</b> Followed by Q & A Session <b>Panel:</b> Jerry Grant (Head of Asset Management, Irish Water), Fiona Regan (Director of DCU Water Institute), Michael Ewing (Environmental Pillar Co-ordinator) and Michael Fitzmaurice (Independent TD for Roscommon-South Leitrim). <b>Chair:</b> Mr Austin O’Callaghan, Communications Manager, IT Sligo

<b>Environ 2015 Programme, Thursday April 9<sup>th</sup></b>	
<b>8:00 AM</b>	<b>Registration – Main Reception Area IT Sligo</b>
<b>9:15 AM- 9:30 AM</b>	<b>Opening of Environ 2015.</b> Professor Vincent Cunnane, President, IT Sligo and Dr. Tom Curran, Chairperson ESAI
<b>9:30 AM – 11:00 AM</b>	<b>Plenary Session &amp; Keynote Addresses: Speakers:</b> Dr. Richard Thorn (President Emeritus IT Sligo), Dr. Micheál Ó Cinnéide (EPA Director), Marianne Kettunen (Senior Policy Analyst, Institute for European Environmental Policy), Dr. Brian Motherway (CEO, Sustainable Energy Authority of Ireland), Chair: Professor Colin Brown (Director, Ryan Institute at NUI Galway)

<b>11:00 AM – 11:30 AM</b>	<b>Coffee; Poster Session 1 &amp; Meet the Exhibitors (Food Court)</b>			
<b>11:30 AM – 12:45 PM</b>	<b>Session 1(A004)</b> Biodiversity	<b>Session 2 (A005)</b> Marine and Coastal	<b>Session 3 (A006)</b> Climate Change	<b>Session 4 (E001)</b> Wastewater Management
<b>12:40 PM – 13:30 PM</b>	<b>Lunch (Food Court)</b>			
<b>13:00 PM – 2:00 PM</b>	<b>ESAI AGM (B1201)</b>			
<b>2:00 PM – 3:45 PM</b>	<b>Session 5 (A004)</b> Biodiversity	<b>Session 6 (A005)</b> Water Quality and Resources	<b>Session 7 (A006)</b> Energy	<b>Session 8 (E001)</b> Wastewater Management
<b>3:45 PM – 4:30 PM</b>	<b>Coffee; Poster: Session 2 &amp; Meet the Exhibitors (Food Court)</b>			
<b>4:30 PM – 6:30 PM</b>	<b>Session 9 (A004)</b> Invasive Species	<b>Session 10 (A005)</b> Water Quality and Resources	<b>Session 11 (A006)</b> Environment and Human Health	<b>Session 12 (E001)</b> Nanotechnology
<b>7:30 PM</b>	<b>Drinks Reception: Pegasus, Clarion Hotel</b>			
<b>8:30 PM</b>	<b>Conference Dinner: Pegasus, Clarion Hotel</b>			

<b>Environ 2015 Programme, Friday April 10th</b>				
<b>9:15 AM – 11:00 AM</b>	<b>Session 13 (A004)</b> Sustainability and Roads	<b>Session 14 (A005)</b> Sustainable Agriculture	<b>Session 15 (A006)</b> Environmental Policy and Communications	<b>Session 16 (E001)</b> Sustainability and Research Innovation
<b>11:00 AM – 11:45 AM</b>	<b>Coffee; Poster Session 3 &amp; Meet the Exhibitors (Food Court)</b>			
<b>11:45 AM – 1:15 PM</b>	<b>Session 17(A004)</b> Environmental socioeconomics	<b>Session 18 (A005)</b> Sustainable Agriculture	<b>Session 19 (A006)</b> Waste management	<b>Session 20 (E001)</b> Energy
<b>1:15 PM – 2:30 PM</b>	<b>Lunch, Prize Giving &amp; Close of Environ 2015 (Food Court)</b>			



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**BIOGRAPHIES:**

**QUESTIONS AND ANSWERS PANEL**

**PLENARY SESSION KEYNOTE SPEAKERS**

**WORKSHOP SESSIONS**

## Questions and Answers Panel



**Mr. Jerry Grant, Irish Water**

Jerry Grant joined Irish Water as Head of Asset Management. He was previously with the Irish Water Programme where he was the Business Lead for Strategic Planning and Capital Programmes. Prior to that Jerry was M.D. of RPS Consulting Engineers for 10 years. He has worked at the forefront of the water services sector in Ireland for 35 years. This has included responsibility for the development of strategic plans for and implementation of some of the largest projects in the greater Dublin area in conjunction with the Dublin Local Authorities.



**Mr. Michael Ewing, Irish Environmental Network** Michael Ewing graduated from Brunel University, England, in Applied Biology (B.Tech. Hons, 1976) (Vertebrate Physiology and Biochemistry). He achieved a First Class Honours Graduate Diploma in Environmental Protection (2002), and a Master of Science, First Class Honours (2003) at the Institute of Technology, Sligo. He also received the William Mason Medal achieving the highest marks in his year. The subject of his M.Sc. thesis was “Public Participation In Environmental Decision-Making”, at [www.gdrc.org/decision/participation-edm.html](http://www.gdrc.org/decision/participation-edm.html) He has worked as an environmental consultant, as a lecturer at the Institute of Technology, Sligo, and wrote course manuals for their post-graduate diploma in environmental protection. He trained with the Environment Council (UK) and then worked as a facilitator and dialogue planner. From 2006-2008 he worked as the Senior Researcher at the Centre for Sustainability at the IT Sligo, leading the research project, “Assessing Access to Information, Participation, and Justice in Environmental Decision-Making”. In 2008 he was employed by the Irish Environmental Network (IEN) to build the advocacy coalition that in 2009 became the Environmental Pillar. In 2010 he was given the additional role of Coordinator of the IEN. He is a member of the National Economic and Social Council since 2009.

**Professor Fiona Regan, Dublin City University**

Professor Fiona Regan is Associate Professor in Environmental Sensing at Dublin City University. She studied Environmental Science and Technology at the Institute of Technology in Sligo and after completing her PhD in analytical chemistry in 1994, and postdoctoral research in optical sensing in 1996 at DCU, she took up a lecturing position at Limerick Institute of Technology. In 2002 Fiona joined the School of Chemical Sciences, DCU, as a lecturer in analytical chemistry, in 2008 she became senior lecturer and in 2009 became the Beaufort Principal Investigator in Marine and Environmental Sensing. She established the Marine and Environmental Sensing Technology Hub (MESTECH), DCU in 2010. Fiona's research focuses on environmental monitoring using sensing and passive sampling. She has special interest in priority and emerging contaminants as well as the establishment of decision support tools for environmental monitoring using novel technologies and data management tools. Her work includes the areas of separations and sensors (including microfluidics), materials for sensing and antifouling applications on aquatic deployed systems. She serves on the editorial board of the Bulletin of Environmental Contamination and Toxicology (2013-present) and is Associate Editor with the RSCs Analytical Methods Journal. She is currently leading the establishment of the Water Institute at DCU.



**Mr. Michael Fitzmaurice, TD.** I am proud to say that my roots go deep into the soil of Ireland. I was born into a small farm in the parish of Glinsk / Creggs on the Roscommon / Galway border. I work this land and am fully acquainted with the difficulties and obstacles faced by small farmers everywhere. I am married to Maria and we have three young children. My greatest hope is that my children and yours will be Free to build decent lives for themselves here in the West of Ireland, should they choose to do so. I am probably best known to many people as Chairperson of the "Turf Cutters and Contractors Association"(TCCA). As part of the TCCA, I along with local communities everywhere have been working to retain the Right of the Irish People to "Cut their Own Turf, for their Own Use, in their own Bogs". I run an Agricultural and Turf Contracting business, which provides local employment on a seasonal and full-time basis. Small and medium enterprise provides the best hope of future prosperity in the countryside and in our rural towns. Our rural towns and villages have been neglected by successive governments. This neglect is evident in the removal of services, the loss of jobs and the lack of infrastructural investment in the surrounding countryside. Every job that is lost, is another son or daughter lost to the scourge of emigration, another family destroyed! A prosperous countryside needs the services of thriving towns. Thriving towns can only exist in a thriving countryside. We need each other. We must work together to build a prosperous future. Nobody else will do it for us. The politics of Division must end! Together, we are greater than the sum of our constituent parts.



### Chair of Q and A Session

#### **Austin O'Callaghan, Communication Manager IT Sligo**

Austin O'Callaghan is Communication Manager at IT Sligo. He is also a journalist with 20 years' experience in the media and broadcast industry. He previously worked as a Senior Broadcast Journalist with BBC Northern Ireland, Eurosport and EuroNews, and continues to freelance as sports reporter with BBC and RTÉ. A native of Sligo, he has a keen interest in environmental matters and is the current PRO of Sligo Tidy Towns.

### Communications in Science Workshop



**Dr. Cara Augustenborg** is Managing Director of an environmental research consultancy, Impact Research Management, and an occasional lecturer in climate change at University College Dublin. She is also on the Board of Directors of Friends of the Earth Ireland, the Irish Environmental Network, and the Environmental Sciences Association of Ireland, and she is the Climate Change Spokesperson for Ireland's Green Party. In 2007, Cara was selected as the Irish Ambassador for Ben & Jerry's™ Climate Change College and sent on a high-profile expedition of Arctic Alaska, where she documented and reported on the effects of climate change and honed her interest in science communication. She manages several EPA research projects as a consultant and specializes in proposal development for EU and national research funding opportunities.



**Mr. David Dodd** is a graduate of Trinity College Dublin in Environmental Science and also holds Certificate and Higher Diploma qualifications in noise and air quality related areas. He recently graduated with a Masters in Science Communication from Dublin City University. He spent 7 years working in environmental consultancy on air quality, noise, groundwater, waste and contaminated land projects. He was a scientific officer with the Environmental Protection Agency for 10 years in Wexford and Dublin working in the areas of waste prevention, persistent organic pollutants, air quality monitoring, air quality and climate change research and science communications activities. He recently joined the Department of Environment Community and Local Government as a scientific policy advisor.

## Plenary Session



**Professor Vincent Cunnane, President IT Sligo.** Professor Vincent Cunnane has been President of IT Sligo since October 2014. He is a native of Stranorlar in County Donegal and he has spent the majority of his career at the University of Limerick where he became the first Vice-President of Research in 2002. In 2008, he became Chief Executive Officer of Shannon Development, contributing significantly to regional development in the Shannon region. Prof Cunnane was also appointed Chief Executive of the Mid West Task Force set up by the Irish Government in January 2009 to bring new investment to the Shannon Region after the cessation of manufacturing by Dell Computers in Limerick. He is a former board member of Shannon Broadband Ltd, Shannon Castle Banquets & Heritage Ltd and the first National Research Support Fund Board. As Chair of the Joint Economic Development Committee of the Limerick City and County Development Boards, Prof Cunnane was appointed to the Limerick Reorganisation Implementation Group by the Minister of Environment & Local Government in July 2011 to merge the Limerick City and County Councils. He is currently (2009-2015) Chairman of the Governing Council of the Dublin Institute for Advanced Studies.



**Professor Colin Brown** is Director of the Ryan Institute for Environmental, Marine and Energy Research at NUI Galway, an inter-disciplinary research institute with over 300 researchers from science, engineering, social science and business and an annual budget of > €7m per annum. The Ryan Institute's research is organised through three special interest groups in Modelling and Observation, Biodiversity and Bioresources, and Economic and Social Impact. It has a commitment to international research collaboration, the educational mission of NUI Galway, and support for a regional, national and EU sustainable development agenda. It promotes innovation and translational research and engages widely with business, state agencies and civil society. Prof Brown's own research is in geophysical remote sensing. He uses ship-borne acoustic remote sensing in the oceans to infer seabed geological and biological processes, air-borne electromagnetic remote sensing to understand coastal groundwater-seawater interactions and satellite remote sensing to characterise ocean wave regime. He has 35 international publications, 1 patent for inferring seabed and sub-seabed physical properties from remotely-sensed seismic and acoustic data. He enjoys hill-walking and spends his spare time wandering over the Connemara hills and beyond.



**Dr. Richard Thorn** is a graduate of Trinity College Dublin (Bachelor degree in Natural Sciences in 1978 and a PhD in 1983) and the Institute of Public Administration (MA in Public Management, 2011). He has published over 200 articles in areas as diverse as earth and environmental sciences, management and strategy, higher education policy and planning and travel. He has been variously President of the Institute of Technology, Sligo, Head of Department of Environmental Sciences in IT Sligo, the first Head of the Castlebar Campus of Galway-Mayo Institute of Technology and, recently, was Project Manager for the first stage of the implementation of Ireland's Higher Education Strategy to 2030. He has chaired or been on the board of many not-for profit organisations and is a past President (2012-2014) and past National Diving Officer (2008) of the Irish Underwater Council – the national governing body for underwater sports, including scuba diving - in Ireland. He is Chairperson of the Board of Leave No Trace Ireland and, amongst other things, is currently working on a biography of the Institutes of Technology.



**Dr. Micheál Ó Cinnéide, Director, Environmental Protection Agency.** Micheál is a graduate of NUI Galway and Harvard Business School. He worked as a Director of Marine Environment Services with the Marine Institute, Galway; in the Department of the Marine as policy adviser, in the Irish aquaculture sector and in the Department of Foreign Affairs. Micheál joined the EPA in 2008. He served as Director in the Office of Environmental Assessment (OEA) for 3 years. The OEA has a lead role in water monitoring and coordination for the Water Framework Directive. In 2014, he completed a DBA at Waterford Institute of Technology, with a research focus on Social Learning and the Water Framework.



**Marianne Kettunen** is a Principal Policy Analyst at the Institute for European Environmental Policy (IEEP). She has over ten years of expertise in issues related to the EU and international biodiversity policy with special focus on assessing the socio-economic importance of biodiversity and ecosystem services and supporting the integration of these aspects into policies and decision-making processes. Among other things, Marianne has been an integral part of the Economics of Ecosystems and Biodiversity -initiative (TEEB), first coordinating the assessment of socio-economic benefits of protected areas to international and national policy-makers, and then leading a scoping assessment on the value of nature in the Nordic Countries (TEEB Nordic). She has also supported ecosystem service assessments for Finland and the Arctic region. Marianne has a long track record in outreach, policy influence and capacity building on the value of nature, ecosystem services and Green Economy. She is the lead editor of a practical guidance book on the socio-economic value of protected areas published in 2013 (Taylor&Francis/EarthScan).



**Dr Brian Motherway** was appointed Chief Executive of the Sustainable Energy Authority of Ireland in May 2012. SEAI is Ireland's national energy authority with a mission to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices. Brian was previously Chief Operations Officer and Head of Strategy at SEAI. He holds Bachelors and Masters degrees in Engineering and a PhD in Sociology.



**Dr C oil n 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. C oil n 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. C oil n is a full member of the International Biometric Society and a founding developer of the RAM Legacy Stock Assessment Database.

# Environ 2015

AN APPROVED EVENT FOR CONTINUOUS PROFESSIONAL DEVELOPMENT





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**ENVIRON 2015**

**ORAL AND POSTER PRESENTATION SCHEDULE**

**Oral Presentation Sessions (1-4): Thursday April 9<sup>th</sup>, 11.30-12.45**

<p><b>Session 1 Biodiversity A004</b></p>	<p><b>Session 2 Marine and Coastal A005</b></p>	<p><b>Session 3 Climate Change A006</b></p>	<p><b>Session 4 Wastewater Management E0011</b></p>
<p><i>Chair Dr. Brian Donlon, EPA</i></p>	<p><i>Chair Dr Aengus Parsons Marine Institute</i></p>	<p><i>Opening Chair Address</i>  <i>Dr Xuefeng Cui, Earth Institute, UCD</i></p>	<p><i>Opening Chair Address</i>  <i>J. Higgins, Veolia</i></p>
<p>A Simulated Population approach to estimating the value of achieving good ecological status in Irish water catchments <b>James Owens</b> NUIG</p>	<p>Sustainable management and beneficial use opportunities for marine dredged sediment <b>Sinead Tangney</b> CIT</p>	<p>Assessing cropland dynamics in Ireland using the Land-Parcel Identification System (LPIS) <b>Jesko Zimmerman</b> TCD</p>	<p>Implementing microbial fuel cells in constructed wetlands for enhanced wastewater treatment with simultaneous electricity generation <b>Liam Doherty</b> UCD</p>
<p>Is mite community structure a good indicator of soil biodiversity? <b>Tara Dirilgen</b> UCD</p>	<p>Intelligence in multi-modal wireless sensor network for marine environment monitoring <b>Dian Zhang</b> DCU</p>	<p>Soil carbon sequestration and storage potential of Irish grasslands <b>Gemma Torres</b> Teagasc</p>	<p>Anaerobic digestion of lipids: The effect of bioreactor design and addition of trace-elements <b>B. Conall Holohan</b> NUIG</p>
<p>Where are the rare birds; diversity, habitats and afforestation <b>Usna Keating</b> UCC</p>	<p>Opportunities for integrated management of Irish estuarine and coastal ecosystems within an emerging national marine policy landscape <b>Christina Kelly</b> QUB</p>	<p>Igniting new research; fire, vegetation and climate dynamics throughout the Holocene, within the Galty Mountains. <b>Donna Hawthorne</b> TCD</p>	<p>The effect of the wastewater treatment process, in particular UV treatment on pathogenic virus removal <b>Kelly Fitzhenry</b> NUIG</p>
<p>Retracing the history of Irish red squirrel (<i>Sciurus vulgaris</i>) <b>Denise O'Meara</b> WIT</p>	<p>The support team for the Atlantic Action Plan <b>Elizabeth O'Reilly</b> NUIG</p>	<p>Environmental lifecycle assessment of dairy products manufactured in the Republic of Ireland <b>William Finnegan</b> NUIG</p>	<p>Energy Benchmarking in Wastewater Collection and Treatment <b>Donald Cronin</b> Cork County Council</p>
<p><b>Poster Oral Presentations</b> <b>E Panter B2; E Dix B3; E Johnston B4; K Fisher B8; S Culhane B10</b></p>	<p><b>Poster Oral Presentations</b> <b>B Heery MC5</b></p>	<p><b>Poster Oral Presentations</b> <b>T Diniz Oliveira CC3</b></p>	<p><b>Poster Oral Presentations</b> <b>R Brennan WW2</b></p>

**Oral Presentation Sessions (5-8): Thursday, April 9<sup>th</sup>, 14.00-15.45**

<b>Session 5 Biodiversity AOO4</b>	<b>Session 6 Water Quality and Resources AOO5</b>	<b>Session 7 Energy AOO6</b>	<b>Session 8 Wastewater Management EOO11</b>
<i>Chair: Dr. M. Broaders IT Sligo</i>	<i>Chair: Dr. Frances Lucy IT Sligo</i>	<i>Chair: Dr. Tom Curran ESAI&amp;UCD</i>	<i>Chair: Dr. Paul Bolger UCC</i>
Non-invasive genetic tests for identification of bat species of Ireland and Great Britain  <b>Andrew Harrington</b> Waterford City and County Council	Overview of Developments in Earth Observation  <b>Colin Browne</b> Ryan Institute NUIG	Potential energy generation from the biogas transformation of poultry slaughterhouse by-products  <b>Aidan Ware</b> CIT	Use of constructed wetlands to treat alkaline leachates  <b>Derek Higgins</b> UL
Influence of multiple stressors on marine sediment microbial communities.  <b>Ciara Murphy</b> UCD	A novel analytical protocol for the detection of E. coli in environmental water samples using $\beta$ -D-Glucuronidase  <b>Ciprian Briciu-Burghina</b> DCU	Achieving 'Net Zero Energy' performance through retrofitting of residential buildings in Ireland  <b>Alan Costello</b> CIT	Key Performance Indicators for wastewater treatment: help or hindrance?  <b>Edelle Doherty</b> NUIG
Scots Pine: A native Irish tree?  <b>Alwynne McGeever</b> TCD	Emission of pharmaceuticals in the environment: an Irish perspective  <b>Favio Bacci</b> UCC	The use of an optical fibre sensing structure based on a palladium alloy for the design of a robust hydrogen sensor  <b>Fionn Downes</b> IT Sligo	Development of a stakeholder-based sustainable optimisation indicator system for urban wastewater treatment plants in Ireland  <b>Glen Gordon</b> IT Sligo
Chemotaxonomy of microalgae isolated from the west coast of Ireland <b>Donal McGee</b> IT Sligo	Sediment transport modelling on the River Bandon  <b>John Gamble</b> CIT	The impact of meteorological and geographic variations on the heat demand of an Irish passive house <b>Evan Finegan</b> CIT	Treatment of dairy processing effluent using IASBR Technology  <b>Emma Tarpey</b> NUIG
What do we really need to know about health benefits from biodiversity?  <b>Caitriona Carlin</b> NUIG	Determination of faecal pollution of beach sand of Dublin Bay beaches  <b>Uxia Sierira Novoa</b> UCD	Outputs of the Forest Energy 2010 – 2014 Programme  <b>Enda Coates</b> WIT	Impact of the Landfill Directive (1999/31/EC) on the concentrations, volumes and treatability of landfill leachate produced in Ireland <b>Raymond Brennan</b> NUIG

<b>Thursday, April 9<sup>th</sup>, 14.00-15.45 CONTINUED</b>			
<b>Biodiversity</b>	<b>Water Quality and Resources</b>	<b>Energy</b>	<b>Wastewater Management</b>
<p>Competition between <i>Lemna minuta</i> and <i>Lemna minor</i> under different resources availability and under different temperatures</p> <p><b>Simona Paolacci UCC</b></p>	<p>Optimization of non-thermal plasma treated textile waste water using RSM in R</p> <p><b>Chaitanya Sarangapani</b></p> <hr/> <p><b>Poster Oral Presentations</b></p> <p><b>W Roberts WQ10</b>  <b>C Sarangapani WQ2</b>  <b>S Gul WQ12</b>  <b>M Radomski WQ7</b>  <b>T Passos WQ9</b>  <b>E Murray WQ4</b>  <b>E Murray WQ5</b>  <b>L Kavanagh WQ6</b></p>	<p>The EU Power System in 2030: Investigating electricity sector challenges</p> <p><b>Sean Collins UCC</b></p>	<p>Remote Sensing of Grasslands Sprayed With Slurry</p> <p><b>Ross Donnelly-Swift UCD</b></p>

**Oral Presentation Sessions (9-12): Thursday April 9<sup>th</sup>, 16.30-18.30**

<b>Session 9</b> <b>Invasive Species</b> <b>AOO4</b>	<b>Session 10</b> <b>Water Quality and Resources</b> <b>AOO5</b>	<b>Session 11</b> <b>Environment and Human Health</b> <b>AOO6</b>	<b>Session 12</b> <b>Nanotechnology</b> <b>EOO11</b>
<p><i>Chair</i> <i>Dr. Joe Caffrey</i></p>	<p><i>Chair</i> <i>Dr. Billy Fitzgerald</i></p>	<p><i>Chair</i> <i>Dr. M. Prendergast, NUI Galway</i></p>	<p><i>Chair</i> <i>Prof. S. Pillai, IT Sligo</i></p>
<p>Pushing the limits? An invasive species at its southern European range limit</p> <p><b>Mary Catherine Gallagher</b> UCC</p>	<p>Exposure to arsenic from groundwater in Ireland: a geostatistical based approach</p> <p><b>Ellen McGrory</b> NUIG</p>	<p>Detection of antibiotic resistant <i>E. coli</i> and antibiotic resistance determinants in drinking-water sources</p> <p><b>Siobhan Kavanagh</b> NUIG</p>	<p>Gold Catalysts for CO-free hydrogen production from formic acid derived from biomass. Effects of support and doping by potassium carbonate</p> <p><b>Monika Zacharska</b> UL</p>
<p>The arrival of the invasive kelp species <i>Undaria pinnatifida</i> in Irish coastal waters: Here to stay?</p> <p><b>James Murphy</b> NUIG</p>	<p>The macroinvertebrate communities of forested headwater streams in Ireland with contrasting aquatic buffer zones</p> <p><b>Cormac Mc Conigley</b> UCD</p>	<p>Investigating the contaminant concentration in various tissues of crustaceans fished and landed in Ireland</p> <p><b>Caoimhin O’Corrain</b> GMIT</p>	<p>Exploring the effect of nanomaterials on soil nitrogen cycling microbial communities</p> <p><b>Conor McGee</b> UCD</p>
<p>Prevention is better than cure: the case for aquatic invasive species control</p> <p><b>Rory Sheehan</b> IT Sligo</p>	<p>An Irish catchment study of emerging contaminant occurrence using passive sampling</p> <p><b>Lisa Jones</b> DCU</p>	<p>Biosand filters: Influence of filter media on biolayer development and filter efficiency</p> <p><b>Greg Beechinor</b> UCC</p>	<p>A role for diatoms in decontamination of pollutants and environmental applications</p> <p><b>Yvonne Lang</b> NUIG</p>
<p>Can microclimates within the plumage of mallard ducks (<i>Anas platyrhynchos</i>) facilitate the spread of invasive <i>Lemna minor</i></p> <p><b>Neil Coughlan</b> UCC</p>	<p>Re-engineering the simple sand filter to remove emerging contaminants from water supplies</p> <p><b>Maebh Grace</b> NUIG</p>	<p>Sustainable health systems</p> <p><b>Michelle O’Dowd Lohan</b> NUIG</p>	<p>High temperature stable anatase TiO<sub>2</sub> photocatalysts using simple source precursors</p> <p><b>Rachel Fagan</b> DIT</p>

<b>Thursday April 9<sup>th</sup>, 16.30-18.30 CONTINUED</b>			
<b>Invasive Species</b>	<b>Water Quality and Resources</b>	<b>Environment and Human Health</b>	<b>Nanotechnology</b>
An investigation into acoustic detection of <i>Lagarosiphon major</i> (Ridley) in an Irish lake <b>Helen Moran</b> IT Sligo	Monitoring of faecal indicator bacteria in streams and sediments in a rural agricultural catchment <b>Lyubov Bragina</b> DKIT	A quantitative risk assessment for heavy metals in drinking water <b>Rachael Clarke</b> UCD	Synthesis of graphene-reinforced silica aerogels for thermal insulation applications <b>Saoirse Dervin</b> IT Sligo
Ecological characteristics of standing waterbodies invaded by alien macrophytes <b>Darren Reidy</b> UCC	The toxicity of agricultural herbicide, fungicide and insecticide on the submerged aquatic macrophyte <i>Myriophyllum aquaticum</i> <b>Louise Esmonde</b> TCD	Effects of community bacterial strain inoculants from <i>Sphagnum</i> moss on the biocontrol of <i>Salmonella</i> and <i>Staphylococcus aureus</i> on alfalfa sprouts <b>Lisa Connole</b> LIT	Synthesis of titanium dioxide nanomaterials for environmental applications <b>Ciara Byrne</b> IT Sligo
Non-target effects of Virkon® Aquatic <b>Jennifer Barbour</b> QUB	A graphene-copper composite as an anti-bacterial agent for potential water treatment applications <b>Declan McGlade</b> DCU	The influence of environmental factors on phlorotannin profiles of commercially valuable Irish brown seaweeds <b>Dara Kirke</b> NUIG	Exploring the spatial patterns of magnetic susceptibility and metal contamination of soils of an urban bonfire. <b>Nessa Golden</b> NUIG
Biological Control of the Invasive Leaf Beetle Pest, <i>Paropsisterma selmani</i> of Eucalyptus Crops in Ireland <b>Dorothy Hayden</b> UCD		Analysis of iodine in <i>Fucus serratus</i> seaweed bathwater. <b>Tarha Westby</b> IT SLIGO	Photocatalytic air remediation and its limits <b>Michaela Jakubickova</b> Technical University of Liberec
<b>Poster Oral Presentations</b> <b>Laverty IS1; K Green IS3; P Quinn IS4</b>		<b>Poster Oral Presentations</b> <b>S Kavanagh EH4; K Lucanova EH2</b>	<b>Poster Oral Presentations</b> <b>A Barrett N1; O Madden N4; I Murray N</b>

**Oral Presentation Sessions (13-16): Friday, April 10<sup>th</sup> 9.15 - 11:00**

<p><b>Session 13</b> <b>Sustainability and Roads</b>  <b>AOO4</b></p>	<p><b>Session 14</b> <b>Sustainable Agriculture</b>  <b>AOO5</b></p>	<p><b>Session 15</b> <b>Environmental Policy and Communications</b>  <b>AOO6</b></p>	<p><b>Session 16</b> <b>Sustainability and Research Innovation</b>  <b>E0011</b></p>
<p><i>Opening Chair Address</i> <i>Dr. Vincent O'Malley, NRA</i></p>	<p><i>Chair</i> <i>Dr. John Finn, Teagasc</i></p>	<p><i>Chair</i> <i>Dr. David Dodd, DEHLG</i></p>	<p><i>Chair</i> <i>Dr. John Bartlett, IT Sligo</i></p>
<p>Identification, treatment and control of invasive, non-native plant species on Irish national roads: Phase 1  <b>Frances Giaquinto</b> NRA</p>	<p>The sustainable management of priority farmland habitats on the Aran Islands  <b>Louise Duignan</b> IT Sligo</p>	<p>Soil status and protection in Ireland: collating knowledge, discovering gaps and engaging stakeholders  <b>Francesca Bampa</b> Teagasc</p>	<p>Assessing the efficacy of Dublin City Council's Fat, Oil and Grease (FOG) Programme through the quantification of FOG waste recovered  <b>David Gibbons</b> UCD</p>
<p>The incorporation of sustainable drainage systems into the National Road Authority's drainage Standards for major Projects  <b>Christian Nea</b> NRA</p>	<p>Development of a nature value index for pastoral farmland – a rapid farm-level assessment  <b>Margaret Hayes</b> NUIG</p>	<p>Relay Risk: Examining the communication of environmental risk through a case study of domestic wastewater treatment systems in the Republic of Ireland  <b>Catherine Devitt</b> UCD</p>	<p>Insights on the antioxidant properties Of microalgae isolated from the Northwest of Ireland  <b>Lorraine Archer</b> IT Sligo</p>
<p>Ultra high performance fibre reinforced concrete for infrastructure construction  <b>William Wilson</b> IT Sligo</p>	<p>Typology of High Nature Value farmland in a Northern Atlantic pastoral landscape  <b>Pamela Boyle</b> IT Sligo</p>	<p>Communities of behaviour change and the meaning of practice: The example of the transition towns movement  <b>Paul O'Connor</b> UCC</p>	<p>Evaluation of the impacts of the EPA 2007 Infrastructure Awards  <b>Abigail Murphy</b> EPA</p>

<b>Friday, April 10<sup>th</sup> 9.15 - 11:00 CONTINUED</b>			
<b>Session 13 Sustainability and Roads</b>	<b>Session 14 Sustainable Agriculture</b>	<b>Session 15 Environmental Policy and Communications</b>	<b>Session 16 Sustainability and Research Innovation</b>
A prediction of the impact of the Dublin Port Tunnel on air pollution emissions, air quality and health  <b>Jiaya Tang</b> TCD	National distribution and descriptive typology of farmland of High Nature Value (HNV)  <b>Caroline Sullivan</b> IT Sligo	How are green infrastructure policies and plans implemented in the historic, urban core?  <b>Macdara Carroll</b> DIT	Mobility biographies and milestones: lessons for sustainable transport in Ireland  <b>Richard Manton</b> NUIG
Common Air Pollutant Projections from the Irish Road Transport Sector under the Emissions Celling Directive (NECD) and Convention on Long-range Trans boundary Air Pollution (CLRTAP): A preliminary Analysis for 2035  <b>Aonghus McNabola</b> TCD	Using Geographical Information Systems to screen Natura 2000 sites against atmospheric ammonia.  <b>David Kelleghan</b> UCD	Scoping land-use policy concerns in Ireland  <b>Tamara Hochstrasser</b> UCD	Use of <i>Sphagnum</i> moss as a New Growth Medium in Advanced Life Support (ALS) Systems  <b>Michelle McKeon-Bennett</b> LIT
		Science and politics and their views on climate change adaptation in the agricultural sectors of four EU Member States  <b>Irene Bullmer</b> UCD	Genetic manipulation of Irish marine cyanobacteria for overproduction of UV-screening compounds, mycosporine-like amino acids (MAAs).  <b>Norma Browne</b> LIT
The Installation of Mammal Mitigation Measures on National Road Schemes in Ireland – an Evaluation of 5 Motorway Projects  <b>Eugene Finnerty</b> UCC	<b>Poster Oral Presentations</b> <b>J Finn</b> SA2;  <b>J Graca</b> SA1  <b>J Carlier</b> SA6		<b>Poster Oral Presentations</b> <b>T Singleton</b> SI7 <b>J Kaur</b> SI2; <b>K McPhillips</b> SI3; <b>M Gavin</b> SI4; <b>M Gavin</b> SI5; <b>M Gavin</b> SI6

**Oral Presentation Sessions (13-16): Friday, April 10<sup>th</sup> 11.45 – 1.15**

<b>Session 17 Environmental Socioeconomics AOO4</b>	<b>Session 18 Sustainable Agriculture AOO5</b>	<b>Session 19 Waste Management AOO6</b>	<b>Session 20 Energy EOO11</b>
<i>Opening Chair Address Dr. Stephen Hynes, NUIG</i>	<i>Chair: Dr. James Moran</i>	<i>Chair: Dr. Ann-Marie Duddy</i>	<i>Chair: Dr. Brian McCann</i>
Economic Impacts of Angling Events in Ireland <b>Paul O’ Reilly</b> IFI	The Intergenerational Transfer of the Irish Family Farm: Underestimating the Importance of Symbolic Capital <b>Shane Conway</b> NUIG	The use of bioassays to assess the effect of different rehabilitation strategies on biological properties of bauxite residue <b>Gerard Finnegan</b> NUIG	The influence of metal selection for catalysts employed to hydrogenate biomass derived chemicals <b>Áine O’Driscoll</b> UL
Efficiency in Irish Nephrops fisheries <b>Ben Breen</b> NUIG	The application of functional soil management to support sustainable intensification on Irish farms <b>Cait Coyle</b> IT Sligo	Identification, characterisation and comparison of bacterial xylanases for industrial applications <b>Jessica Coyne</b> DKIT	Methane to methanol – A renewable solution for alternative fuels <b>Barbara Schaller</b> UL
Using contingent valuation and value transfer to estimate the value of achieving Good Environmental Status under the MSFD in EU Atlantic states. <b>Daniel Norton</b> NUIG	The spatial and temporal variation of ambient atmospheric ammonia concentrations in Ireland <b>Brian Doyle</b> UCD	Comparing the resource efficiency practices of large-scale building projects to small-scale building projects on selected case studies in Ireland <b>Jan Gottsche</b> GMIT	The effect of vehicle efficiency improvements and electric vehicle penetration on the energy sector in Ireland <b>Eamonn Mulholland</b> UCC
The importance of a robust and transparent methodology in determining materiality for corporate sustainability reporting <b>Ruth Hegarty</b> IT Sligo	Effects of lime application on the active soil microbial community during a barley growing season <b>Camilla Thorn</b> NUIG	Methane yields and assessment of pathogen removal via co-digestion of pig manure and food waste <b>Conor Dennehy</b> NUIG	Overcoming the Barriers to SME Engagement in the Smart Grid Market in Ireland <b>Margaret Tallott</b> Údaras na Gaeltachta
<b>Friday, April 10<sup>th</sup> 11.45 - 1:15</b>	<b>CONTINUED</b>		

<b>Environmental Socioeconomics</b>	<b>Sustainable Agriculture</b>	<b>Waste Management</b>	<b>Energy</b>
<p>Sustainable planning for the Environmental Impacts of Tourism in Ireland: A Local Authority Perspective</p> <p><b>Emmet McLoughlin</b> IT Sligo</p>	<p>Assessment of novel ι-carrageenan hydrogel blends as environmentally friendly seed coating agents for durum wheat seeds</p> <p><b>Maya Hotta</b> AIT</p>	<p>Comparison of composting and vermicomposting as compost maturation treatments – effect on end product quality and plant growth parameters</p> <p><b>Tara Duggan</b> UCC</p>	<p><b>Poster Oral Presentations</b></p> <p><b>J Desmond E4</b></p> <p><b>M Gavin E5</b></p>
<p><b>Poster Oral Presentation</b></p> <p><b>S van Osch ES2; D Morris ES1</b></p>		<p><b>Poster Oral Presentation</b></p> <p><b>J Cruz WM1; Y Jiang WM5; T Wallace WM4; C Finnegan WM2</b></p>	
<b>AWARDS AT LUNCH</b>		<b>PLEASE STAY!</b>	



# nviron 2015

**Institute of Technology, Sligo**

**April 8<sup>th</sup> to 10<sup>th</sup> 2015**

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**ABSTRACTS ORAL PRESENTATIONS**

## 1. Restoring plant species richness and forage quality to hay meadows on the River Shannon Callows

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The Shannon Callows, from the Irish *caladh* meaning river meadow, is one of the last unregulated floodplains remaining in western Europe. In terms of farming practices, the floodplain is managed as pasture or for hay. The hay-meadows, which comprise approximately a third of the callows, are mown annually, support a diversity of plant species and provide valuable forage resource for farmers. The callows are designated as Special Area of Conservation (SAC) due to the extensive areas of two Annex I semi-natural grassland habitats listed in the EU Habitats Directive: Lowland hay meadows and *Molinia* meadows. Due to a combination of unprecedented flooding and other management issues over the last decade, mowing has become infrequent. This has led to an increased abundance of the competitive tall forb *Filipendula ulmaria*, a decline in plant species richness and a reduction in hay value on affected meadows. In order to maintain the hay-cutting tradition, solutions are required to restore the conservation status and hay quality of the meadows through reducing the dominance of *F. ulmaria*. This research addresses the restoration of the meadows by experimentally testing the effectiveness of different hay-cutting treatments. Three treatments are being compared; one summer cut (control), two summer cuts (July & September), two summer cuts plus strewing green hay. The first treatments were applied in summer 2013 and were repeated in 2014. Relevés and biomass samples were taken before the treatments were carried out in 2013, forming the base-line data. Field sampling is currently being repeated annually to monitor changes in vegetation composition. Initial data demonstrate the base-line differences in vegetation and other variables between sites, while data from the second year already show varying changes in vegetation composition over the five study sites in relation to the treatments.

**Keywords:** species-richness, hay quality, low-intensity farming, meadow restoration

## 2. Is mite community structure a good indicator of soil biodiversity?

Tara Dirilgen<sup>1</sup>, Julio Arroyo<sup>1</sup>, Wim J. Dimmers<sup>2</sup>, Jack Faber<sup>2</sup>, Dorothy Stone<sup>3</sup>, Rachel E. Creamer<sup>3</sup>, Jose-Paulo Sousa<sup>4</sup>, Rüdiger Schmelz<sup>5</sup>, Bryan Griffiths<sup>6</sup>, Romeu Francisco<sup>4</sup>, Thomas Bolger<sup>1</sup>

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The sustainable use of soils requires the protection of soil biodiversity because of its importance in the delivery of ecosystems services. However, no effective indicator exists which would allow assessment of the current state of biodiversity. This study, which is a component of the EU EcoFINDERS project, examines the use of Acari (mites) as a possible biological indicator of soil biodiversity. Thirty-six sites were sampled across 10 European countries spanning four biogeographical regions (Alpine, Atlantic, Continental and Mediterranean) and 3 land-uses for both biotic and abiotic variables. Results show a significant effect of biogeographic region on mite communities; in particular, the Mediterranean region has a rather distinct composition. Land use also has an effect on mite community composition. Cross-taxon congruence among soil taxa was variable and generally weak and there was little similarity between the patterns of variation in mite community structure and those of other taxonomic groups. There was also variation in the indicator values of individual sub-orders. Mesostigmata were correlated with soil microbial activity, as assessed using Multiple Substrate Induced Respiration, and Prostigmata were correlated with Collembola. Overall, our results do not support the use of single taxonomic groups as indicators of soil biodiversity in below-ground terrestrial ecosystems.

**Keywords:** mites, biodiversity, cross-taxon congruence

### 3. Where are the birds of open habitats? Abundance, diversity and afforestation

Usna Keating<sup>1</sup>, Ilse Corkery<sup>1</sup>, John Lusby<sup>2</sup>, Sandra Irwin<sup>1</sup>, John Quinn<sup>1</sup>, John O'Halloran<sup>1</sup>

<sup>1</sup>School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland

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Forests occupy approximately 11% of land cover in Ireland and current government policy aims to increase forest cover to 18% of land cover by 2046. In Ireland, the conservation of threatened habitats and species is required by European law. Thus, sustainable forest expansion that is compatible with conservation requires support from scientific research. Negative impacts of afforestation on biodiversity have previously been reported, with evidence that impacts vary with preceding habitat or land use. This study investigates how plantation forests impact upon bird diversity in adjacent open habitats. Using GIS, 47 regions throughout the Republic of Ireland were chosen to represent four habitat types: improved grassland, wet grassland, raised bog and blanket bog. Over 30 km of transects were surveyed in each habitat type and all species of birds seen and heard within 100 m were recorded. The bird communities recorded in blanket bog were most similar to communities in raised bog, while communities in the two grassland habitats were also most similar to each other. The lowest bird density was recorded in blanket bog habitat. However, both bog habitats tended to have higher densities of birds of conservation concern than either improved or wet grassland habitats. The observed impact of plantation forest proximity on key open habitat bird species are discussed for the selected habitats. The findings of this study can be used to identify suitable areas for future afforestation with respect to Ireland's commitments to conserving rare habitats and species and therefore to guide sustainable development of the forest sector.

**Keywords:** birds, diversity, habitat, forestry, afforestation, open habitat, edge effects

#### 4. Retracing the history of Irish red squirrel (*Sciurus vulgaris*)

Denise O'Meara, Andrew Harrington, David O'Neill, Peter Turner, Catherine O'Reilly

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There are two species of squirrel in Ireland, the native Eurasian red squirrel (*Sciurus vulgaris*) and the invasive North American grey squirrel (*Sciurus carolinensis*), introduced in 1911. The red squirrel is believed to have been historically present in Ireland but was likely driven to extinction in the 16<sup>th</sup> Century. Historical records show that the red squirrel was reintroduced throughout the 19<sup>th</sup> Century, mostly using stock from Great Britain, but some were likely of Continental European origin. Using hair-tubes and innovative DNA techniques (qPCR, microsatellite and mtDNA analyses), we show that contemporary and historical insights into the red squirrel population can be revealed using DNA extracted from squirrel hair. Our results confirm historical and previously published data that the Irish red squirrel population exhibits British and Central European ancestry. While the population overall exhibits high levels of genetic diversity and variability; at a local level this diversity is quite low likely as a result of the small number of founding individuals introduced from multiple locations across a fragmented landscape, thus preventing population mixing. Such information is important for population monitoring and reintroduction programs to prevent problems associated with inbreeding, outbreeding, local scale extinctions and the conservation of genetic heritage. Due to the non-invasive nature of the survey technique, which does not require trapping or direct handling of the animal, the strategy is useful for red squirrel groups relying on volunteer effort.

**Keywords:** Sciuridae, conservation genetics, historical introductions, population monitoring

## **5. Sustainable Management and Beneficial Use Opportunities for Marine Dredged Sediment**

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Dredging is essential to maintain navigational access to ports and harbours. In Ireland approximately 1.2 million wet tonnes of dredge sediment is generated annually with the majority disposed at sea. This paper investigates the technical and economic feasibility and social acceptability of a range of specific beneficial uses of marine sediments across North West Europe with the multi-partner project funded under the EU Interreg Civil Engineering Applications of Marine Sediments (CEAMaS) project. Surveys and structured interviews have been undertaken with industry stakeholders. Survey results have quantified the current volumes of dredge sediment generated in Ireland with specific project data including sediment characteristics, sediment volumes generated and sediment management practices. Disposal at sea was practiced for over 85% of sediment generated for the projects surveyed. Structured stakeholder interviews have provided an understanding of attitudes towards various sediment management practices and the challenges faced. Relevant information is presented in a database format. Sediment samples from a range of locations across partner countries were gathered and tested for physical and chemical characteristics; site locations included the Port of Cork, Bantry Harbour, Port of Dunkirk, France, Amoras, Belgium and Lift Up Lowlands project, The Netherlands. The sediment quality results have been compared to Irish, French, Flemish and Dutch National Standards for disposal at sea and different beneficial uses to allow identification of potential management options. The chemical results show some sediment contaminant values exceeding the national standard limits. The Irish sediment contaminant levels were below the upper limits indicating the potential for some beneficial use. Site specific data is currently being applied to analyse the economic and environmental feasibility of implementing different sediment management options, e.g. wetland habitat creation, beach nourishment.

**Keywords:** Dredging, Marine Sediment, Material Management, Beneficial Use

## 6. Intelligence in multi-modal wireless sensor network for marine environment monitoring

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According to the Integrated Marine Plan for Ireland 2012, the Irish ocean economy will generate €6.4 billion a year in turnover by 2020, contribute 2.4% of GDP by 2030, and support approximately 1% of the total workforce. In Ireland, 99.5% of foreign trade is facilitated through seaports, of which 42 percent of the gross domestic product (GDP) is exported through Dublin Port. These increasing exploited resources need to be monitored, managed and protected efficiently and effectively. Modern marine environmental sensing technologies, such as autonomous Wireless Sensor Networks (WSNs), provide the capability to meet these challenges of high spatial and temporal scales. In recent years, the development of sensing technology is reaching a maturational stage in terms of cost and accuracy, which enables the opportunity to monitor large geographical areas with high temporal frequency. However, significant amount of data generated from *in situ* sensor networks incapacitates manual analysis. These multitudinous data need to be automatically processed, indexed and catalogued in a smarter way that can be easier understood, accessed and managed by operators, scientists and policy makers. Moreover, current research works show that WSNs have their own limitations, for example reliability issues, passive systems and context-less data. The aim of this work is to fill the gap between current aquatic monitoring systems and futuristic ideal large-scale multi-modality smart sensing networks for marine environmental monitoring. To illustrate this, we proposed our vision of such smart sensing system, showing two case studies of automated data processing from *in situ* measurements, *in situ* data processing stream, and from camera-based visual sensing data and visual data processing stream. Ultimately, we combine abnormal events detection results from *in situ* sensor and shipping traffic detection from visual sensor to illustrate the benefit of coupling multiple sensing modalities. Both case studies demonstrate how state-of-the-art computing science technologies can be applied to the marine environment monitoring domain to provide next generation information that support marine scientists and policy makers in better understanding marine ecosystems and to allow well informed decision making.

**Keywords:** intelligence, wireless sensor network, marine environment monitoring

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## **7. Opportunities for integrated management of Irish estuarine and coastal ecosystems within an emerging national marine policy landscape**

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Estuaries are rich in biodiversity and are important in the provision of goods and services. These include the provision of food and raw materials, cultural services, climate regulation, flood protection and nutrient cycling. Consequently, estuarine and coastal areas tend to be attractive to human settlement. However, unmanaged human activity can lead to conflict and degradation of natural systems. Given that estuaries are favoured sites for urban, port and industrial activities, as well as the anthropogenic pressures emanating from the catchment and marine environment, estuaries tend to be under more pressure than other ecosystems. This makes effective estuarine management a complex task as it must address a wide range of issues including water quality, spatial management and resource use. IMMERSE is a doctoral research project established to develop an Integrated Environmental Management and Monitoring system (EMMS) for Irish estuarine and coastal ecosystems. Stage 1 of the project involves developing a proposed framework of integrated environmental management based on a set of devised principles of good practice and international case studies. In stage 2 this framework will be piloted in two case study areas: the Shannon Estuary and Dublin Bay in consultation with local stakeholders. This will be the main empirical investigation stage of the project. Stage 3 of the project will involve reviewing the outcomes of the case studies, refining the framework and finalising an Environmental Management and Monitoring System template for the adoption of integrated estuary management across Ireland. The project will, in turn, adhere to a number of EU Directives (WFD, MSFD, Floods, Natura 2000) and will make a major contribution to developing Irish marine and coastal policy where currently there is no over-arching national policy. The development of good practice guidelines is likely to be relevant to other jurisdictions and practitioners.

**Keywords:** estuary, coastal, marine, integrated management, ecosystem, governance

## **8. The support team for the atlantic action plan**

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The Strategy for the Atlantic Ocean area was launched by the Commission on 21 November 2011 to identify key challenges and opportunities to create sustainable jobs and growth. Following a consultation process, priorities were established in the Atlantic Action Plan and adopted by the Commission in May 2013. The Action Plan does not have a dedicated budget but the European Commission has set up the **Support Team for the Atlantic Action Plan** to provide guidance and proactive support to public and private organisations, research institutions and investors. The support team is operating through five “focal points” based in all the countries covered by the Atlantic Strategy (France, Ireland, Portugal, Spain and the UK). The Socio-Economic Marine Research Unit (SEMURU) has been appointed as Focal Point Ireland. Through this role Focal Point Ireland is working to disseminate information on the Action Plan, its research and investment priorities and possible funding tools. It also provides a “match-making platform” to bring potential project partners together, and advise them on the use of EU financial instruments for projects implementing the Action Plan, including those by the European Investment Bank (EIB), or any other public or private funding channels at European, national and regional/local level. The support team is acting as the “one-stop-shop” for stakeholders interested in operating in the fields covered by the plan and providing an important role in the implementation of the Atlantic Action Plan.

**Keywords:** Atlantic Strategy, marine policy, marine funding

## 9. Assessing cropland dynamics in Ireland using the Land-Parcel Identification System (LPIS)

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Carbon dynamics linked to shifts in croplands and grasslands are considered a major factor in the global Greenhouse Gas (GHG) budget. While the effects of cropland dynamics on the GHG budget are well studied, assessing land-use change at a national level is subject to uncertainty. In order to improve reporting, countries are starting to shift from national statistical datasets to high resolution spatial data, such as the Land-Parcel Identification Systems (LPIS) within the European Union (EU). In the present case study we analysed national LPIS data for the Republic of Ireland (years 2000 to 2012) looking specifically at cropland dynamics to assess (i) the improvement in overall land-use assessment when using high-resolution spatial datasets, and (ii) the potential uncertainty introduced due to limitations of the LPIS using the example of fallow/setaside land. Currently, fallow/setaside is not eligible for subsidies under EU law. Therefore it may not be reported in national LPIS datasets. According to the IPCC best practice guidance for LULUC reporting such temporary land-uses should however be reported as cropland if returning to such within five years. This discrepancy may potentially lead to a significant underestimation of annual cropland and land exiting cropland annually. The analysis revealed that even though the annual cropland area in Ireland is relatively stable ( $3752.3 \pm 542.3 \text{ km}^2$ ) croplands are subject to ongoing dynamics, with the total area having been cropland at some stage in the 12 year timeframe being twice as large ( $7373.4 \text{ km}^2$ ). A detailed analysis showed that this dynamic is caused by constant shifts between croplands and non-croplands rather than permanent land-use change. Furthermore, it could be shown that a large proportion ( $69.8 \pm 10.7\%$ ) of parcels leaving cropland each year will return within the next five years and should therefore be considered cropland under IPCC reporting regulations.

**Keywords:** Greenhouse gas emissions, land-use, land-use change, climate change, agriculture

## 10. Soil carbon sequestration and storage potential of Irish grasslands

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Capture and storage of soil organic matter (SOM) enhances soil quality and helps to mitigate climate change. Through aggregation, SOM becomes unavailable to soil microorganisms, thus preventing its mineralisation and subsequent CO<sub>2</sub> emissions to the atmosphere. Smaller aggregate sizes have greater protection potential. Forty grassland sites were selected as being a representative selection of the eight main soil types in Ireland, which cover 70% of the total land based upon the Irish Soil Information System. For each horizon, 1 kg of soil was collected up to 1 metre depth (where possible) and stored at 4°C. Through a wet sieving procedure, four aggregate sizes were isolated: Large Macroaggregates (>2000 µm), macroaggregates (250-2000 µm), microaggregates (53-250 µm) and silt & clay (<53 µm). Results show that, despite not finding significant differences between soil types in surface horizons, soil types did behave differently in deeper horizons. Brown Earth profiles displayed a larger macroaggregate fraction in subsoils compared with other soil types. Luvisols and Typical Surface-water Gleys contained more microaggregates and an increase in silt and clay fraction compared to surface horizons, these fractions having a greater carbon content. Due to the strong organic matter-clay bonds created in the silt & clay sized aggregates, and the occlusion and inaccessibility for bacteria occurring in the microaggregates, these two fractions are linked to long-term carbon storage (i.e. carbon sequestration). These fractions show an increase with depth in soils associated with clay illuviation. In general, the scientific community focuses on carbon content of the top 30 cm when calculating soil carbon stocks. The current research highlights a major gap in the carbon accounting mechanisms, and emphasises the need for the identification of carbon pools in soils at depth to account for carbon sequestration in grassland soils.

**Keywords:** Carbon sequestration, aggregation, depth

## **11. Fire, Vegetation and Climate dynamics throughout the Holocene, within the Galty Mountains**

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In recent years fires have increased globally, in both tropical and temperate regions, as a result of deforestation and drought, climate change, rural depopulation, and, paradoxically, through fire suppression. The future susceptibility to fire is predicted to be large, creating a major management issue throughout the warming world. This study looks at fire in the Irish landscape over the past 12,000 years, in an attempt to understand its relationship with the surrounding vegetation and climate. The study also addresses how fire affects the landscape, how long an area needs to recover after a fire and also what conditions promote fire ignition. Eight study sites have been examined and two will be discussed here; Borheen and Diheen Lough which are located within the Galty Mountains. Macroscopic charcoal analysis, pollen analysis and radiocarbon dating were applied to lacustrine sediment, to reconstruct the character of past fire regimes at these sites. Ireland is no exception to climate change and the projected increase in temperature and seasonality will have a significant impact on wildfire. It is therefore important to examine previous fire and vegetation patterns to understand their nature and stimuli, to potentially project future patterns in wildfire, and help mitigate and manage the negative effects of fire in the future. Results presented will include the frequency and magnitude of past fire within the Galty Mountains, a statistical analysis comparing the regional activity within the area, and a detailed analysis of how fire affects the vegetation here. This work presents the first chronological comparison of regional fire activity across various locations throughout Ireland, and provides a base line level of data which can be drawn on in future scenarios when fire frequency is expected to increase. The data presented was completed as part of a four year PhD programme and significant results will be presented.

**Keywords:** Fire, Holocene, Vegetation, Climate, Ireland

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## 12. Environmental lifecycle assessment of dairy products manufactured in the Republic of Ireland

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In 2015, the milk quota system that is in place in Europe is to be abolished, instigating an increase in milk production. This increase will aid in addressing the world's ever growing demand for food but will incur increased stresses on the environmental impact and sustainability of the dairy industry. In this study, an environmental lifecycle assessment will be performed in order to estimate the environmental impacts, including global warming potential (GWP), eutrophication potential, cumulative energy demand and water depletion, associated with the main dairy products manufactured in the Republic of Ireland. Initially, a macro-scale cradle to processing factory gate study examining the greenhouse gas emissions associated with the Irish dairy industry is performed. The results of this macro study of the industry will identify the major contributors to GHG emissions within the dairy processing sector. This information will then be used when compiling a more detailed survey of the individual plants within the Irish dairy processing industry. The survey will include details on the volume of raw milk processed, production statistics, raw milk transportation to the plant, electrical and thermal energy usage, water consumption, wastewater treatment, as well as details on the packaging materials and cleaning chemicals used. Once this survey is complete, a comprehensive environmental lifecycle assessment of the Irish dairy processing industry will be performed for the manufacture of butter/milk powder, cheese and fluid milk. 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. The results of the current study may also be used as an international comparison for macro-scale studies. Additionally, methods used in the current study may be incorporated into similar international studies.

**Keywords:** dairy, environmental life cycle assessment, global warming potential, Ireland, milk processing

### **13. Implementing microbial fuel cells in constructed wetlands for enhanced wastewater treatment with simultaneous electricity generation**

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Constructed wetlands (CWs) have long been identified as a sustainable technology for wastewater treatment. By integrating microbial fuel cell (MFC) technology the wastewater treatment performance of CWs is improved while electrical power is produced. The compatibility, and subsequent combination, of CWs and MFCs is based on the fact that they are both biological systems engaged in the degradation of organic matter. Additionally, MFCs require a redox gradient – an anaerobic anode and aerobic cathode – which can be found naturally in CWs depending on flow direction and wetland depth. Two identical lab-scale CWs were built and operated for a period of 150 days and fed with the effluent of a CW treating swine slurry. The CWs consisted of five layers: a 90mm gravel support layer; a 210mm dewatered alum sludge cake layer; a 100mm granular graphite layer; a 200mm dewatered alum sludge cake layer; a 100mm granular graphite layer at the surface. In one of the wetlands the graphite layers were connected via an external circuit converting the system into a CW-MFC with the buried graphite layer functioning as an anode and the upper graphite layer acting as a cathode. The connection of the external circuit improved the COD removal efficiency of the wetland from 74% to 83% while producing over 4 Wh of electrical energy per kg of COD removed in the wetland. The improvement in COD removal was attributed to the CW-MFCs enhanced ability to remove organics in an anaerobic environment with the anode acting as an insoluble terminal electron acceptor thereby increasing the metabolic rate of anaerobic bacteria. The producible current was found to be closely related to the soluble COD arriving at the anode as opposed to influent loading on the system and the lower section of future CW-MFC studies should focus on optimizing the availability of soluble COD at the anode. Overall, the CW-MFC is a promising technique to achieve the dual goals of wastewater treatment and energy production.

**Keywords:** wastewater treatment, electricity generation, constructed wetland, microbial fuel cell

## 14. Anaerobic digestion of lipids:

### The effect of bioreactor design and addition of trace-elements

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Anaerobic digestion (AD) is a sustainable biological wastewater treatment method. It can tackle a range of industrial effluents in energy positive manner. As a result of the abolition of EU milk quotas in 2015 the Irish dairy industry is expected to increase output by 50% over the coming 5 years. The lipid fraction of dairy wastewater is currently removed and disposed of either to landfill or by land-spreading. This study sought to apply various strategies for the utilisation of the complete dairy wastewater stream including the lipid fraction as a bio-resource through AD treatment. The potential energy gain from the anaerobic treatment of lipids is relatively high producing 1.425 litres biogas per gram of lipid compared with 0.830 l/g of protein (Figure 1). Three bioreactor designs are compared to identify their efficiency in the AD treatment of lipid-rich dairy wastewater. An Up-flow Anaerobic Sludge Bed (UASB), UASB-Anaerobic Filter (UASB-AF) and Expanded Granular Sludge Bed (EGSB) bioreactor were trialled at a 72 hour Hydraulic Retention Time and an Organic Loading Rate of 0.83 Kg/m<sup>3</sup>/day. The trial also investigated the addition of trace elements (TE) to the bioreactors in an attempt to increase the rate of digestion of lipids. An increased efficiency and stability of the bioprocess was visible in the performance data of the UASB-AF and EGSB when compared with the UASB. The addition of TE resulted in increased lipid removal in all bioreactors with a subsequent increase in biogas production. The observed positive effects of both bioreactor design and addition of TE highlights the potential for a multi-faceted approach, which could lead to an efficient and sustainable utilisation of AD for the treatment of lipid-rich wastewater.

**Keywords:** anaerobic digestion, lipid-rich wastewater, trace elements, bioresource utilisation

## 15. The effect of the wastewater treatment process, in particular UV treatment on pathogenic virus removal

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Human pathogenic viruses of concern include Norovirus (NoV) as outbreaks of 'winter vomiting bug' can have significant health and economic impacts. Little is known about the removal of NoV in wastewater treatment plants (WWTPs) as the virus lacks a suitable tissue culture and so infectivity cannot be assessed. This project investigated the use of FRNA bacteriophage as (i) a potential surrogate for norovirus response/behaviour and (ii) a model to determine the fate of viruses through a municipal wastewater treatment plant. The project also evaluated the efficacy of membrane filtration (microfiltration and ultrafiltration) as a pathogen removal method and two ultraviolet-based technologies; pulsed UV and low pressure UV as pathogen disinfection methods. The potential impacts of parameters such as organic carbon, metals and suspended solids, (typically present in wastewater) on the investigated pathogen removal processes were also analysed. The key findings of the study included: -Due to the high resistance properties of bacteriophages to UV treatment and its morphological similarities to norovirus, the use of this virus as a potential surrogate has value. This option may currently offer the most effective method of determining the efficiency of disinfection processes (in particular UV) in achieving norovirus reduction. -The impact of suspended solids on pathogen removal via UV varied widely between samples and wastewater treatment facilities tested. The implementation of batch tests prior to installation of new UV systems would be useful to inform design and system range requirements such as the site-specific impacts of hydraulic residence times and wastewater characteristics (e.g. organic carbon and suspended solids). Furthermore, continuous commissioning, via periodic verification trials of installed UV systems may enable operators to ensure optimal operation of existing systems. -The operation efficiency of the treatment plant as a whole should be taken into consideration when selecting a particular tertiary treatment system as a poor performing plant may impact significantly on UV disinfection processes. -Biofouling control of membrane filtrations systems poses a significant maintenance and operational challenge. Further work could focus on design, operational and cost challenges that may be encountered when such technology is deployed on-site.

**Keywords:** Wastewater treatment, pathogenic virus removal, tertiary treatment, UV

## 16. Energy Benchmarking in Wastewater Collection and Treatment

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Energy benchmarking has been used in countries such as Austria to improve energy performance by 30% over 10 years in wastewater collection and treatment. This study develops a system of energy benchmarking that could be implemented to reduce energy consumption in Ireland. Through implementation of a national survey of local authorities, Irish Water, published EPA wastewater discharge license documentation and Census 2011 small area population statistics, a data sample of sewerage schemes was collated. The data sample was taken from 59 Irish sewerage schemes and consisted of actual energy usage values and associated variable operational values related to energy usage, for both wastewater collection and treatment. Using this data, a multiple linear regression analysis was carried out to determine two equations of significant predictor variables which would predict mean energy usage for both wastewater collection and treatment. A five-variable linear regression model equation was used to predict the energy usage for each WWTP sample data point ( $R^2 = 86.8\%$ ). This multivariable equation was used to develop an energy benchmarking model that would provide an energy performance score between 0 (very poor) and 100 (excellent) based on the actual energy usage and the predicted mean energy usage. Using sensitivity analysis, the wastewater treatment benchmark model was found to be robust and logical. A three-variable regression model equation of wastewater collection system energy usage ( $R^2 = 59.6\%$ ) was not as robust. Single variable energy benchmark models were also developed based on; actual energy usage, load treated, flow treated and treatment capacity utilised. The Irish data sample value of 45.9 kWh/P.e./annum for the 15,000-30,000 P.e. WWTP range is 48% greater than the German target of 31 kWh/P.e./annum for the 10,000 to 30,000 P.e..

**Keywords:** energy usage in wastewater collection and treatment, multivariable linear regression analysis, predictive equations, energy performance benchmarks

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## 17. Non-invasive genetic tests for identification of bat species of Ireland and Great Britain

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All bat species and their roosts are protected by law in Ireland, and specialised bat surveys carried out by experienced surveyors are required where a development may potentially impact on a bat roost site. Non-invasive genetics is increasingly being used as a tool for the conservation management of wild mammal species, including bats. The use of qPCR as a method of analysing DNA samples collected in the field has significant advantages over conventional PCR and DNA sequencing in reducing the time and cost involved in laboratory work. Additionally, it provides a measure of the quality of a DNA sample which can inform on the worth of more detailed subsequent DNA analysis of particular samples. Species-specific qPCR identification tests were designed for eighteen of the bat species recorded in Ireland and Great Britain, including all species known to be resident on both islands. The relevant DNA tests were applied to a non-invasive field study of 55 bat roosts in County Waterford in southern Ireland and were successful in identifying the bat species present, including mixed-species roosts. This method of DNA testing will add to the array of tools available to bat surveyors to identify bat species using roosts and will be especially useful in cases where roosts contain multiple species, where the number of bats present is small or bats are otherwise difficult to directly observe.

**Keywords:** wildlife conservation, bats, non-invasive genetics, mammal surveys

### **18. Influence of multiple stressors on marine sediment microbial communities**

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It is generally accepted that biodiversity influences ecosystem functioning. Microorganisms are a key driver of ecosystem processes, but it is not fully understood how environmental changes impact on the composition and functioning of microbial communities. The objective of this study was to test whether two different types of disturbance; biological and chemical and their interaction alter microbial community composition and function. A field experiment was set up on marine intertidal sediment where wastewater was applied and the non-native oyster; *Crassostrea gigas*, was introduced over a 45 day period. Sediment and pore-water were sampled three times over the course of this period on days 1, 15 and 45. Microbial community composition was assessed using terminal restriction fragment length polymorphism of the 16S rRNA gene. Ammonia, total oxidised nitrogen and silica concentrations in sediment pore water was used as an indication of biogeochemical activity. Of the two disturbances, wastewater caused the biggest changes in both ammonia concentrations in the pore water and bacterial community composition. However, on plots that contained both oysters and waste water, an interaction occurred whereby the oysters appeared to alter the impact the wastewater had on the pore-water biogeochemistry as well as the microbial community composition.

**Keywords:** intertidal sediment, microbial ecology, biogeochemistry, invasive species

### 19. Scots Pine: A native Irish tree?

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5000 years before 1950AD (cal BP) Scots Pine (*Pinus sylvestris*) experienced a major population decline across Europe, which led to its ultimate extirpation in Ireland about 1500 cal BP. The current populations of *P. sylvestris* in Ireland originate from Scotland, introduced as plantations during the 18<sup>th</sup> century. Since the original Irish *P. sylvestris* became extinct and the current *P. sylvestris* populations were introduced by humans, the native status of this species is disputed. This work presents the paleo record of a forest of *P. sylvestris* in the Burren, Co. Clare. A sediment core was taken from a site in the Burren, and fossil pollen was extracted and counted to determine how the tree population had changed since 1600 cal BP. The data suggests that *P. sylvestris* survived and recovered from the national population decline, and has maintained a continuous presence at this location, right up to the present day. Hence, this could be a native Irish population of *P. sylvestris*, having persisted in the unique Burren landscape independent of the population collapse 5000-1500 cal BP and originating from before the re-introduction 200 years ago. Identifying a native Irish Scots Pine population gives new opportunity for changes in the future conservation of biodiversity in Ireland, most particularly by contributing to ongoing efforts to restore native Irish woodlands.

**Keywords:** *Pinus sylvestris*, Biodiversity, native, paleoecology, Burren, Ireland

## 20. Chemotaxonomy of microalgae isolated from the west coast of Ireland

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The structural diversity and distribution patterns of pigments in phytoplankton species are taxon-specific, facilitating their application as chemotaxonomic markers in oceanography. These plastid-pigment types are used to ascertain the diversity, abundance and ecotype distribution of photosynthetic organisms present in the environment. Carotenoids are a class of tetraterpenoid pigments which function to protect the cell from photo-oxidation. Due to their antioxidant properties, they have wide applications as functional foods and as biopharmaceutical adjuvants for the treatment of chronic inflammation, diabetes, cancer, age-related macular degeneration or cardiovascular disease. In this study, microalgae were isolated from the west of Ireland and successfully brought into culture. Chemotaxonomic pigment profiles were established for selected strains utilising a Chromolith C18 monolithic HPLC column. The bimodal porous nature of the monolithic stationary phase skeleton provides a highly interconnected surface area, offering high speed separation of analytes with minimal column backpressure and fast mass transfer kinetics. Employing a monolithic HPLC column resulted in a reduction in analysis time from 60 min to 6 min. Pigments were identified by comparing retention times and UV-vis spectral fine structure to a mixture of pigment standards and published spectral data. The purpose of this screening is to aid in the identification of strains showing promising carotenoid profiles, including  $\alpha$ - and  $\beta$ -carotene, lutein, zeaxanthin, astaxanthin and fucoxanthin. Candidate strains with promising bioactive profiles will be selected for further quantitative studies and up-scaling in photobioreactors.

**Keywords:** microalgae, chemotaxonomy, blue biotechnology, monolithic HPLC, carotenoids

## 21. What do we really need to know about health benefits from biodiversity?

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Since a healthy environment is essential for our health and wellbeing, management of this resource has strategic importance for human health. In Ireland, as elsewhere, trends of an aging population and rising socio-economic inequality compounded by excess consumption, sedentary lifestyles and social isolation increase the burden of mental and physical illness, as restricted public funding limits capacity to deliver health care services. Links between biodiversity and health are hot topics in research and practice internationally because biodiversity is essential to a health-sustaining environment; and defining the health benefits of biodiversity may instil greater appreciation of it and lead to better protection of natural resources. This research examines the benefits to health from engaging with biodiversity in Ireland with a view to making recommendations for policymakers and practitioners. Quantifying health benefits related to biodiversity is a major challenge. In seeking to influence policy in this area, we must explain the difficulty in obtaining quantitative evidence of health benefits related to biodiversity. Here we appraise the questions that have been addressed in current literature. We evaluate key themes and challenges emerging from currently available material and make recommendations for further research. Questions regarding differential benefits of various types of green space with more or less biodiversity are probably impossible to answer. Rather, we must engage planners, health practitioners, conservationists and communities to ask how we can best provide biodiverse spaces to suit individual preferences and life stages.

**Keywords:** biodiversity engagement, health benefits, evidence base, policy and practice

**22. Competition between *Lemna minuta* and *Lemna minor* under different resources availability and under different temperatures**

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The relative competitive abilities, in terms of relative growth rate (RGR) and chlorophyll content, of the invasive alien duckweed *Lemna minuta* and the cogenetic native *Lemna minor* were tested under different levels of nutrient, light supply and temperature. We found that *L. minuta* grew faster than *L. minor* over all concentrations of nitrate tested, at high concentrations of phosphorus, higher light intensity and higher temperature. *L. minor* grew faster than the alien species *L. minuta* at concentrations of phosphorus higher than 500 µg/l, under light regimes higher than 20 µmol m<sup>-2</sup>s<sup>-1</sup> and under temperature higher than 15°C. The distribution of the two species in the natural environment did not, however, reveal that *L. minuta* was always dominant in nutrient-rich or well-illuminated habitats, in contrast to the laboratory results. It is concluded that the dominance of one freshwater plant species over another is probably determined by a complex suite of physical and biological factors and that simplistic models of relative growth rate cannot explain observed natural distributions.

Keywords: *Lemna*, alien species, competition, light, eutrophication, temperature

### 23. Overview of Developments in Earth Observation

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The Earth System (ES) is responding to natural and anthropogenic forces which pose significant threats to sustained societal and economic development. ES Science investigates the coupled physical, chemical and biological processes which drive changes to atmospheric composition, land use and ocean circulation. This necessitates deployments of Earth Observation systems, from *in-situ* sensor networks, to airborne and shipborne remote sensors, to global-system satellite sensors. These are essential for quantification spanning spatial scales of nano-to-global and temporal scales from seconds to decades. The expertise and infrastructure to advance our understanding of ES change requires the integration of research in observation systems, state-of-the-science high-performance computing informatics and predictive modelling. This paper will provide an overview of some of the potential for Earth Observation using, *inter alia*, the new European Space Agency Sentinel satellites, marine and airborne remote sensing data. The paper will give a detailed example of the potential of high-resolution airborne electromagnetic and radiometric remote sensing data from the TELLUS Border project to assess potential groundwater resources and surface conditions associated with different soil types and grasslands on the east coast of Ireland. The data can be used to infer sub-surface electrical conductivity, to depths ~ 40m below surface, associated with variable hydrogeological properties such as porosity, clay content and hydraulic conductivity in the sands and gravels overlying the bedrock.

**Keywords:** environmental change, Sentinel satellites, marine, airborne remote sensing, hydrogeology

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## 24. A Novel Analytical Protocol for the Detection of *E. coli* in Environmental Water Samples using $\beta$ -D-Glucuronidase

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A method for the quantification of faecal pollution indicator bacteria, *Escherichia coli* (*E. coli*), was developed and tested on environmental water samples. The method relies on the measurement of  $\beta$ -D-Glucuronidase (GUS) activity which is an *E. coli* marker enzyme. The developed protocol involves two main steps: sample preparation and GUS quantification (Fig 1). Syringe filters were used with a dual purpose, for the recovery and pre-concentration of *E. coli* from the water matrix but also as  $\mu$ L reactors for bacteria lysis and GUS extraction. The enzyme activity was further measured using a continuous fluorometric assay developed in the laboratory and the results were compared with standard culture based methods. The optimisation for each step of the protocol (steps [1] to [6] in Fig. 1) will be discussed together with the analytical performance of the method. The main advantages of this technology are: the short time required for analysis (45 min, sample preparation + 30 min, detection time), minimal sample manipulation, minimal reagent consumption and the potential for near real-time monitoring. This method could aid stakeholders in meeting early warning requirements and water safety plans for bathing areas.

**Keywords:** *Escherichia coli*,  $\beta$ -D-glucuronidase, fluorescence, enzymatic assay

## 25. Emission of pharmaceuticals in the environment: an Irish perspective

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Emission of pharmaceuticals for human use is influenced by trends in prescribing, trends in dose strength and excretion rates of parent compounds or metabolites. Historical patterns of use of pharmaceuticals in Ireland were analysed to generate forecasts of emissions and identify substances displaying sharp consumption increases and therefore potential for cumulative occurrence in aquatic environments receiving wastewater effluents. A Holt-Winters time series filter was adapted to dispensing data using the statistical programme R to analyse consumption trends; observations ranged between year 2008 and year 2013. The analyses provided linear and seasonal forecasts, delivering rapid prediction of emission monthly increases. Validation of the forecasts was achieved using training and test datasets. Using the criterion of at least 150% in Volume Dispensed Increase (VDI) between 2008 and 2012 an initial formulary of 98 most prescribed drugs in Ireland was reduced to 4 substances of potential concern, 2 antidiabetic drugs (pioglitazone, VDI = 406.6%; sitagliptin, VDI = 373.2%) and 2 antiepileptic drugs (pregabalin, VDI = 219.2%; levetiracetam, VDI = 174.4%). Emissions to wastewater of pioglitazone have plateaued since 2010 and are estimated to be currently 0.35 kg/month whereas emissions of sitagliptin are 21.4 kg/month. The current discharge of pregabalin to wastewater is estimated at 279.5 kg/month. Levetiracetam wastewater emissions are estimated to exceed 500 kg/month. Because of continuous emissions and intrinsic chemical characteristics some pharmaceuticals, for example pregabalin, have the potential to be quasi persistent in the environment. Due to poor removal in wastewater treatment the current environmental loading of pregabalin for Ireland is estimated at 229.2 kg/month. Emissions of pregabalin to wastewater are expected to continue increasing by ~3.5 kg/month, a current growth rate of 15.0% per annum. Forecasts of pharmaceutical emissions can assist in prioritising scientific research in this growing source of emerging pollutants.

**Keywords:** Pharmaceuticals in the environment, pharmaceutical emissions, emerging pollutants, priority substances

## 26. Sediment Transport Modelling on the River Bandon

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The River Bandon is located west of Cork City in the South Western River Basin District with a catchment area of 608km<sup>2</sup>. The town of Bandon, the largest urban settlement within the river catchment, has a history of flooding with significant river improvement works planned for the summers of 2015 and 2016. A one dimensional hydrological software modelling package, HEC-RAS, has been applied to the river system as part of the overall river improvement project. The model simulates hydraulic and sediment transport conditions on the river and covers a 10.5km stretch of the river with 239 cross -sections from upstream of the town of Bandon to approximately 6.5km downstream. The model includes the river's main tributaries (Bridewell, Millstream and Brinny) and various river structures. Calibration of the hydraulics of the model was undertaken for both in-bank and out of bank flow at the two hydrometric stations located within the model boundary. Satisfactory water level calibration was achieved by adjusting the Manning roughness coefficient to produce the lowest root mean square error for flows ranging from 148m<sup>3</sup>/sec to 330m<sup>3</sup>/sec (return periods of 2 to 100 years respectively using the L-moments approach) yielding RMSE= 0.085, E=0.993 and BE=-0.024. The hydraulic model was successfully validated using river flows for the calendar year of 2010 (with flows ranging from 2.97m<sup>3</sup>/sec to 172.6m<sup>3</sup>/sec yielding RMSE=0.066, E=0.95 and BE=-0.63). Calibration of sediment conditions in the model has involved the analysis of the field suspended sediment concentration data at a measurement sensor on the river. The HEC-RAS model is being used to assess sediment transport rates and potential bed level change in the river. The model will also be applied to simulate the potential sediment transport impacts of the river improvement works on the river system.

**Keywords:** Sediment transport, HEC-RAS Bandon

## **27. Determination of Faecal Pollution of Beach Sand in Dublin Bay Beaches**

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In Ireland, under the EU revised Bathing Water Directive (rBWD), bathing water quality is classified based on the levels of Faecal Indicator Bacteria (FIB), categorising designated bathing waters as “excellent”, “good”, “sufficient” or “poor”. Although the rBWD specifies water quality, it does not include microbial standards for the beach sand area, where people spend the majority of their time when using recreational waters. This study, funded by Environmental Protection Agency (EPA), aims to detect FIB, pathogenic bacteria and associated viruses present in beach sand; estimate the potential risks to public health and suggest management measures to reduce these risks. To date, intestinal enterococci levels, in beach sand and water, in conjunction with tides are continuously measured from beaches around Dublin Bay, with data from Sandymount Strand shown here. Bathing in Sandymount has been banned several times during the last bathing season due to high levels of FIB in water; however, this study shows that the highest levels of intestinal enterococci are in fact evident in dry sand (levels approximately 100 times higher than wet sand and water) which is not currently addressed in legislation. Furthermore, the dispersion of pollution in the beach sand area has displayed heterogeneity in contrast to the homogeneity of the water. This may be a result of non-point sources of contamination. Microbial Source Tracking (MST) technique has been used to discriminate between the different non-point sources of faecal pollution such as human or individual animal species whereby human and gull markers have shown to be the main contributors of the contamination, followed by horse and dog markers. Currently, this study has found no evidence of the ruminant marker, a result that is as expected due to the urban surrounding area of Sandymount beach. This study highlights the necessity to revise current EU bathing water legislation to address the high microbiological levels evident in beach sands.

**Keywords:** Faecal Indicator Bacteria, beach sand, pollution, Microbial Source Tracking

## 28. Optimization of Non-thermal plasma treated textile waste water using RSM in R

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The present study aimed at degradation of model dye i.e., methyl orange by Non-thermal plasma (NTP). Response Surface Methodology (RSM) was used to investigate the efficacy of plasma process parameters such as voltage (30, 40 & 50 kV), treatment durations (30-120 seconds) on degradation efficiency of dye. Central composite design was employed to optimise the degradation of dye by non-thermal plasma treatment. It was observed that the predicted values are in significant ( $p < 0.001$ ) with regression coefficients 0.99, 0.99, 0.96 for degradation efficiency, ozone concentration and pH respectively. Predicted results were found to be in good agreement with experimental results. A second order polynomial equation was proposed to predict the process efficiency using statistical software R with rsm package. The ANOVA results showed that the coefficients of polynomials for degradation efficiency and ozone concentration responses indicated the prominence of positive linear effects ( $p < 0.001$ ) whereas negative linear effect was seen for pH. Positive linear effect of variable emphasises that treatment time is the most dominant factor ( $p < 0.001$ ) meaning that higher degradation efficiencies are achieved with increase in treatment durations. The negative linear effects variables explain an increase in acidity of dye with raise in voltage and time. The negative quadratic effects for degradation efficiencies and positive quadratic effects for pH responses were observed from the CCD model. However, for ozone concentration the positive quadratic of voltage ( $p < 0.01$ ) which produces a curvilinear effect it means the voltage and treatment time are important factors for degradation. This study showed that CCD model and response surface methodology could be employed to optimise the colour degradation parameters of Non-thermal plasma treated model dyes while minimising the number of experiments required.

**Keywords:** Non-thermal plasma, Methyl orange, RSM, R.

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## 29. Potential energy generation from the biogas transformation of poultry slaughterhouse by-products

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The slaughtering industry is a major facet of the agro-industrial sector across Europe; within Ireland alone approximately 77.4 million poultry, primarily broiler chickens, were slaughtered in 2013. This equates to over 170,000 t live weight, with 25-35% of the live weight of the animal being deemed a by-product of the process. A number of different processes exist to convert organic waste streams/biomass into energy, the technology of interest in this study was biogas transformation; the biological conversion of degradable organic material into methane. The demand for renewable sources of energy, driven by The Renewable Energy Directive 2009/28/EC, is ever increasing. While at the same time legislation, Animal By-Products Regulation 1069/2009/EC, dealing with the collection, storage, processing, use and disposal of animal by-products has become more austere. In this regard, biogas transformation is a promising alternative for the treatment of animal by-products and the production of a multi-faceted “advanced” biofuel. Triplicate Biochemical Methane Potential (BMP) assays of the individual waste streams (soft offal, wastewater sludge, chicken manure along with a mixed waste stream), under mesophilic conditions were undertaken. The results demonstrated methane yields of between 240-500 ml of CH<sub>4</sub> per gram of Volatile Solids for the individual waste streams, with the highest being soft offal at 499.11 ml of CH<sub>4</sub> per gram of Volatile Solids at a VS content of 39% of its fresh weight. In tandem an energy balance based on the sampled slaughtering facility, processing 14,040 tpa of dress carcass weight indicated that approximately 35% of the electrical demand and 77% of the thermal demand (equating to 50% of the total annual energy consumption 43,467,840 MJ) could be subsidised through the biogas transformation of only the soft offal produced from the sampled slaughtering facility.

**Keywords:** anaerobic digestion, biogas, organic waste streams

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### 30. Achieving ‘Net Zero Energy’ performance through retrofitting of residential buildings in Ireland

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The residential building sector accounted for 27% of all primary energy consumption in Ireland in 2011. Consequently, the concept of low energy buildings for new and existing dwellings is becoming increasingly relevant. Net zero energy building (nZEB) performance is where for every unit of energy the building consumes over a year, it must generate a unit of energy to maintain an overall net balance. This research focuses on retrofitting the current building stock, which stands at almost 2 million housing units, to meet nZEB performance. The study introduces a bespoke software tool (NetZERO) which establishes the level of retrofit required to achieve nZEB performance for existing dwellings considering the influence of site location, local climate, operational energy use, phased retrofit strategies and economic conditions. The methodology characterised by NetZERO is applied to four case studies which represent various combinations of dwelling type, site characteristics, retrofit specification and micro-generation systems. Case study 1 examines a two-storey semi-detached dwelling in an urban setting (Dublin region). Case study 2 consists of a one-story detached dwelling in a rural setting (Mid-West region), while Case studies 3a and 3b comprise a one-story detached dwelling in a sub-urban and rural setting respectively (South-East region). A net zero energy balance over one year is achieved for case studies 2, 3a and 3b. The energy efficiency retrofit applied to each dwelling yields energy savings of between 54-61%. The greatest potential for energy savings is associated with space heating which represents between 56-62% of the total energy consumption. The ability of each site to meet the residual energy demand using on-site generation is essential; however this varies according to site climate, location and terrain. The sites which possess the ability to generate large amounts of wind energy present a more technically and economically feasible case to achieve nZEB performance.

**Keywords:** Energy, Buildings, Low Energy Buildings, Net Zero Energy, Retrofit, Energy Efficiency, Micro-Generation

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### **31. The use of an optical fibre sensing structure based on a palladium alloy for the design of a robust hydrogen sensor**

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The effectiveness of hydrogen as a clean renewable energy source has been extensively demonstrated. However, with a Lower Explosive Limit of 4%, it is potentially hazardous. Hydrogen gas diffuses rapidly and escapes through most forms of containment due to its atomic nature. Therefore in order to fulfil the commercial acceptance of hydrogen as an energy source, there must be a future focus on the development of fast, accurate, robust hydrogen sensors. Several sensing platforms are currently in use for hydrogen gas sensing, including electrochemical, metal oxide, and thermal conductivity sensors. Optical fibre based sensors provide an ideal sensing platform for this area since they require no electrical components which could bring a risk of ignition. Hydrogen sensing can be achieved by coating the surface of an optical fibre with a hydrogen sensitive material such as palladium (Pd). Palladium is highly selective in the absorption of hydrogen and its optical properties change measurably with surrounding hydrogen concentration. In the case of the surface plasmon resonance (SPR) sensors examined here, as the Pd surface absorbs Hydrogen, the resonant wavelength at which the plasmon oscillates undergoes a red-shift which is in proportion to the hydrogen concentration present. Pd-based sensors are prone to flaking and loss of sensitivity over time as they are continually exposed to hydrogen. By alloying the Pd layer with another carefully chosen material, we hope to prevent flaking while improving hydrogen permeability and reactivity. The objective of this research project is to develop a computational model which will allow us to determine the optimal structure for a SPR optical fibre based hydrogen sensor employing a palladium alloy. To date, we've seen promising results for one particular alloy. This allowed us to design an optimal hydrogen sensor based on sensor operating parameters such as the sensitivity and signal to noise ratio.

**Keywords:** Hydrogen Sensing, SPR sensors, Optical Fibre Sensors, Surface Plasmon Resonance

### **32. The impact of meteorological and geographic variations on the heat demand of an Irish passive house**

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This research assesses the impacts of various meteorological and geographic factors on a passive house in Ireland. The dwelling performance is simulated to determine how these parameters influence the energy performance of a passive house in Ireland, namely the space heat demand. A virtual passive house is developed with a thermal envelope designed to achieve a space heat demand of 8kWh/m<sup>2</sup>/yr, based on Dublin airport meteorological data. This virtual dwelling is then simulated in a representative spread of 14 locations across Ireland, using Met Éireann synoptic data stations which retain meteorological records to include; temperature, solar radiation, wind speed and humidity. The impact of geographic parameters is also a contributing factor to variations in heat energy demand. These factors include; altitude, distance from coasts and exposure due to open plane or sheltered valley locations. Analysis of the Met Éireann data shows variations in temperature, from an average of 4.44°C to 7.96°C over the heating season, in Belmullet and Valentia respectively. The same data shows a variation in solar radiation from an average of 1.82 to 2.50 sunshine hours per day, in Malin Head and Rosslare respectively. The maximum variation in energy performance, simulated across all 14 locations, identifies a 210% variation in space heat demand between Valentia, Co. Kerry and Clones, Co. Monaghan. Further analysis shows that there is little direct correlation between meteorological data and the energy performance of the virtual dwelling. There are currently no legislative requirements or guidelines in Ireland to determine the impact of these meteorological and geographic variations on a building's design or performance. The continuing research aims to develop a set of guidelines which will assist designers in gauging the impact of these potential variations on an Irish passive house.

**Keywords:** passive house, climate variations, geographic impacts, energy conservation

### 33. Outputs of the Forest Energy 2010 – 2014 Programme

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The Forest Energy Programme 2010 – 2014 (extended until June 2015) is a DAFM funded project run in collaboration between Waterford Institute of Technology, University College Dublin, and the Danish Forestry Extension. The research programme is focused on evaluating methods of mobilising biomass from Irish forests, characterising Irish wood fuel, and investigating methods of quantification of Irish wood fuel for payment purposes. During the programme a number of empirical trials have been performed including: I) A comparative study of whole tree harvesting, integrated harvesting, and cut to length harvesting, for energy on a Sitka spruce first thinning site in Co. Kilkenny (approx. 1 ha). II) A stump harvesting for energy trial on four conifer clearfell sites in Ireland (approx. 4 ha). III) A residue bundling case study on a conifer clearfell site in Co. Kilkenny (3.7 ha). IV) Biomass estimates from residue bundling on six sites in Ireland (153 truck loads, total of 9700 bundles). V) The spatial and temporal variation of moisture content, density, calorific value, ash content, and chemical composition (C,H,N, Cl, S, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) of six commercial tree species in Ireland, by tree component (stem, top, wood, bark, branch, leaf), and the development of an online database of the dataset. VI) Drying trials of roundwood, residue bundles, and stump wood, using automated weighing systems at a terminal in Ireland. VII) A firewood storage trial to evaluate the drying rates of firewood under different conditions in Ireland.

**Keywords:** Wood Energy, Biomass, Forestry, Thinning, Clearfell, Residues, Stumps, Bioenergy

### 34. The EU power system in 2030: Investigating electricity sector challenges

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Ambitious targets have been set out to the year 2050 regarding CO<sub>2</sub> emissions reductions and the presence of low carbon technologies in the 28 European member states. Results from the PRIMES energy system model for the 2030 EU Climate and Energy package indicate the level of penetration of renewables, the spread of fossil fuels and the presence of low carbon technologies in 28 European member states out to the year 2050. This work investigates the challenges faced by the European power system as the EU transitions to a low carbon energy system. Results from a partial equilibrium energy system model (PRIMES) are used to develop power plant portfolios for the year 2030 for each member state and these portfolios are further scrutinized for technical appropriateness through the use of a dedicated power system model. The power plant portfolios represent electricity system results aligning with an overall ambition of a 32% reduction in GHG for the EU as a whole relative to 1990. The dedicated power systems model, PLEXOS, is used to construct and model the electricity sector with increased technical and temporal resolution. This work aims to understand the robustness of a transitional low carbon electricity sector and identify challenges and operational concerns which may accompany that transition. We conclude that increased variable renewable generation such as offshore wind, onshore wind and solar will lead to levels of curtailment with some Member States experiencing a disproportionate level of curtailment. Also, wholesale electricity prices will increase from today levels but installed capacities of renewables and interconnection capacity will have strong member state impacts limiting the ability of prices to converge. In addition, congestion on interconnection lines limits the efficient movement of electricity particularly in Central and Eastern Europe.

**Keywords:** Energy systems modelling; Power systems modelling; Soft-linking

### 35. Use of Constructed Wetlands to treat alkaline leachates

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For every tonne of alumina produced approximately 1-2 tonnes of insoluble solids (bauxite residue) are produced. Drainage leachates from bauxite residue (red mud) disposal sites are invariably alkaline and a potential source of pollution to surface and ground waters. Despite various attempts to neutralise the residual caustic through intensive chemical and physical practices, the resulting BRDA leachate remains 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 old residues generating high pH leachates. Conventional treatments of these leachates can add considerable time and cost to refinery closure plans. Constructed wetlands are artificially engineered ecosystems designed to manipulate biological processes but doing so from within a semi-controlled natural environment. These man-made systems are designed to emphasize specific characteristics of natural wetland ecosystems for improved treatment capacity. Compared to conventional treatment systems, constructed wetlands are low cost, are easily operated and maintained, leading to their popularity with regulatory authorities and industries alike. Although there is a long history in using constructed wetlands as a passive method of treating acidic wastes (eg. mine tailings and drainage), there is limited published evidence of their potential to treat alkaline wastes. A constructed wetland trial was constructed within the Bauxite Residue Disposal Area (BRDA) at Aughinish, Ireland to assess the potential of treating elevated pH red mud leachate to a standard (<pH 9) that can be directly discharged into the surrounding environment. The 40 m<sup>2</sup> plastic lined reed bed contains three types of reeds typically found in wetlands -*Phragmites australis*, *Typha latifolia* and *Sparganium erectum*. The performance of the wetland over the first 18 months (in terms of water chemistry, soil and vegetation analysis) examining the potential use of constructed wetlands as a long term remediation technology for alkaline leachates is presented.

**Keywords:** Constructed Wetlands; Leachate; Alkalinity; Environment

### 36. Key Performance Indicators for Wastewater Treatment: Help or Hindrance?

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Benchmarking using key performance indicators (KPIs) has been identified as an effective means to sustainably manage wastewater treatment plants (WWTPs) (Möller *et al.* 2012). A key challenge in the development of KPIs utilised for benchmarking, is the identification of reliable data sources for KPI variables (Matos *et al.* 2003). Furthermore, sampling frequency can impact on the development of KPIs and comparison between wastewater treatment facilities. This is linked to the high-variability both in volume and concentration of wastewater influent in many facilities (Lawrence 2010). An incorrect method for combating these challenges using performance indicators involves developing extensive lists of KPIs in order to ensure that no performance issues are left unnoticed. These lists of KPIs are often unnecessary and overwhelming for new toolkit users (Doherty *et al.* 2014). This is due to a number of aspects that the user may find daunting including the level of accurate data required to calculate these KPIs and the extensive and continual commitment required from the toolkit user in order to maintain these KPIs throughout the duration of the study. To design a set of KPIs which will adequately measure a WWTPs performance, without deterring users due to the excessive commitment required to manage these KPIs, it is necessary to both identify and validate potential KPIs. Validation ensures that each KPI has a unique purpose as part of a benchmarking system and more importantly, ensures that the conclusions drawn from one KPI couldn't have been reached from a separate KPI in the set.

**Keywords:** Key Performance Indicators, Resources, Wastewater Treatment, Benchmarking

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### 37. Development of a Stakeholder-Based Sustainable Optimisation Indicator System for Urban Wastewater Treatment Plants in Ireland

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This presentation describes the development process of a Sustainable Optimisation Indicator (SOI) system for small-to-medium sized activated sludge (AS) wastewater treatment plants (WwTPs). Applied optimisation studies and preliminary plant manager/operator surveys indicate the need for a more consistent and sustainable operational approach and the requirement for performance evaluation and optimisation of existing AS WwTPs. This applied research assisted in the identification of key parameters for incorporation into the SOI system. A literature review determined the range and scope of existing international performance assessment, indicator and benchmarking systems for wastewater services. A stakeholder-based participatory approach was utilised to contribute to indicator formulation. Stakeholders with varying levels of technical knowledge of, interest in, and influence on AS WwTP operational performance were engaged in the consultation process mainly using online surveys and interviews. Stakeholders were invited to indicate the level of importance that they place on a range of issues associated with the operating performance of urban WwTPs and identify other relevant important issues. Applied plant optimisation research findings were used in conjunction with stakeholder consultation survey results to develop a Draft SOI set. The main SOI categories developed include Environmental, Operations & Management Personnel, Operational Asset Management & Maintenance, Process Monitoring & Treatment Efficiency, Biosolids Residuals & Waste Management, Service Quality, Operating Cost & Revenue and Safety & Public Health. This system of indicators is designed to provide plant performance metrics relevant to the information requirements of all key stakeholders. At a plant operation/management level, it allows the implications of current operational practices to be evaluated, assists with future planning of resources/funding for plants and provides a rationale for sustainable decisions and strategies. It is a first step towards monitoring and benchmarking of AS WwTP operations in Ireland and reporting of plant performance to a range of stakeholders including environmental organisations.

**Keywords:** activated sludge, optimisation, performance assessment, indicators, sustainability

### 38. Treatment of dairy processing effluent using IASBR Technology

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The dairy industry is one of the most polluting industries globally, generating an average of 2.5 litres of wastewater on average 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 increases of up to 50% in milk processed being predicted by 2020. This increase in production will lead to a corresponding increase of wastewater production. NUI Galway are investigating the potential of Intermittently Aerated Sequencing Batch Reactors (IASBRs) for treating wastewater from dairy processing plants in a sustainable and cost efficient manner. The IASBR is a novel technology, developed in NUIG, and has been previously used to treat other types of high strength industrial wastewater, as well as municipal wastewater. This project is industry-oriented, with many large dairy producers in Ireland involved from its inception. Wastewater samples, which have been provided by dairy processing plants, have been tested to determine the levels of nutrients and organic matter they contain. The results indicate that there is a large variation in wastewater composition between different plants. These variations, in both flow rates and composition, have previously been identified as one of the major problems faced by environmental managers of dairy processing wastewater treatment. A laboratory scale unit will be set up in the near future. Following this, a pilot scale unit will be launched at an industry partners' wastewater treatment plant. The aim of this project is to investigate whether the IASBR technology can be used to treat dairy processing wastewater effectively and more efficiently in terms of energy and cost. Additionally, working alongside project partners UCC, the microbiological communities will be examined at various points in the IASBR cycle to fully understand the nutrient removal mechanisms which occur in the IASBR.

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

### **39. Impact of the Landfill Directive (1999/31/EC) on the concentrations, volumes and treatability of landfill leachate produced in Ireland**

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The European Union Landfill Directive (1999/31/EC; EC, 1999) and subsequent legislation have driven major change in waste management in Ireland in the last 20 years, with the number of open municipal solid waste landfills decreasing from 95 in 1995 to four in 2014 (EPA, 2014). The Landfill Directive set target decreases in percentage waste consigned to landfill for each member state, target decreases in the quantity of biodegradable municipal waste sent waste to landfill, and also placed responsibility on landfill operators to budget for the aftercare of a landfill site for a minimum of 30 years after waste ceases being placed in the landfill. Before the implementation of this Directive, landfilling in Ireland was unregulated and poorly planned. Landfills were unlined and designed based on the ‘dilute and disperse’ model. The Directive has forced a drastic change on the manner in which landfills, and specifically landfill leachate, is managed. In recent years, leachate management has become a major concern for landfill and wastewater treatment plant (WWTP) managers alike, as increasingly stringent water quality emission limits placed on WWTPs by the Water Framework Directive (2000/60/EC; EC, 2000). This has resulted in increased costs associated with wastewater treatment, and concerns over disposal of landfill leachate and security of outlet for leachate have become a major concern for landfill managers. In many cases, WWTPs have been forced to cease accepting leachate to comply with licence requirements, and landfill leachate is often transported hundreds of miles for treatment. This paper examines the impact of the Landfill Directive on landfilling practices and how this has influenced the concentrations and volumes of landfill leachate produced in Ireland.

**Keywords:** wastewater treatment, ammonium, landfill leachate, landfill directive

#### 40. Remote sensing of grasslands sprayed with slurry

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Under the Nitrates Directive, Ireland must protect the environment from Nitrogen pollution. There are restrictions on when and where slurry can be spread and closed periods during which slurry spreading is not permitted. Slurry spreading that occurs during the closed period could be due to inadequate storage facilities. Farm inspections must be carried out to ensure compliance with this legislation. Remote sensing may offer a solution to aid in monitoring slurry spreading on grasslands during the closed period. Monitoring slurry spreading on farmlands can be difficult and not always feasible to check every farm during the closed spreading season. Imagery obtained from Satellite Pour l'Observation de la Terre (SPOT) sensors was used to locate and detect slurry spreading events that were cross-referenced with data obtained from farms about the exact location and date of these events. The Normalized Difference Vegetation Index (NDVI) was calculated for pixels from fields with slurry and fields with no slurry. The difference between the fields was shown to be statistically significant ( $P < 0.001$ ). Testing the model for prediction indicated it was about 70% accurate. This research required voluntary participation from farms and obtaining records of slurry spreading for monitoring purposes is a sensitive issue. The accuracy of the model could be improved by local councils who have greater access to slurry spreading records kept by farms.

**Keywords:** Remote Sensing, Slurry, Grasslands, NDVI, Nitrates Directive

**41. “Pushing the limits? An invasive species at its southern European range limit”**

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Despite the threats posed by invasive species to ecosystems globally, there is often a paucity of information regarding the effects of these species on native species and ecosystems. Where such data exists, it is often restricted both spatially and temporally. In particular, the invaded range limits of non-native species are often overlooked, in fact they may not even be recorded for many invasive species. However, monitoring invasive species at these locations could provide invaluable information regarding the future abundance and range expansion of invasive species. The invasive barnacle species *Austrominius modestus* (= *Elminius modestus*) is native to Australasia, and has been present in Europe for just over seventy years. Since its initial introduction, this species has become widespread around European coasts, and is now the dominant barnacle species at some locations within its invaded range. The Algarve, Portugal has been recorded as the southern limit of *A. modestus* in Europe. Rapid assessment surveys along the southern coast of Portugal in June and July 2014 extended the most southerly location of this species, and found that although *A. modestus* was present at the majority (83%) of sites surveyed, the native barnacle species *Chthamalus montagui* was the dominant species at all survey sites. Extremely dense settlements of *C. montagui* ( $510 \pm 116$  ind.  $25 \text{ cm}^{-2}$ ) were recorded during this study. However, despite being capable of reproducing during this time, a total of only five *A. modestus* settlers were recorded in thirty-two experimental plots across four sites. The strong competitive pressure exerted by the native *C. montagui* on the invasive *A. modestus* at the settlement and recruitment stage, will likely have a controlling effect on the future abundance and range expansion of *A. modestus* at its southern European limit.

**Keywords:** Invasive species, range limit, Portugal, barnacle, *Austrominius modestus*

**42. The arrival of the invasive kelp species *Undaria pinnatifida* in Irish coastal waters: Here to stay?**

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Alien seaweeds represent one of the largest groups of marine aliens in Europe. Large-scale substitution of dominant native seaweeds with alien species alters coastal biodiversity and can negatively impact ecosystem services. The Asian kelp *Undaria pinnatifida* (Wakame) is an emblematic invader that has established populations over a range of habitats, coastal areas and biogeographic provinces around the world through various introduction vectors, from shipping to farming. It was first reported in the island of Ireland in 2012 and has the potential to spread further and threaten coastal biodiversity there. *U. pinnatifida* has specific environmental requirements for growth and reproduction of its microscopic and macroscopic life stages, with particular sensitivity to changes in water temperature, light intensity and day length. However, there is only limited understanding about how the combined effects of these environmental parameters may affect its potential expansion into non-native habitats in northern European coastal waters. We have developed an individual-based modelling approach to integrate the basic data on the physiological responses of *U. pinnatifida* to changing environmental conditions (collected over many years of cultivation in Japan and elsewhere) into an overall model of population growth. This can then be used to explore the effects of changing environmental conditions on growth dynamics and make predictions about potential expansion and establishment into new habitat ranges around Ireland. We compare the predicted growth dynamics with measurements of real-world populations of *U. pinnatifida* in Brittany, France and make predictions about the potential future spread of the species in Ireland.

**Keywords:** *Undaria pinnatifida*, invasive species, seaweed, individual-based model

### 43. Prevention is better than cure: the case for aquatic invasive species control

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The invasive Asian clam *Corbicula fluminea* (Müller, 1774) has established a high density and self-sustaining population within the tidal reaches of the River Barrow, Ireland. A field trial was carried out to test the respective efficacy of three different mechanical dredge methods, Box, Electric and Hydraulic, at reducing *Corbicula* clam numbers by estimating changes in abundance and biomass immediately following dredging. Sites were identified by SCUBA divers and ROV. Samples were collected before and after test by SCUBA divers. Three test plots were defined by *Corbicula* density and biomass into: high density high biomass (HH); high density low biomass (HL); low density low biomass (LL). Each dredge type, operated from a commercial fishing boat, were tested on each of the predefined plots. A maximum pre-dredge density of 17,870 individuals/m<sup>2</sup> and a biomass of 43.9kg/m<sup>2</sup> were recorded. A reduction of greater than 95% biomass and 95% density was achieved at the site with highest density and biomass (HH). Rare or Threatened Aquatic Species are at risk from invasive species either due to direct impacts, or through changes in ecosystem functioning. From January 1<sup>st</sup> 2015 a new EU Regulation targets preventing the introduction and managing the spread of invasive alien species, including rapid eradication where deemed necessary. The impacts on biodiversity by control methods, like dredging in the case of *Corbicula*, can be high and should be used in a targeted and informed fashion only. This begs the question, is temporary localised reduction in rare or threatened species sustainable and justified in order to reduce invasive' propagule pressure and the risk of secondary spread?

**Keywords:** Asian clam, management, mechanical removal, dredge, sustainable, population density

**44. Can microclimates within the plumage of mallard ducks (*Anas platyrhynchos*) facilitate the spread of invasive *Lemna minuta*?**

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Our ability to predict and manage the spread of alien, invasive plants is limited by a lack of understanding for their potential to disperse. Invasive *Lemna minuta* has spread within a few decennia throughout Europe. However, the mechanism by which the species continues to spread remains a matter of speculation. Birds as carriers of propagules are major agents in the dispersal of plants, animals, fungi and microbes. But there is a lack of empirical data in relation to bird-mediated, epizoochorous dispersal. The microclimate found within the plumage likely plays a pivotal role in propagule survival during flight conditions. In this study, hypothesised epizoochorous transport of *L. minuta* propagules by mallard ducks was investigated. Desiccation resistance is considered the key limitation of the colonization capability of Lemnaceae. Therefore, we analysed retention of viability in *L. minuta* kept outside the liquid growth medium, and within the plumage of mallard ducks (*Anas platyrhynchos*). Our data show prolonged viability of *L. minuta* fronds inserted between the feathers of a mallard duck. Specific humidity found within the plumage was on average 1.5-3.0 times greater than ambient specific humidity. Thus, the plumage can supply a microclimate buffered from that of the exterior environment. Taking together evidence of entanglement and retention of *L. minuta* between the feathers of live ducks, with retention of viability, we consider it likely that mallards contribute to *L. minuta* dispersal. These data have implications for the management strategy of invasive macrophytes and aquatic biodiversity.

**Keywords:** dispersal; *Lemna minuta*; invasive aliens, plumage; mallard duck

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

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

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

#### **46. Ecological Characteristics of Standing Waterbodies Invaded by Alien Macrophytes**

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A general objective of the EU Water Framework Directive is that member states achieve “good ecological status” for all surface waters. Freshwater habitats are particularly vulnerable to invasion by exotic species, including many species of alien submerged and floating macrophytes. The incomplete recording of the distribution of alien aquatic plants in Irish freshwaters may hinder the effective management and control of these species. Similarly, the abiotic and biotic characteristics of the macrophyte-invaded habitats in Ireland are not well described. We surveyed 70 standing water bodies in Cork, including invaded and uninvaded systems, and quantified hydrochemical and physical habitat characteristics and macrophyte assemblages. 61% of macrophyte communities were found to contain at least one invasive species, 28% contained only native species and 11% of surveyed waterbodies contained no submerged or floating macrophytes. Distinct macrophyte communities were identified among waterbodies, and were related to key physical and biological variables. Differences in native species diversity were identified using the Shannon-Wiener Diversity Index when alien-invaded systems were compared to uninvaded systems. Alien-invaded systems did not appear to have lower species richness, but did have a characteristic suite of species and physical-chemical variables. This study enhances knowledge of invaded aquatic ecosystems and how they differ from uninvaded counterparts. Such knowledge has implications for the implementation of effective management of standing waterbodies and control of aquatic invasive species.

**Keywords:** Invasive Species, Native Species Diversity, Macrophyte Assemblages, Species-Environment Relationships

#### 47. Non-target effects of Virkon® Aquatic

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Biosecurity measures to reduce the spread of non-native invasive species are of growing importance, since eradication measures are rarely possible after initial establishment stages. Chemical biosecurity measures are increasingly used in close proximity to waterways to cleanse gear, vessels and equipment that are to be used in multiple aquatic systems in an attempt to limit the spread of damaging invasive species. Virkon® Aquatic (Dupont) is a biocide manufactured for use in aquaculture to reduce the impact of fish pathogens and bacteria but is now being used widely as a disinfection procedure against the spread of invasive species. Previously, we have shown up to 93.33% mortalities in the target invasive species *Corbicula fluminea* when treated with Virkon® Aquatic at manufacturer suggested concentrations of 2% solution for a 5 minute immersion time. Here, ecotoxicological assessment measures are used to examine the impact of Virkon® Aquatic to a non-target amphipod, *Gammarus pulex*. *G.pulex* were exposed to Virkon® Aquatic in 72 hour static renewal toxicity tests at concentrations of 0.6-2mgL<sup>-1</sup> (significantly lower than those described in manufacture solution guidelines) and end points recorded as LC<sub>50</sub> and LC<sub>100</sub>. The LC<sub>50</sub> recorded for *G.pulex* was  $\geq 1.25\text{mgL}^{-1}$  and the LC<sub>100</sub> was  $\geq 3.20\text{mgL}^{-1}$ . The results presented demonstrate that even a very low concentration of Virkon® Aquatic, such as that potentially experienced in the water system during run off or leaching from terrestrial disposal, could be extremely harmful to aquatic invertebrates, particularly those whose morphology are not as protective as that of bivalve clams. We suggest an increased awareness of Virkon® Aquatic use around waterways and potential improved protocols in order to better control the use and disposal of spent chemical. Further research is underway to consider the potential terrestrial impacts of such procedures.

**Keywords:** Biosecurity, Freshwater, Virkon® Aquatic, Ecotoxicology, *Gammarus pulex*

#### 48. Biological Control of the Invasive Leaf Beetle Pest, *Paropsisterma selmani* of Eucalyptus Crops in Ireland

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An exotic leaf beetle pest, *Paropsisterma selmani*, accidentally introduced into Ireland from Australia, now poses a significant risk to Irish commercial Eucalyptus crops. This is the first Paropsine beetle to become established in Europe and it was first noticed damaging foliage crops in Kerry in 2007. Both adult and larval stages of the beetle defoliate crops, depressing yields and rendering foliage crops unmarketable. In the absence of any natural control, damage levels can escalate rapidly. A consequence of inevitable insecticidal usage resorted to by foliage growers to avert losses, is the disruption of the already established biocontrol agent, a parasitic wasp, *Psyllaephagus pillosus*, of the blue gum psyllid, *Ctenarytaina eucalypti*. A parasitic wasp, *Enoggera nassau*, used as a biocontrol agent of similar leaf beetles in New Zealand was imported into a quarantine insectary in University College Dublin in 2012 for further study. This study proposes to (a) assess the suitability and efficacy of the primary egg parasitoid *E. nassau* as a biological control agent of *P. selmani* in Ireland; (b) investigate whether *E. nassau* will persist in the temperate European climate; and (c) determine the extent of the host range of *E. nassau*, testing native fauna, to fulfil the risk assessment required for a release application. Trials examining the life history and efficacy of the wasp at a range of temperatures (10, 15, 18, 20 & 23° C) show positive results for the wasp in cooler climates such as Ireland and northern Europe. Host specificity screening trials conducted to date show that no significant interest was shown by the wasp in eggs of native Chrysomelidae and Coccinellidae. The role of this highly specific parasitoid as a biocontrol agent across different Eucalyptus industries is discussed.

**Keywords:** Paropsine beetle, egg parasitoid, host specificity screening

#### 49. Exposure to Arsenic from Groundwater in Ireland: a Geostatistical Based Approach

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Globally many parts of the environment have been contaminated with metals from geogenic and/or anthropogenic sources. The presence of metals such as arsenic in groundwater is both a key public concern and potential health issue due to its toxicological profile. Arsenic affects the safe supply of drinking water in many countries around the world including Ireland. In order to assess the spatial distribution of arsenic in Ireland, pre-existing groundwater, data from several government agencies and organisations were collated as part of a national collaboration established by National University of Ireland, Galway. Groundwater data collected by the Environmental Protection Agency (EPA) spans the years 1993-2012 with >8000 data points for arsenic. These data are derived from a network of approximately 275 groundwater wells, in order to establish representative water quality for the purpose of meeting Water Framework Directive objectives. In addition, many localised data sets collected by the Health and Safety Executive (HSE) and Local Authorities were also examined. Utilizing both ArcGIS and R, the data were analysed using established geostatistical techniques. This study highlights that, while arsenic is not widespread, it is persistently elevated in certain localities around Ireland. More detailed groundwater monitoring studies in combination with hydrogeochemical analysis are currently being undertaken at a local scale in order to determine the mobilisation and speciation of arsenic and other geochemical parameters within the groundwater system. This work is currently being used for better groundwater management in potentially affected areas.

**Keywords:** arsenic, GIS, Ireland, geostatistics, groundwater management, water quality

**50. The macro invertebrate communities of forested headwater streams in Ireland with contrasting aquatic buffer zones**

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The riparian zone is the area alongside a water body and marks the interface between aquatic and terrestrial habitats. Changes to the vegetation of the riparian zone may be one of the most consequential anthropogenic actions, in terms of its influence on the structure and function of stream biota. Conifer plantations were in the past planted to the edge of streams impacting the biota through tunnelling and changes to allochthonous carbon inputs. To combat this and other potential impacts on the adjacent streams, the Forest Service, Department of Agriculture & Food (currently Department of Agriculture, Food and the Marine) introduced guidelines in 1991, stipulating the establishment of aquatic buffer zones (ABZ) (10–25m) in riparian zones within the national forest estate at time of initial planting or restocking. To investigate whether the vegetation present in the ABZ influences the aquatic community, streams with four distinct ABZ types were sampled, i.e. ABZs dominated by scrub, those with predominantly grassland habitats, control sites with no forestry in the area and sites where conifers had been planted to the streams edge. Within each of the four ABZ types, eight streams were sampled, evenly split between peaty and mineral soils. At each site six surber samples were collected. Macroinvertebrates within the samples were identified to the lowest taxonomic level feasible. Community data was analysed using PERMANOVA to identify structural and compositional effects of ABZ and soil type. Taxa were assigned to functional feeding guilds for comparisons of functional capacity. Water chemistry had a significant effect on community composition and structure as well as the percentage of the community classified as grazers or predators. ABZ type had an effect on the feeding guilds but not total community. The lack of an effect of ABZ type on the community illustrates the greater influence of stream water chemistry.

**Keywords:** Conifer plantations, feeding guilds, riparian zone, aquatic buffer zones

## 51. An Irish Catchment Study of Emerging Contaminant Occurrence using Passive Sampling

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The challenges of monitoring our waters for compliance with WFD and the expansion of the list of organic chemicals that are to be added for monitoring, provides impetus for investigation of alternative monitoring approaches such as passive sampling. The work being carried out represents an important collaboration between two research centres (DCU & MI) together with agency (EA UK and Inland Fisheries Ireland) and industry (TelLab) to assess the potential of passive sampling in monitoring priority pollutants in Ireland. This project pilots the use of passive sampling technology (PDMS and POCIS) combined with biota monitoring to assess the presence of priority substances in Irish surface waters. The project focuses in particular on new pollutants earmarked as candidates for the Annex X priority substances list under the EU Water Framework Directive e.g. E2 and EE2, pharmaceuticals, pesticides, PFOS etc. This considers the implications for compliance with current and proposed EQS and investigates the potential for incorporating passive sampling and biota testing in future compliance, investigative and trend monitoring. Results of water, biota and passive sampling will be presented together for samples collected in the Dublin catchment. A separate study on the occurrence of the pyrethroid pesticide cypermethrin was also conducted. Several sites along the River Liffey, Dublin, were sampled for pharmaceutical as well as other organic pollutants. A POCIS device was deployed at each location and water samples were collected at T-0 and T-4 Weeks. Pyrethroids have a low toxicity relative to other pesticides (specifically the organochlorines) so have recently been used in place of more toxic pesticides. This study involved collection of water samples alongside PDMS and SPMD samplers. Cypermethrin was detected in high levels in the water and PDMS samplers. From the investigation it is clear that passive sampling can play an important role in screening of waters for emerging contaminants, especially for hydrophobic substances where they could be incorporated into a risk based approach to monitoring. Also, passive sampling has demonstrated that it has a role to play in trend monitoring to illustrate where waters are improving in quality over time, thereby offering the WFD monitoring programme a valuable tool.

**Keywords:** passive sampling, surface waters, coastal waters, WFD

## 52. Re-engineering the simple sand filter to remove emerging contaminants from water supplies

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Five million people die annually from unsafe drinking water. Over one billion lack access to clean water. In developing countries, people are affected by basic contaminants such as nitrate, aluminium, organic carbon and ammonium. In developed countries, urbanization, population growth and technology developments lead to emerging contaminants (EC) such as disinfection by-products (DBP) and pharmaceuticals. Engineered solutions that are sustainable, low-cost and globally effective are therefore required. This study investigated the use of waste materials and engineered filtration technologies as mechanisms for removing key basic and emerging contaminants. The study demonstrated how filters may be designed on a case-by-case basis to remove contaminants particular to various on-site conditions. A variety of sands and waste materials were first used in feasibility studies to determine their efficiency in removing various EC. These include sand, granular activated carbon (GAC), zeolite, flyash, Bayer residue, ground granular blast furnace slag (GGBS) and bottom ash. Based on these results, laboratory-scale slow and intermittent sand filters were designed, using layers of media, to target specific contaminants. Results from these led to the refinement of a design which will be tested at an operational drinking water treatment plant. The research considers life cycle assessments of each material to ensure improved outcomes at water treatment plants and maximize the sustainability of implemented designs. The final design should be low cost and sustainable, and where possible, use locally available materials. Given current needs to ensure greater cost-efficiencies and reduced environmental impacts of engineered solutions, the filters could provide robust, simple and cost-effective solutions for the removal of new and emerging contaminants in water supplies.

**Keywords:** drinking water, filtration, emerging contaminants, media re-use, sustainability

### **53. Monitoring of faecal indicator bacteria in streams and sediments in a rural agricultural catchment**

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Faecal coliforms including *Escherichia coli* are commonly used as faecal indicator bacteria (FIB) of recent contamination of water bodies with human or animal waste. Studies have shown that aquatic sediments can also contain elevated levels of FIB that can persist in sediments for months, and can re-contaminate the water column during high flows. There is little work, however, on contamination of sediments in agricultural catchments and none relating to the impact of streamside fencing on levels. Sediment samples were collected from three headwater tributaries in a catchment where intensive cattle production is the main agricultural practice, in April, July, and October 2013 and 2014. Samples were also collected from a site in a catchment with no intensive agriculture. Preliminary data showed that all sites in agricultural catchment were heavily contaminated with faecal coliforms (including *E. coli*) and that values were highly variable both between tributaries and from site to site. Values were highest where cattle had access to the stream. Concentrations were significantly lower in a fenced stream than in two unfenced streams. Future work will include investigations of the conditions under which FIB are resuspended, and persistence of pathogenic bacteria in sediments.

**Keywords:** *E. coli*, sediment, freshwater

**54. The toxicity of agricultural herbicide, fungicide and insecticide on the submerged aquatic macrophyte *Myriophyllum aquaticum***

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From the latest available figures herbicide, fungicide and insecticide application in Ireland amounts to 86.2% of the total quantity of pesticide applied to the land each year. This is equivalent to 1,310,823 kg of active ingredient per year. With this quantity of application it is inevitable that some pesticide will make its way into watercourses and freshwater habitats impacting on non-target organisms. This study examines the impact of five commonly used agricultural pesticides on the non-target aquatic macrophyte *Myriophyllum aquaticum*. These pesticides include two herbicides (glyphosate and mecoprop-p), two fungicides (mancozeb and chlorothalonil) and an insecticide (chlorpyrifos). The aims of this study are firstly, to determine the toxicity of these substances on *Myriophyllum aquaticum* and secondly, to investigate the potential of *Myriophyllum aquaticum* for use as a test organism in future toxicity tests. Small cuttings of the plant are exposed to each pesticide at a range of concentrations (0.01%, 0.1%, 1%, 5% and 10%) over a 14 day period. To determine the impact of these pesticides on the growth of the macrophyte measurements of shoot length, biomass wet weight, biomass dry weight and root development are taken every two to three days for the duration of the experiment. To date the results indicate that roots are the most sensitive endpoint to pesticide exposure for all five pesticides examined. Dry weight measurements proved to be the least reliable measurement of toxicity. In all cases growth of some if not all measurement points was inhibited by pesticide exposure. The study helps us to identify the impact these pesticides have on non-target aquatic macrophytes. It also supports the use of *Myriophyllum aquaticum* in future toxicity tests as a representative species for all aquatic macrophytes.

**Key words:** Herbicide, Fungicide, Insecticide, *Myriophyllum aquaticum*, Toxicity

## 55. A Graphene-Copper Composite as an Anti-Bacterial Agent for Potential 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 (Krasner et al. 2006). Graphene is a relatively new carbon nanomaterial which shows potential as an adsorptive agent for contaminant removal and can be composited with biocidal metals like copper for anti-bacterial purposes (Maliyekkal et al. 2013) (Das et al. 2013). The development of an anti-bacterial graphene based material for potential integration into a drinking water treatment system has been investigated. Synthesis and characterisation of three materials; graphene oxide (GO), reduced graphene oxide (rGO) and a graphene-copper composite (Cu-rGO) was carried out. An evaluation of the anti-bacterial efficacy of the three materials has been carried out in both solid and liquid media against *E. coli*. Synthesis of graphene materials was carried out via chemical exfoliation and further chemical reduction for composite generation. The characterisation of the materials was carried out via scanning electron microscopy (SEM) and energy-dispersive x-ray spectroscopy (EDX). Anti-bacterial evaluation in solid media was carried out using the disk diffusion method and shake flask studies were employed to examine the effect of materials in buffer solution. SEM and EDX analyses confirmed the formation of graphene materials and a copper-composite containing 40% w/w copper. Neither GO nor rGO showed any anti-bacterial effect when tested in either solid or liquid media. Cu-rGO was effective at a concentration of 0.4mg in solid media and as low as 10ppm in liquid tests and shows potential for application in a water treatment system.

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

## 56. Detection of antibiotic resistant *E. coli* and antibiotic resistance determinants in drinking-water sources

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The increasing prevalence and dissemination of antimicrobial resistant bacteria is of concern worldwide. Contaminated drinking water may contribute to dissemination of antimicrobial-resistance and rapid, convenient methods are required to facilitate detection of low level contamination. A filtration enrichment protocol for detection of Verotoxigenic *E. coli* (VTEC) was adapted for this purpose. Up to 30L of water were filtered and filters were enriched in buffered peptone water containing ertapemem (10 µg) or cefotaxime (25 µg) disks. DNA extracts of enrichments were examined for *bla*<sub>CTX-M groups 1, 2 and 9</sub> and carbapenemase-encoding genes (*bla*<sub>KPC</sub>, *bla*<sub>GES</sub>, *bla*<sub>IMI</sub>, *bla*<sub>OXA-48</sub>, *bla*<sub>VIM</sub>, *bla*<sub>IMP</sub>, *bla*<sub>NDM-1</sub>, *bla*<sub>OXA-23</sub>, *bla*<sub>OXA-51</sub>, *bla*<sub>OXA-24/40</sub>, *bla*<sub>OXA-58</sub>). Positive enrichments were cultured on chromogenic agar for isolation of ESBL *E. coli* and carbapenem resistant *Enterobacteriaceae* (CRE). Experiments were performed on water spiked with control strains at 10<sup>2</sup> CFU/L and raw water from 2 rural water supplies. Target genes were detected from spiked water and the control strains were recovered on chromogenic agar. In rural drinking water sources the *bla*<sub>CTX-M group 1</sub> gene was detected and *E. coli* containing *bla*<sub>CTX-M group 1</sub> was recovered (in addition to STEC O26). OXA 48 and OXA 51 targets were detected only from antibiotic-free enrichments. We describe a convenient method for rapid detection and isolation of antimicrobial resistant bacteria from large water volumes simultaneously with detection of VTEC. The *bla*<sub>CTX-M group 1</sub> gene was detected in rural drinking water sources. *bla*<sub>OXA-48</sub> and *bla*<sub>OXA-51</sub> were also detected but organisms were not recovered suggesting the genes reflected environmental organisms inhibited by the concentration of ertapemem used. Application of this method will support evaluation of drinking water sources for low level contamination with specific pathogens (e.g. VTEC) and antimicrobial resistance in indicator organisms such as *E. coli*.

**Keywords:** Groundwater, antibiotic resistance, *E. coli*

## 57. Investigating the contaminant concentration in various tissues of crustaceans fished and landed in Ireland

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This study was initiated in response to the European Food Safety Authority issuing a series of rapid alerts pertaining to elevated levels of contaminants in the edible tissues of crustaceans emanating from Ireland. As a paucity of data exists regarding contaminants in crustaceans fished and landed in Ireland, the main focus of this study was to quantify and characterise the distribution of Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and polyaromatic hydrocarbons (PAH) in the edible tissues and digestive organs of Edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*), and Dublin Bay prawn (*Nephrops norvegicus*) landed along the Irish coast. The white muscle tissue and internal organs of 180 individual *Cancer pagurus*, 15 *Homarus gammarus* and 50 *Nephrops norvegicus* were dissected, tissue samples pooled and analysed by means of capillary gas chromatography coupled with high resolution mass spectrometry (HRGC/HRMS). Mean claw tissue concentrations for *Cancer pagurus*, *Homarus gammarus* and mean abdomen tissue concentrations for *Nephrops norvegicus* were found to be compliant with existing EC legal limits of 6.5pgTEQg<sup>-1</sup> for PCDD/F&PCBs with corresponding values of 0.120±0.005 pgTEQg<sup>-1</sup>, 0.124±0.002 pgTEQg<sup>-1</sup>, and 0.122± 0.005 pgTEQg<sup>-1</sup> respectively. Elevated levels were determined in the digestive and reproductive organs (gonads and hepatopancreas) with mean tissue concentrations of 4.028± 2.88 and 3.033± 1.20 pgTEQg<sup>-1</sup> for *Cancer pagurus*, while the homogenised mixture of both organs in *Homarus gammarus* resulted in a mean value of 3.26± 1.87 pgTEQg<sup>-1</sup>. Although gonads and hepatopancreas tissue are considered in this study, EU regulations state that the maximum levels set for contaminants in crustaceans applies to “muscle meat from appendages (legs and claws) and abdomen, exempting the digestive and reproductive organs from standards. Similarly, mean claw tissue levels of 0.418±0.016ng g<sup>-1</sup> for *Cancer pagurus* and 0.60±0.183ng g<sup>-1</sup> *Homarus gammarus* complied with the 75ng g<sup>-1</sup> maximum limit for the ∑6 marker PCBs, with levels increasing to 7.026±6.17 ng g<sup>-1</sup> (gonad) to 11.59±6.88 ng g<sup>-1</sup> (hepatopancreas) in *Cancer pagurus* and 13.94±10.40 ng g<sup>-1</sup>. The predominant predictor for tissue contamination in both species was found to be lipid content. They are currently no MLs for PBDEs, PAHS (except smoked products) in crustaceans. As PAHs are well known to be rapidly metabolised in fish and crustaceans, levels were found to be less than the limit of quantification (LoQ) in all samples.

**Keywords:** Crustaceans, *Cancer pagurus*, *Homarus gammarus*, Polychlorinatedbiphenyls, Dioxins, Furans

## **58. Biosand Filters: Influence of filter media on biolayer development and filter efficiency**

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Access to safe drinking water remains a major global challenge with 1.1 billion people globally consuming water which is unsafe to drink. The majority of people without access to safe drinking water live in developing nations, including sub-Saharan Africa, South and East Asia. For those in developing nations without a centralized water treatment system there are a number of domestic drinking water treatment technologies available, of which biosand filters (BSFs) have been identified as the most sustainable in terms of treatment efficiency and user satisfaction. Despite the widespread use of BSFs, the development of the biolayer and the operational parameters that influence biolayer development, and ultimately filter efficiency remain poorly understood. The aim of this study was to examine the effect of different filter media on biolayer development and filter efficiency. Hydrad biosand filters (n=3) were used with two different sands: silica sand and builder's plastering sand. Filters were charged daily with 20 L of water from the Curraheen River. The BSFs containing silica sand had a starting filtration rate of 0.48 L/min, while the plastering sand BSFs had a filtration rate of 0.94 L/min. A number of water quality parameters were assessed in pre-filtered and filtered water, including thermotolerant coliforms, dissolved organic carbon (DOC), UV<sub>254</sub>, nitrate, nitrite and orthophosphate. Community level physiological profiling (CLPP) with Biolog Ecoplates<sup>TM</sup> were used at biweekly intervals to assess the changes in the functional diversity of the microbial community of the biolayer over the duration of the experiment. The results so far indicate variations in biolayer development and filter performance with plastering sand showing greater removal of thermotolerant coliforms than the silica sand. Higher DOC and lower UV<sub>254</sub> consumption rates were observed for silica sand in comparison to the BSFs containing the plastering sand.

**Keywords:** Biosand Filters (BSFs), Point-of-use (POU) water treatment, domestic drinking water treatment, thermotolerant coliforms

## 59. Sustainable Health Systems

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There is growing international consensus that public health and sustainable development are interrelated and need to be addressed in an integrated manner. The UK National Health Service and health systems across Europe, USA and Canada have developed sustainable health systems which have led to financial savings, fewer emissions, improved public health and mitigation against the effects of climate change. Measures include low cost interventions which provide immediate gains both financially and socially, as well as longer-term actions which create a more sustainable low carbon and resource-efficient organisation. The Irish health service can make significant financial savings and contribute to environmental protection and improved public health by embedding sustainability measures into its culture and every-day practises. This presentation will summarise the findings of a literature review undertaken to identify key message and good practises from sustainable health systems across Europe and Internationally. The literature review will contribute to the development of a National Sustainability Strategy for the HSE. This study explored the linkages between sustainable development and health, examined key national policy drivers for sustainable development and existing activities for sustainable development within the HSE across a range of topics including leadership and engagement, health and wellbeing, food, energy, water, waste, pharmaceuticals, transport and procurement. The study also examined sustainability strategies and measures in health systems internationally, identified best practises and their relevance to the Irish context. Adopting a sustainability-based approach in the Irish health service has the potential to achieve significant economic benefits and will lead to a better environment and to resilient, sustainable communities. The vision is that a sustainable health service will deliver high quality healthcare, and lead to improved public health without damaging the environment.

**Keywords:** Sustainability, health, health systems, health service

## 60. A quantitative risk assessment for heavy metals in drinking water

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Over 62% of biosolids produced in Ireland are spread on agricultural land as a means to amend or fertilise the soil with nutrients. The beneficial reuse of biosolids must be evaluated relative to potential risks which include, amid other concerns, impacts to water quality due to mobilisation of inorganic contaminants. Recent research has shown the potential of heavy metals to enter surface water systems through runoff water following the land application of biosolids. A quantitative Monte Carlo simulation model was developed to evaluate the risk of contamination from heavy metals to surface water, and subsequently to tap water, in Ireland. The exposure assessment model evaluates likely metal (Cu, Cd, Cr, Zn, Ni and Pb) runoff from four different biosolid treatments. The study considers the potential initial concentration of metals in runoff, levels in surface water systems, the effects of drinking water treatment (coagulation/flocculation, sedimentation, filtration and disinfection), water consumption levels and evaluation of likely human exposure. Results of the exposure assessment coupled with the lifetime average daily dose (LADD) toxicity endpoint, show that the metals Cu and Zn had the highest chronic daily intake rate (LADD values 2.0E-03 and 1.9E-03 ug/Kg bw/day, respectively). The Hazard Quotient (HQ) was highest for Cu (HQ = 4.7E-02), but was still below the threshold value of risk (HQ < 0.01 No existing risk). Sensitivity analysis revealed that water consumption, concentration in runoff, filtration reduction, coagulation/flocculation efficiency (correlation coefficient values, 0.72, -0.51, -0.30 and 0.21, respectively) were the most important parameters that affected model results. Preliminary results have shown that the levels of metals in the experimental biosolids and subsequent application to land, do not pose a significant threat to human health under the conditions monitored. The model developed may be of interest to local authorities, government agencies and other stakeholders to evaluate the potential exposure and risk of organic and inorganic contaminants through water consumption.

**Keywords:** exposure, metals, runoff, risk, water

**61. Effects of community bacterial strain inoculants from *Sphagnum* moss on the biocontrol of *Salmonella* and *Staphylococcus aureus* on alfalfa aprouts**

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The distinctive ecosystem created by *Sphagnum* moss bogs is often one low in microorganism populations and numbers. In fact, these areas are known for their antiseptic conditions. Much of this has been attributed to the acidic surroundings created by the cation-exchange properties of live mosses, as well as the release of polyphenols into its environs, both of which are a deterrent to the growth of many microbes. However, it is possible that ‘bacterial community’ competition may be a factor; where the natural bacterial population found on and around *Sphagna* can inhibit the growth of other pathogenic strains. Microbial communities collected from *Sphagnum magellanicum*, Clara Bog, Co.Offaly, revealed a small but interesting assortment of bacteria and fungi. Work presently is focused on the identification of 12 strains found in these samples. Future work will examine the ability of this natural inoculum to inhibit the growth of foodborne pathogens. Alfalfa seeds will be soaked for 2 hours in bacterial suspensions obtained from the moss. The inoculated seeds will be planted in two separate recirculating hydroponic systems. The water supply of these systems will be spiked with a suspension of either *Salmonella typhimurium* or *Staphylococcus aureus*. The seeds will be grown for 7 days, with sampling during days 1, 3 and 7. At each sampling alfalfa sprouts will be sonicated to recover micrflora from the surface, and the resulting suspensions diluted and plated on selective and non-selective media. Previous published and unpublished studies have concluded that the natural bacterial population obtained from alfalfa sprouts and radishes were efficient at reducing, and in some cases, eradicating the presence of food-borne pathogens introduced to the water supply. It is expected that this study will have similar findings.

**Keywords:** sphagnum, food borne pathogens

## **62. The influence of environmental factors on phlorotannin profiles of commercially valuable Irish brown seaweeds**

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Phlorotannins are highly polar polyphenolic compounds in brown algae, composed of phloroglucinol (1, 3, 5-trihydroxybenzene) monomers. They have been reported to play several ecological roles including wound healing, defence against microbial infection, UV protection and herbivore and fouling deterrence. Their strong anti-oxidant activity is considered to be associated with their unique molecular skeleton, which acts as electron traps to scavenge peroxy, superoxide and hydroxyl radicals, making them highly attractive compounds for commercial applications. The phlorotannin pool within brown algae is not constant but rather is in a state of flux, continuously responding to environmental changes in irradiance, temperature, nutrient availability, exposure and salinity, resulting in unique chemical profiles within algae under slightly differing conditions. These driving factors have been investigated in this study. The impact of salinity on phlorotannin profiles was studied in *F. vesiculosus* collected from two sites differing in their natural saline regime. Q-ToF-MS verified the presence of phlorotannins in the samples, while UPLC-MS/MS provided evidence of variation in the degree of polymerisation (DP) between the two locations. Specimens from mixed, fully marine sites contained larger phlorotannin structures with molecular weights of up to 22 phloroglucinol units (PGU) ( $m/z$  2730.2) whereas specimens from a sheltered inlet possessed much smaller polymers of 9 PGU ( $m/z$  1117.1). The associated bioactivity was monitored via colorimetric assays. The samples possessing higher molecular weight phlorotannins represented a higher level of activity. Experimental exposure to varying salinity levels only incurred slight shifts in already present phlorotannins structures and did not induce the production of high molecular weight phlorotannins; therefore the observed natural differences between the sites may be a result of additional factors synergistically acting upon phlorotannins.

**Keywords:** Phlorotannins, brown algae, salinity, bioactivity, UPLC-MS/MS, QToF-MS

### **63. Analysis of iodine in *Fucus serratus* seaweed bathwater**

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The tradition of seaweed baths has been revived recently in Ireland. Although the commercial seaweed bath providers claim many physiological benefits of bathing, to date there has been no documented research about the characteristics of these baths, their chemical composition and any link to health effects. The focus of this research has been to determine the concentration of iodine and other chemical characteristics of the bathwater and its potential effect on the body. Following validation of the Sandell-Kolthoff spectrophotometric micro-method, the levels of iodine in simulated seaweed bathwater extracts, containing the seaweed *Fucus serratus*, have been determined over a 12 month period. Results show that the concentration of total iodine ranges from 0.8 to 14ppm. Further characterisation of the bathwater has been completed. The effect of temperature on the release of iodine has been investigated. Simulated seaweed baths were prepared at temperatures ranging from 20°C to 80°C and demonstrate a marked increase in the release of iodine with increased temperature. Experiments to measure the pH of the simulated bathwater over 12 months indicate that the pH is very stable and gives rise to an acidic environment (average pH 5.8). The acidity of the bathwater will have an effect on the speciation of iodine present: under such conditions, iodine gas (I<sub>2</sub>) and iodate (IO<sub>3</sub><sup>-</sup>) are expected to predominate over iodide (I<sup>-</sup>). Studies are underway to determine if iodine, present in *Fucus serratus* seaweed bathwater, is taken up by the body during a seaweed bath. Analysis of the urinary iodine concentration (UIC) of samples collected immediately prior to bathing and following bathing over 32 hours can establish if there is an increase in UIC as a result of taking a seaweed bath. A UIC of 100ppb-199ppb indicates optimal iodine nutrition. Preliminary results will be presented.

**Keywords:** Iodine, *Fucus serratus*, Sandell-Kolthoff, pH, urinary iodine concentration

**64. Gold catalysts for CO-free hydrogen production from formic acid derived from biomass:  
Effects of support and doping by potassium carbonate**

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Formic acid (FA) is a non-toxic by-product of biomass cellulose hydrolysis used for production of levulinic acid. Catalytic FA decomposition has a great potential to produce hydrogen for fuel cells. Furthermore, FA can be used as a hydrogen donor in catalytic hydrogenation reactions. Gold can catalyze all kinds of reaction and possesses an ability to perform highly selective and efficient catalysis at low temperature to achieve targets of green chemistry. All catalysts were prepared by deposition-precipitation technique to get 3 wt.% of Au. We showed for the first time that Al<sub>2</sub>O<sub>3</sub> is a better support than MgO, CeO<sub>2</sub>, ZrO<sub>2</sub> and La<sub>2</sub>O<sub>3</sub> supports to stabilize active Au species for hydrogen production from FA decomposition and doping of the Au catalyst with potassium ions leads to a considerable improvement of the catalytic performance. Thus, a 3 wt.% Au/Al<sub>2</sub>O<sub>3</sub> catalyst with 3 wt.% of K is an effective and stable (>26 h) catalyst for the FA decomposition at low temperature (<360 K). It provides CO free hydrogen production. The K-doping effect could be explained by the presence of K<sup>+</sup> ions in FA liquid condensed in the catalyst's pores, which stabilize formate ions in the solution providing a different mechanism of FA conversion through these ions as compared to the undoped catalyst.

**Keywords:** hydrogen production, formic acid decomposition, K-doping, Au catalysts

## 65. Exploring the effect of nanomaterials on soil nitrogen cycling microbial communities

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The use of nanomaterials is becoming increasingly more widespread in industry and, as a consequence of this, environmental contamination is likely to increase. Currently, little is known about the fate of these particles in natural ecosystems and how they will affect ecosystem functional processes. The nitrogen cycle is one of the most important biogeochemical processes in soil and is essential for sustainable agricultural systems. In this project the effect of nanomaterials on soil ammonia oxidising bacteria (AOB) and archaea (AOA) was investigated in two soil based microcosms. An initial microcosm experiment investigated the effect of 50 ppm of two particle forms of aluminium oxide, silica and silver on pastureland soil community structures, while a subsequent experiment investigated concentration effects of silver particles at 10, 25 and 50 ppm. The experiments were run for 30 days in the dark at 22°C with constant soil moisture content. Soil was sampled over time and urease activity, bacterial and archaeal *amoA* gene abundance and bacterial ammonia oxidising community structure examined. Aluminium oxide and silicon dioxide particles were not found to have significant effects at 50 ppm. However, both nano and micron silver particles significantly reduced soil urease activity at a similar concentration. Although ammonia oxidising bacteria community structures were significantly altered by both silver particles, the abundance of bacterial *amoA* gene was reduced by the nano silver particle only. In contrast, the abundance of the *amoA* gene from archaea was significantly reduced by both nano and micron silver particles. These findings indicate that silver particles may have potentially serious impacts on the soil nitrogen cycle.

**Keywords:** nanoparticles, nitrogen cycle, environmental microbiology, toxicology

## **66. A role for diatoms in decontamination of pollutants and environmental applications**

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Diatoms, unicellular microalgae, have a characteristic ornate siliceous cell wall, referred to as the frustule. The elaborate architecture of the frustule, at both the nano- and micro-scale, lends these structures to proposed applications in catalysis, separation science, filtration, and emerging nanotechnologies. Furthermore, diatoms can be prodigious producers of extracellular polymeric substances (EPS). EPS are excreted by diatoms in response to changes in environmental conditions. Reports in the literature have observed that both EPS abundance and EPS composition can be modified by alterations to environment including light limitation, nutrient limitation, and exposure to either organic or metal pollutants. It has been suggested that EPS may find a role in decontamination of pollutants through the formation of aggregates, whereby the EPS sequesters the pollutant forming a gel-like network. The potential to exploit diatoms as a 'green' approach to alleviating contamination is the focus of our research. Diatoms are proposed to serve a dual role in this environmental application; firstly, as factories for the production of naturally occurring EPS, and secondly, harvested frustules will serve as platforms for filtration and photo-catalytic disinfection.

**Keywords:** diatom, extracellular polymeric substances, photo-catalysis

## 67. High temperature stable anatase TiO<sub>2</sub> photocatalysts using single source precursors

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Among the three commonly occurred phases (anatase, rutile, and brookite) of TiO<sub>2</sub>, the anatase form is reported to be the best photocatalyst due to the improved charge-carrier mobility and the greater number of surface hydroxyl groups. The anatase to rutile transition in titania photocatalysts usually occurs at a temperature between 500 °C to 700 °C. Development of a high temperature stable (above 1000 °C) anatase phase is important for various environmental applications (*e.g* self-cleaning ceramic tiles, anti-microbial sanitary wares *etc*). In the current study, the effect of anionic dopants such as nitrogen, fluorine and phosphorous (N, F and P) for improving the high temperature stability of anatase TiO<sub>2</sub> using ammonium hexafluorophosphate as a single source dopant (method A) and multiple sources (method B) were undertaken. Method A was seen to produce a more stable anatase phase, 100 % at a temperature as high as 1000 °C when compared to method B which showed 100 % rutile phase at 900 °C. Kinetic analysis shows a marked increase in the photocatalytic degradation using materials calcined at 1100 °C for method A (0.042 min<sup>-1</sup>) compared to that for method B (0.005 min<sup>-1</sup>) prepared under similar conditions. Commercial photocatalyst Evonik-Degussa AEROXIDE® sample showed a rate of 0.202 min<sup>-1</sup> when tested yet a decrease to 0.031 min<sup>-1</sup> was seen at 1100 °C. The current investigation showed that a single source precursor is more favourable to obtain high temperature stable anatase phase photocatalysts.

**Keywords:** photocatalyst, anatase, rutile, and brookite, high temperature stability

## **68. Synthesis of graphene-reinforced silica aerogels for thermal insulation applications**

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Improving energy efficiency is essential in order to safeguard a sustainable future with secure and affordable energy and environmental sustainability. The new Energy Performance of Buildings Directive (EPBD), Directive 2010/31/EU, calls for increased national regulation for energy efficiency in homes and buildings. Consequently, the Irish government has committed to increasing energy efficiency by 20%, through the National Energy Efficiency Action Plan 2020. There is therefore a requirement for novel insulating materials alternative to traditional cumbersome insulation. This investigation aims to develop an innovative, low cost, thermal insulating coating or paint additive, with a high near IR reflectance, capable of improving the environment and the global energy demand. The paint additives will act as an extra layer of insulation reducing energy loss in homes and improving thermal protection, thus increasing the energy efficiency of buildings. The current study aims to investigate the effectiveness of graphene-aerogel composites for thermal insulation applications. Aerogels are dry, low-density, porous, solid frameworks of gel isolated in-tact from the gel's liquid component. These low density nanoporous materials offer superior thermal insulation properties due to their high levels of porosity. Silica aerogels, in particular, have become increasingly prevalent within the building industry due to their improved performance and reduced production cost. The porosity of a silica aerogel is more than 90% exhibiting a thermal conductivity lower than that of air, resulting in a material ideal for thermal insulation. However aerogels are fragile if not shaped effectively. Thus the potency of aerogels is often reinforced with composite materials. Graphene is a two-dimensional ultra-lightweight material, renowned for its mechanical properties and pronounced surface area. Consequently, composite formation between graphene and silica concedes the possibility of enhancing both the strength and surface area of aerogels. The nanocomposite aerogels will be prepared via cost effective techniques, focusing primarily on sol-gel technology, hydrothermal synthesis and microwave assisted synthesis. The talk will mainly address the preliminary results on the synthesis and characterisation of graphene materials and aerogels.

**Keywords:** energy efficiency, thermal insulation, silica, graphene, nanocomposite aerogels

## 69. Synthesis of titanium dioxide nanomaterials for environmental applications

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Titanium dioxide exists in three different crystalline forms in nature. These are anatase, brookite and rutile. Rutile is the most natural form found in nature and is reported as the most thermodynamically stable phase. Anatase and brookite are both metastable phases and convert irreversibly into rutile at elevated temperatures. Titanium dioxide is the most researched photocatalyst due to its ease of preparation, availability, strong oxidizing ability nontoxicity and its long-term stability. Anatase is regarded widely as the most photocatalytically active of the three phases. The anatase to rutile transition occurs in pure synthetic  $\text{TiO}_2$  at temperatures between  $600^\circ\text{C}$  to  $700^\circ\text{C}$ . Various chemical additives can be used to extend the anatase to rutile phase transition to higher temperatures. Some dopants, such as  $\text{Cu}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Fe}^{2+}$ , etc., are known to accelerate the reaction while others, such as  $\text{SO}_4^{2-}$  and  $\text{PO}_4^{3-}$  retard it. The ability to produce a stable anatase phase photocatalyst with the required properties at elevated temperatures ( $\geq 1000^\circ\text{C}$ ) is desired for its applications. Some of the environmental applications of the photocatalytic anatase include water purification (removal of hazardous substances/disinfection), air purification, in agriculture removal of residual pesticides, energy conversion (solar cell) and water splitting (hydrogen evolution). Preliminary results on the effect of chemical additives to anatase to rutile transition will be discussed.

**Keywords:** titanium dioxide, anatase, photocatalysis, anatase-rutile transition

**70. Exploring the spatial patterns of magnetic susceptibility and metal contamination of soils of an urban bonfire**

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Bonfires are a major pollution source in urban soils, but there is a lack of knowledge about the impacts and spatial extent of bonfires on soil metal concentration and magnetic properties. In this study, a total of 379 soil samples were collected from a traditional bonfire site on a  $1 \times 1 \text{ m}^2$  grid system and analysed for total metal concentration and low frequency magnetic susceptibility ( $MS\chi_{lf}$ ). High resolution maps of the spatial distribution of Cu, Fe, Mn, Pb, Sr, Ti, Zn and  $MS\chi_{lf}$  were created and a significant relationship between each of the metals and  $MS\chi_{lf}$  was revealed. Elevated levels of each metal were observed, with median and maximum values of 68 and 1117  $\text{mg kg}^{-1}$  for Cu, 114 and 985  $\text{mg kg}^{-1}$  for Pb and 561 and 21 681  $\text{mg kg}^{-1}$  for Zn in particular, indicating the site may pose a significant health risk. The spatial patterns were generally consistent, with Zn and Fe in particular, encompassing the position of bonfires. The spatial extent of influence of bonfires was estimated at approximately 10 meters, in line with the extent of bonfire materials. In addition, laboratory based experiments involving soil colour and the effect of temperature on  $MS\chi_{lf}$  indicated that bonfires only raise soil temperatures to a maximum of 300 °C, having little effect on  $MS\chi_{lf}$ . The results of this study indicate the importance of metal contamination associated with bonfires in urban soils.

**Keywords:** metal contamination, bonfire soil, magnetic susceptibility, spatial analysis

## 71. Photocatalytic air remediation and its limits

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Among the air remediation solutions, the photocatalysis process has been considered as a promising technology. Furthermore, the application area of such materials is not limited to NO<sub>x</sub> and VOCs removal from the air, many of these photoactive surfaces exhibit also self-cleaning and antimicrobial properties. The use of photocatalysts has been reported in many publications, which are devoted to e.g. building walls self-cleaning maintenance (the famous Church “Dives in Misericordia), depollution of street areas, road tunnels, highway noise barriers as well as to indoor applications. Commercialisation of photocatalytic cleaning technologies is still ahead of proving their function by reliable testing. The determination of photocatalytic efficiency, which is generally given by degradation or removal of harmful adsorbed substances during the air or water cleaning, or the evaluation of self-cleaning and antibacterial function through standardised procedure is thus very important. The standardised nitrogen oxide degradation test as specified in ISO 22197-1 serves as the first approved test. Although the ISO standard systems focused on the direct comparison among different photoactive surfaces already exist, there is a still an effort to set up the more suitable ones. Moreover, the crucial point seems to be the demonstration of photocatalysts performance under the real conditions. It appears that the efficiency, the long term performance and the real impact on air quality of photocatalysis have not been still investigated enough. The formation of harmful intermediates such as carcinogenic nitrous acid HNO<sub>2</sub> and oxygenated hydrocarbons (e.g. aldehydes) as a result of the interaction between NO<sub>x</sub>/VOCs and surfaces containing TiO<sub>2</sub> has not been effectively assessed. The production of these species may represent an important source of secondary pollutants in urban environment. Accordingly, there is an urgent need to improve characterisation of such surfaces under relevant atmospheric conditions compared to the currently available ISO standards. In order to solve the existing gap between assumptions and reality on how to clean air by photoactive materials is one of the tasks for research team of Nanotechnology Center in Liberec. We generated new composite materials with photoactive function performance, which was determined according to existing ISO standards for NO<sub>x</sub> removal, self-cleaning and antibacterial properties. These materials are also tested under the real condition of the expected application in order to understand the true limits of the photocatalysts for different fields. The model calculations and more innovative experimental tools should be developed to quantify the photocatalytic pollutants removal from the atmosphere more precisely. Finally, the broad international collaboration is very important to give answers, if photocatalysis has to be more than just promising technology to clean our environment.

**Keywords:** hydrogen sulphide, spent mushroom compost, health and safety

## 72. Bench Marking Sustainability of Road Infrastructure

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National Road Authorities (NRAs) across Europe continually strive to improve the performance of their national road networks. This improvement has been underpinned by significant research in the optimisation of road planning, design, construction and maintenance, which has enhanced the understanding of the social, environmental and economic aspects of managing a complex road network. These aspects form the three pillars of sustainability and currently they are addressed at different levels across most European countries, through various policies programmes and plans. Whilst there is common understanding on some aspects of sustainability there is not a common understanding of sustainability as a whole and thus how to benchmark and improve overall performance. In 2010, the NRA developed a sustainability evaluation tool for road infrastructure. The tool was based on the US Green Roads System. However, based on a number of pilot studies, this evaluation tool became part of a Conference of Directors of Roads (CEDR) transnational research study known as '*Sustainability for National Road Authorities*' (SUNRA) which was tasked with identifying how NRAs can contribute to sustainable development. This study involved: 1. Providing a common way of defining sustainable development within the context of European NRAs, 2. Identifying how to measure sustainable development at a strategic level and integrate sustainable development decision making into key intervention points, and 3. Developing a sustainability rating system framework that will enable NRAs to improve performance within the context of building and managing roads.

**Keywords:** Sustainability, Measurement, Road Networks, Evaluation Tool, SUNRA

### **73. Identification, treatment and control of invasive, non-native plant species on Irish national roads: Phase 1**

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In 2006, the NRA recognised the need for guidelines to contain the spread of invasive alien plant species (IAPS) and noxious weeds occurring on the Irish road network. It responded by publishing the "*Management of noxious weeds and non-native invasive plant species on National Road schemes*", which was revised in 2010 to include new innovations on IAPS control. In January this year, the NRA initiated a research pilot programme to assess the extent of IAPS on the national road network and to roll-out a national strategy to effectively control their spread. Focusing on Japanese knotweed (*Fallopia japonica*) and Giant rhubarb (*Gunnera tinctoria*), the first phase involves a pilot study of two counties (Galway and Kerry), and four key actions: -Development of a rapid survey method to assess extent of infestations, -Categorisation of infestations by level of severity and risk of spread, -Identification of appropriate methods of control and urgency of treatment for each infestation, and -Development of a strategy for national roll-out. In undertaking this work, the NRA recognises the progress already made by other agencies. Nevertheless, it is increasingly apparent that the problem of IAPS is not sector specific, and a partnership approach between different disciplines and agencies is necessary to develop strategic approaches to controlling the spread of these plant species at a regional/national level. Regulation 49 of the 2011 Birds and Natural Habitats Regulations, EU Regulations on IAS, and the Directive on the sustainable use of pesticides all put increasing obligations on relevant agencies to develop and deliver good practice. The NRA believes this is best initiated through multi-agency, cross sector collaboration. To this end we are seeking the interest of agencies and individuals to participate in further discussions on how to best progress this national initiative.

**Keywords:** National Roads Authority (NRA), *Fallopia japonica*, *Gunnera tinctoria*, national strategy

## **74. The Incorporation of Sustainable Drainage Systems into the National Road Authority's Drainage Standards for Major Projects**

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One of the functions of the National Roads Authority ('the NRA') is to specify standards in relation to construction works for national roads (Section 19(1)(g) of the Roads Act, 1993, as amended). In order to inform the specification of standards in relation to roads drainage for major projects, the NRA commissioned a number of research projects, which included a NRA-funded post-doctoral study. This post-doctoral study reviewed the current approach to the design of drainage systems and provided guidance on the use of sustainable drainage systems for national road projects in Ireland. The research recommended that the NRA's drainage standards be revised to allow a movement away from a traditional approach of point-discharging road runoff to streams and rivers through detention basins to a more linear diffuse discharge through vegetated systems allowing for some infiltration to groundwater as well as a significantly reduced and treated discharge to surface waters. The study was based, amongst other things, on a number of site visits and on consultation with design engineers and hydrologists. This presentation will outline key aspects of this research and illustrate how the study has informed the recent publication of the new NRA's drainage standards for major projects.

**Keywords:** SuDS, Sustainability, Roads, Drainage, Standards, Research

## 75. Ultra High Performance Fibre Reinforced Concrete for Infrastructure Construction

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All economies are now under pressure to deliver sustainable solutions for all infrastructures. One of the key challenges is to improve the management of natural resources in order to reduce current levels of anthropogenic environmental pressures. According to the NRA, the majority of bridges on Ireland’s national road network have been designed for substantially lower design loads than they are currently supporting. It is required to replace or strengthen and repair these bridges to reach and exceed a 120 year design life. Ultra-high performance fibre reinforced concrete (UHPFRC) is used worldwide to improve the structural performance of bridges, extend their working life and reduce environmental impact. UHPFRC is an encouraging new development in concrete technology as it exhibits much higher strength than conventional concrete. As a result thinner structures are constructed leading to reductions in the structure’s self-weight and the volume of concrete and natural raw aggregates used in their construction. However, UHPFRC is not being used to its full potential in Ireland due to the high production costs. This presentation will discuss the developments in designing a new type of UHPFRC using locally sourced materials, where possible, to produce a sustainably viable material for the Irish construction industry. Using mix design calculations and experimental testing, two different mixes consisting primarily of rapid hardening high strength cement, silica fume, sand and high strength steel fibres have been proposed. Numerical modelling methods are being used to extrapolate the experimental results to produce prediction models that will be used to modify existing bridge design guidelines for use with UHPFRC.

**Keywords:** sustainability, infrastructure, bridges, concrete

## **76. A prediction of the impact of the Dublin Port Tunnel on air pollution emissions, air quality and health**

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The OECD highlights that Heavy Goods Vehicles (HGVs) could produce over 40% of the air pollution in urban areas where they only account for 10% of all transport operations. The Dublin Port Tunnel (DPT) was opened as a dedicated route for HGVs between Dublin Port and the national road network. An HGV management strategy was also introduced in order to remove these vehicles from the city centre. This infrastructure and policy should improve the lives of city centre inhabitants by reducing air pollutants and making it possible to reallocate valuable road space to public transport. This study aims to conduct an assessment of the impact of the DPT and HGV management strategy on air pollution emissions, air quality and health impact in Dublin city centre. VISUM is used as a traffic simulation tool with input data obtained from records of axle counters installed at a number of locations in the city prior to the opening of the DPT. MOVES (Motor Vehicle Emission Simulator) software is then applied as an emission modelling tool to assess changes in emissions. Dispersion modelling will be employed as a next step to evaluate air quality changes through TAPM (The Air Pollution Model) software. Finally, a health impact analysis will be conducted applying BenMAP (Environmental Benefits Mapping and Analysis Program) software which predicts health and associated economic impacts from changes in air pollution concentrations. The results indicate that the construction of the DPT and the implementation of an HGV strategy in Dublin reduced air pollution emissions. Thus the air pollution impact of HGVs on city centre inhabitants is expected to be significant. The results of this investigation can inform policy makers on the costs and benefits of these changes in public infrastructure and policy from an air pollution perspective.

**Keywords:** Air Pollution; Transport impacts on Environment; Emissions Modelling; Health Impact

**77. Common Air Pollutant Projections from the Irish Road Transport Sector under the Emissions Ceiling Directive (NECD) and Convention on Long-range Trans boundary Air Pollution (CLRTAP): A preliminary Analysis for 2035**

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The contribution of the road transport sector to air pollution is a well-established concern. This investigation comprised air emission projections of common air pollutants in Ireland to 2035 (NO<sub>x</sub>, SO<sub>2</sub>, NMVOC, NH<sub>3</sub> and PM<sub>2.5</sub>) for reporting under NECD and CLRTAP. Emission projections were estimated using the methodological guidance provided in the EU recommended EMEP/EEA air pollution emission inventory Guidebook, 2013. Previous emission projections for air pollution in Ireland were estimated using a historical emission inventory which has been revised this year using a more detailed level of data. This improvement facilitated the forward extrapolation of total mileage data for different vehicle class in Ireland. The fleet size for different vehicle classes was also forecasted using new inventory data and macro-economic data available from different government agencies. Linear regression, trend analysis, and the COPERT model were used for estimating the emission projections. The results of this investigation outline the distribution of air pollutants emission projections across the road transport sector for every five years until 2035 starting from 2015. These results also facilitate a comparison of the impacts of the new input data and improved estimation methodology over previous estimates of air pollutant emission projections. Results under existing policies showed that total SO<sub>2</sub> emissions reduced by more than 4% in 2015 and is predicted to reduce by about 26% in 2035. Similarly PM<sub>2.5</sub> emissions reduced by approximately 49% in 2015 and 10% in 2035, whereas NH<sub>3</sub> emissions reduced on average by 17% in each projected year in comparison to the figures from the previous investigation. NMVOC emissions also reduced in the three reporting years, except 2025. NO<sub>x</sub> emissions increased by about 16% in 2015 and by 9% in 2035. Although overall figures and trends show some similarity with the previous investigation, modal distribution of air pollutants were changed, especially for goods vehicles. This research also presents preliminary air pollutants estimations under additional policy scenarios.

**Keywords:** Air Pollution; Transport; PM<sub>2.5</sub>; NO<sub>x</sub>; emission projections modelling

## **78. The Installation of Mammal Mitigation Measures on National Road Schemes in Ireland – an Evaluation of 5 Motorway Projects**

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Roads are known to affect wildlife and ecosystems in a number of ways. The most commonly reported impacts include: traffic mortality; habitat loss and degradation; habitat fragmentation; and increased human activity in adjacent areas. In addition, roads also create permanent barriers to the dispersal of wildlife, which can isolate populations and lead to population decline. As a result, the National Roads Authority has developed a series of ecological and landscaping guidelines to mitigate the effects of roads on wildlife during the various stages of road development. In order to evaluate current practices in the planning, design and construction of mammal mitigation measures e.g. mammal underpass and mammal resistant fencing on national road schemes, desktop studies and post-construction field surveys were undertaken on five recently completed motorway schemes. A total of 101 mammal underpasses (600 mm diam.) were identified across the five schemes. The crossing structures were reviewed with respect to a number of criteria likely to affect the performance of the structures. These included: susceptibility to flooding; adequacy of associated fencing and ease of access for target species. This study offers an opportunity to evaluate the current condition of mammal mitigation measures on road schemes in Ireland and to ensure that future transport infrastructure is not constructed to the detriment of wildlife and ecosystems.

**Keywords:** Mammal, Roads, Underpasses, Mitigation

### **79. The sustainable management of priority farmland habitats on the Aran Islands**

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The Aran Islands have long been recognised for their significant natural heritage; 75% of total land area is designated as Natura 2000 under European legislation. The landscape is largely a mixture of rare habitats – limestone pavement, orchid-rich calcareous grassland and machair - that are a product of, and depend on, extensive farming systems. However, extensive farming practices are under threat due to the low financial returns and high labour inputs associated with small-scale and spatially fragmented farming systems that are composed of relatively low productivity semi-natural grasslands. As a result, undergrazing and changes to traditional farming practices are leading to a decline in the quality of these habitats. AranLIFE, a large-scale demonstration project, aims to enable farmers to reverse negative trends through the delivery of targeted management plans designed to achieve specific biodiversity gains in Natura 2000 habitat. This PhD project has three main objectives: 1.To develop a grazing management model that incorporates optimal grazing regimes to maintain plant biodiversity, as well as elucidating nutritional deficits in forage resource. 2.To assess the relationship between management practices and habitat quality at field level in order to provide an evidence base for optimal conservation management strategies. 3.To profile the socio-economic environment using stakeholder surveys in order to understand the social, institutional and economic context within which farms operate. We will develop a farm typology that integrates variables derived from baseline farm survey data (e.g. stocking rates, scrub species and bracken cover), and GIS information and satellite imagery (e.g. the spatial structure of farms and broad habitat types therein). The typology provides an opportunity to investigate the diversity of farm types within and between islands, and inform better spatial targeting of project actions - particularly monitoring of the impact of project actions on the conservation status of priority habitats.

**Keywords:** conservation, orchid-rich calcareous grassland, grazing management

## **80. Development of a nature value index for pastoral farmland – a rapid farm-level assessment**

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Sustainable agriculture is important for the safeguarding of natural resources (e.g. semi-natural habitats, clean water and energy), food production and for the survival of rural communities. As part of the EU strategy towards sustainability Member States are committed to identifying and protecting areas of agrobiodiversity. Identification of the extent and support of High Nature Value (HNV) farmland across the EU was an important policy requirement of Member States Rural Development Programmes (RDP) (2007-2013) but problems defining the extent of HNV farmland have delayed progress to date. Following a five step statistical process, we developed a simple 10 point nature value index based on percentage improved agricultural grassland, stocking density (LU/ha UAA) and length of linear habitats per hectare on a farm. We propose a nature value index which has potential to be applied to a range of pastoral farming systems across Europe. This index is a simple to use, easily accessible identification tool based on farm-level data which can be utilised in sustainability indices and HNV farmland identification.

**Keywords:** High Nature Value farmland, pastoral farming systems, sustainable agriculture

## **81. Typology of High Nature Value farmland in a Northern Atlantic pastoral landscape**

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High Nature Value (HNV) farmland supports high levels of biodiversity and is associated with farming practices that provide a range of ecosystem services such as clean air and water. Extensive farming practices are intrinsically linked to HNV landscapes. However, most agri-environment schemes implement measures which support actions on intensive farm systems. A greater understanding of extensive farming systems associated with HNV landscapes will allow for the development of better targeted supports for farmland biodiversity. A typology of HNV farmland was developed based on fifty-eight farms within a pastoral landscape in the north west of Ireland. Farm habitat surveys and farmer questionnaires were completed to gather data on a range of farm biodiversity and farm management variables including habitat number, field size, habitat patch size, stocking levels, artificial fertiliser use and length of linear features. Using PCA and Cluster Analysis, thirteen farm types were identified. Ten distinct extensive farm types that contribute to high levels of biodiversity and three intensive types with limited biodiversity value were described. Threats to extensive systems, such as abandonment, were also highlighted. The typology describes the farming systems which have contributed to the development of a HNV landscape of the north west of Ireland. This typology can be used to guide the development of better targeted measures within agri-environmental schemes which will be more beneficial environmentally and economically in future.

**Keywords:** farm typology, High Nature Value farmland, biodiversity, agri-environment supports, cluster analysis

## **82. National distribution and descriptive typology of farmland of High Nature Value (HNV)**

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HNV farmland typically comprises low intensity farming that supports high biodiversity and a range of wildlife habitats. This type of farmland is vital for the conservation of semi-natural habitats and the plants and animals associated with them. It is an EU policy requirement to identify, assess and support these farming systems through national Rural Development Programmes. This research identified the potential national distribution of HNV farmland in Ireland using geostatistical methods. Habitat surveys and management questionnaires were carried out on 102 farms across 10 key sites identified as having high HNV farmland potential during 2013 and 2014. Using these data the distribution of HNV farmland in Ireland was mapped and typologies of HNV farmland were assessed and described. Supporting HNV farmland is essential to ensure vibrant rural communities and guarantee the delivery of environmental public goods such as high quality water, air and soil, resilience to flooding, and farmland biodiversity. It is impossible to target and design policy support capable of maintaining and restoring HNV farmland without knowing its distribution, extent and main characteristics. This research presents an assessment of the distribution, extent and typology of HNV farmland in Ireland.

**Keywords:** HNV farmland, agroecology, biodiversity, rural development

### **83. Using Geographical Information Systems to screen sensitive Natura 2000 sites against atmospheric ammonia**

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The Food Harvest 2020 (FH2020) strategy aims to increase Irish primary agricultural production by 33%. Following the increase in total annual national ammonia emissions from 1990 at 107 Gg to the 1998 high of 121 Gg, ammonia emissions had decreased to an 11 year low of 103 Gg by 2011. Considering agriculture accounts for 98% of Ireland's ammonia emissions, any increase in agricultural activity will lead to an associated increase in atmospheric ammonia emissions, assuming no change occurs in management practices. Atmospheric ammonia poses a significant threat to habitats and species accustomed to low nutrient environments, such as bogs, heathlands and sand dunes. The mechanisms of impact on natural habitats and species from increased levels of atmospheric ammonia are numerous: i) outcompeted by nitrophilous plant species; ii) direct toxicity to plants at high levels; iii) eutrophication; iv) acidification; and associated secondary impacts such as the depletion of food resources (lichens) for the Kerry slug. This study has assigned UK critical loads of ammonia to every Irish Natura 2000 site, which were then screened against modelled ammonia deposition maps of Ireland. This was used as a means to identify the most vulnerable sites to atmospheric ammonia. If agriculture expansion plans under FH2020 are to function within a sustainable environment, it is necessary to classify and evaluate resultant ammonia emissions; thus complying with the Habitats Directive (92/43/EEC), and subsequent devolved National European Communities (Birds and Natural Habitats) Regulations 2011 (SI 477/2011).

**Keywords:** ammonia, air pollution, Natura 2000, agriculture

#### **84. Soil Status and protection in Ireland: collating knowledge, discovering gaps and engaging stakeholders**

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The withdrawal of the proposed European Union (EU) Soil Framework Directive in May 2014 highlights the strong need to think differently about soils and their functionality to secure sustainable development and food production. The European Commission, acknowledging Rio+20 on the *Zero Net land degradation* goal by 2030, remains committed to the objective of soil protection through the *7<sup>th</sup> Environment Action Programme*, the *Resource Efficiency Roadmap* and the forthcoming *Sustainable Development Goals*. Member States should take appropriate action since results and reporting on the status of soils, regulatory context, networks, and shared knowledge are limited. The Soil Status project aims to evaluate the state of the art on data for soil quality in Ireland and related research. A full review of all available Irish data from soil based projects funded to date is being undertaken. Following this assessment, a metadata catalogue documenting data and methods used in these projects has been developed. The metadata catalogue is based primarily on the general SAFER ([erc.epa.ie/safer](http://erc.epa.ie/safer)) concept already accessible to the public. SAFER contains datasets and information from the EPA's Research Programme. The new metadata catalogue SAFER-SOIL contains more structured details specifically related to soil inventories and mapping (e.g. scale, climate, management, ancillary data, etc.). The final SAFER-SOIL shall identify gaps in knowledge or data, provide soil information for stakeholders and optimise future research projects. Project metadata can be queried in many ways including by related soil functions and effectiveness as a policy driver. This would guide the development of soil monitoring network strategies and scenario analyses to inspire and foster further action at National and EU level. The final output of this research is to inform environmental policy on the requirements for future soil protection and to develop a communication strategy to highlight the importance of soils across all sectors of society.

**Keywords:** soil protection, metadata, soil policy, Ireland, monitoring, stakeholders

**85. Relay Risk: Examining the communication of environmental risk through a case study of domestic wastewater treatment systems in the Republic of Ireland**

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Risk-based regulation has become increasingly prevalent in environmental policy. However, a key challenge to the implementation and communication of risk-based regulation is the divergence between expert and non-expert perceptions of risk. While experts may emphasise the quantitative aspects of risk, non-expert groups tend to include emotions, experiences and feelings in their assessments of risk likelihood. Effective risk communication can provide a means of addressing this divergence. Using the case study of domestic wastewater treatment systems (DWWTS), this exploratory study identifies householders’ attitudes and perceptions towards environmental risk regulation, and householder responsibility for the maintenance and operation of their DWWTS. A qualitative research approach was used. This involved four focus groups, selected on the basis of geographical variation, comprising a total of N = 26 householder participants, and two additional semi-structured interviews. Results show that individual concern with respect to their DWWTS is motivated by the presence of tangible environmental indicators that signal a problem with their system. In communicating the risks of poorly operating DWWTS, householders are most responsive to public health related messages. Financial cost and lack of information and awareness on DWWTS issues, and the potential risk implications, are identified as barriers to proper maintenance. Trust in communicators, the perceived credibility and impartiality of authorities, transparency and the perceived objective of regulation, are important features for householders in terms of how they respond to regulation and related communication on environmental risk. Understanding societal attitudes is central to effectively engaging with the public, and informing an improved approach to future environmental engagement.

**Keywords:** domestic wastewater treatment systems, environmental regulation, Ireland, qualitative research, risk communication

## **86. Communities of Behaviour Change and the Meaning of Practice: The Example of the Transition Towns Movement**

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While much research on achieving pro-environmental behaviour change has remained wedded to a rational-choice model, recently there has been greater emphasis on the physical, social, cultural and institutional contexts that shape and constrain people's choices about energy use. In particular, practice theory is increasingly being used to understand why people continue energy-inefficient behaviours even when they have sufficient information and economic incentives to change. Practices are performed by individuals but shaped and sustained by collective conventions and contexts, which they in turn help to reproduce. They are shaped by a complex interplay of technological systems, infrastructures, institutions, social norms, and individual agency. Using the Transition Towns Movement as an example, the author suggests that we can deepen our understanding of practices by studying their meanings for the interpretative communities within which they unfold and how this is constructed. Social behaviour is not simply rationally-goal orientated or determined by socio-technical systems but is profoundly influenced by the interpretative communities within which individuals reside. These communities in turn are underpinned by factors such as physical and social setting, collective memory, circles of recognition, group boundaries, shared rituals, and tradition, which provide the context within which particular practices become meaningful. Practices which are legitimate or prestigious within one interpretative community may be meaningless, unimportant or even unimaginable within another. Energy efficient behaviour needs to have significance within the interpretative frameworks of those targeted in order for practices to change. Where this is achieved, existing social settings can be mobilised as 'communities of behaviour change' to promote energy-efficient behaviours. The argument will be illustrated by the example of the Transition Towns Movement as a 'community of behaviour change' which legitimates and reinforces pro-environmental behaviour in its members.

**Keywords:** Energy efficiency, practice theory, behaviour change, Transition Towns

**87. How are green infrastructure policies & plans implemented in the historic, urban core?  
*Case Studies of George's Quay, Dublin and Victoria Business Improvement District, London***

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Green infrastructure is a relatively new concept that is increasingly being adopted into statutory plans and policies, offering enormous potential as a tool for enhancing the sustainability of urban environments. The research question was how green infrastructure can be meaningfully applied and implemented to the historic, dense, urban core of cities, an environment which would appear to be particularly difficult for such implementation. The research adopted a case study methodology and included a review of the literature pertaining to green infrastructure in the urban core as well as a comparative analysis of two case studies, the George's Quay Local Area Plan, Dublin and the Victoria Business Improvement District, London. This case study research involved documentary analysis, direct observations and semi-structured interviews. The research found that green infrastructure has entered the lexicon of local authority staff and its potential multiple benefits for the urban environment are recognised. The fact that green infrastructure strategies are now being included in plans for urban centres does not necessarily translate into implementation on the ground. Technical barriers to implementation that were identified included lack of space and extensive underground services in the inner city. Organisational challenges were also identified, with calls for cross-departmental collaboration, as well as engagement with local communities and the private sector to promote implementation. Financial challenges exist with reduced budgets across the public sector. Innovative approaches and models for delivery of green infrastructure projects are required. These include combinations of regulatory penalties and financial incentives, such as grants, for the private sector. Public-private collaboration can leverage project delivery and there is consensus that pilot projects are vital for the promotion and greater understanding of green infrastructure in the dense urban core. Green infrastructure provides an efficient and effective means of increasing urban sustainability and creative, opportunistic approaches are required to implement it.

**Keywords:** green infrastructure, planning, policy, implementation

## 88. Scoping land-use policy concerns in Ireland

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Ireland is obliged to achieve a 20% reduction in non-ETS greenhouse gas emissions (which include emissions from agriculture and transport) by 2020. Land-use change will be needed to reach this target, but targets associated with other economic strategies must also be considered. The objective of this work was to identify key policy concerns with regard to land-use and climate change mitigation in Ireland and to match these policy concerns with information needs of stakeholders. A number of relevant policy statements were compared regarding their targets and the knowledge gaps identified. Furthermore, interviews with stakeholders were conducted, where stakeholders were asked about past experience of land-use change as well as their decision making process regarding land use policy. Stakeholders were also giving information about their visions for land-use and the context in which they are making decisions. Preliminary results from this effort and an overview over the EPA-funded project that these results will feed into will be presented. Identifying policy concerns and information needs of stakeholders is the first step in trying to address conflicts and trade-offs in policy targets for land use in Ireland with an evidence-based approach.

**Keywords:** climate change mitigation, evidence-based policy making, adaptive policy making, sustainability, cross-sectorial approach

**89. Science and politics and their views on climate change adaptation in the agricultural sectors of four EU Member States**

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Sound environmental policy should be based on science. Today, we know that it is 95% certain that humans are mostly to blame for temperature increases since 1951 (Climate Nexus), it is less clear what effects climate change will have. Clearly, *'[climate change] is not something that is here today. That has happened. It is something that we think is going to happen. And we are anticipating that we are going to have major effects which are going to influence production systems'* (science interviewee, winter 2014, Ireland). However, in politics not everyone is as clear on this: *'[w]ell, in adaptation it is interesting because people are beginning to see changes and trends, now the jury is out whether they are just cyclical or actual climate change trends like the weather patterns'* (politics interviewee, winter 2014, Ireland). Thus, there is a difference in how different systems of society, such as science and politics, describe climate change at the moment. This paper draws on empirically found views on climate change adaptation in the agricultural sector from the fields of politics and science from four EU Member States (Ireland, the UK, France, and Germany) and applies a socio-legal systems theoretical lens to explain the differences in communication it finds. The paper concludes that there are differences in communication between different systems of society and argues that these differences in views on climate change and the adaptation to it can add up to difficulties in communication between different parts of society. Since, in the case of agriculture, the economic system has to adapt, the paper also concludes that it is easiest to implement climate change adaptation in countries where the economic system (or part of it) steers adaptation.

**Keywords:** adaptation to climate change, socio-legal systems theory, European Union, environmental policy

**90. Assessing the efficacy of Dublin City Council's Fat, Oil and Grease (FOG) Programme through the quantification of FOG waste recovered**

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Fat, oil and grease (FOG) is a waste by-product of food production. FOG enters the sewer network as a result of poor management practices in domestic and commercial kitchens, and is the cause of 50-70% of in-line sewer blockages. FOG forms a hardened solid in pipes as a result of physical and chemical property changes that occur within the sewer network, reducing capacity, and increasing the risk of overflow. Sewer overflow poses significant risk to public health and the urban environment through the release of high concentrations of pathogens, nutrients, and bio-solids (faeces). In 2008, Dublin City Council (DCC) introduced a FOG Programme to address recurring FOG related blockages within the sewer network. The programme requires food service outlets (FSOs) in the DCC functional area to hold a trade effluent discharge licence, install and maintain grease trap systems (GTSs), and introduce best management practices to reduce the quantity of FOG entering the sewer network. A study area in Dublin city centre of approximately 160 FSOs was assessed over a period from 2008-2014 (c. 7% of the FSOs in Dublin) to assess the efficacy of this programme in reducing the FOG risk to the sewer network. Over 2,000 environmental monitoring inspections performed in the study area since the inception of the programme were reviewed to track: GTS installation, GTS maintenance, and FOG disposal. The study has found that compliance within the study area with the licence conditions has increased steadily since the programme commenced, resulting in over  $200 \times 10^3$  litres of FOG being redirected from the sewer network in 2014. The objective of this project is to give spatial and temporal representation to the effect the DCC FOG Programme has in reducing the risk posed by FOG to the urban environment, through the quantification of the waste recovered from FSOs and the development of GIS maps at key time steps since implementation, thus aligning with the sustainability theme of the conference. Further details of the research study are available at <http://ssu.ie/research/fog>.

**Keywords:** FOG Waste, grease trap, used cooking oil, sewer network, wastewater management

## **91. Insights on the Antioxidant Properties Of Microalgae Isolated From The Northwest Of Ireland**

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Microalgae are a heterogeneous and diverse group of microorganisms capable of accumulating substantial concentrations of high-value products under specific conditions, making them hence promising organisms for biotechnological applications in the nutraceutical, functional food, animal feed, biofertilisation and biofuel sectors. There has been renewed interest in the last decade in natural sources of antioxidants, particularly as functional food health products and industrial preserving agents. Microalgae can exhibit a variety of adaptive responses to oxidative stress and utilise an antioxidant defence system comprising a range of enzymes (*e.g.* superoxide dismutase or catalase) and non-enzymatic metabolites (*e.g.* ascorbic acid, glutathione or carotenoids). This study is aimed at assessing the antioxidant potential of microalgae strains isolated from aquatic habitats in Ireland and successfully brought into culture. Genetic characterisation of the microalgae was carried out by means of 28S rRNA gene targeted PCR, sequencing and phylogenetic tree construction. A number of cultures were grown in nutrient-enriched media in an illuminated incubator to generate biomass. Biomass was concentrated from several strains and antioxidants were extracted with specific solvents. The extracts were screened for total antioxidant activity using a modified volumetric Trolox-ABTS assay, an optimised Folin-Ciocalteu (FC) method for polyphenol fractions and the Lichtenthaler equations for carotenoid determination. Future work will focus on complementing the results by assessing potential DNA oxidative damage of the extracts using the Comet Assay as well as fluorescence micro-imaging to highlight the sub-cellular distribution of flavonoids. The most promising strains will be cultured in scaled-up culture vessels so as to investigate the effects of physiological stress on their antioxidant capacity.

**Keywords:** Microalgae, antioxidant activity, high-value metabolites

## 92. Evaluation of the impacts of the EPA 2007 Infrastructure Awards

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In 2007 the Environmental Protection Agency (EPA) launched an Infrastructure funding scheme under their research programme '*Support for instrumentation and Related Infrastructure.*' A total of 13 grants were awarded, arising from an EPA Funding Commitment of €1.5m. The individual awards ranged from €50,000 to €500,000 to fund the purchase of a variety of research infrastructure, from small mobile equipment to large scale laboratory equipment, which was procured and installed over a two year period. A review of the scheme was carried in 2014 to collate feedback on the impacts of the scheme on research capabilities gained by researchers who had purchased specialised equipment. The 'sharing' of equipment was a vital aspect of the funding scheme. Benefits arising from the receipt of infrastructure funding included: 1-Benefits to the host Institution: -Equipment was a core part of research and enhanced the research output, publications, citation numbers and recognition. -Research and training for Graduate to Post Doctorial levels. 2-National and International Benefits: -'Sharing' of equipment created partnerships and enhanced collaborative research efforts between industry and research experts at national and international levels. -Leveraging of national and international funding e.g. European funding. 3-Feedback to improve future Infrastructure funding schemes: -To secure and gain long term benefits it was important to encourage the institutions to provide adequate support with trained technicians, maintenance and running costs. This review highlighted that there is a clear need for more infrastructure funding schemes of this type. The positive outcomes gained from this process are seen to extend far beyond that of the receipt of specialised research equipment; enhancing Ireland's collaborative and competitive potential in research and innovation, and driving Irish partner participation in European funding, such as Horizon 2020.

**Keywords:** Environmental Protection Agency, Infrastructure, Research, Outputs, Innovation

### **93. Mobility biographies and milestones: Lessons for sustainable transport in Ireland**

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Ireland faces significant challenges in improving sustainability in transport. This research adopts a life course approach towards mobility practices. For example, there is significant evidence to show that key life events, including childbirth, residential relocation, and changes in employment or education status influence travel patterns. Furthermore, major mobility-related life events such as getting a driving licence or buying the first car have also been shown to significantly influence people's mobility practices. Previous studies advocate a mobility biography approach which maps trajectories in the mobility domain and whether and how these are related to life events. At the same time, individual consumption biographies reflect wider structural conditions in society, including prevailing 'systems of provision' that organise the delivery of goods and services and their subsequent consumption. Linking individual mobility biographies to the histories of key mobility policies and related structural developments can thus cast new light on the causes and consequences of (un)sustainable mobility practices. Yet, to date, few mobility biography studies have considered such linkages between effects of structure and agency as well as the effects of mobility socialisation whereby individuals become exposed to societal norms and values regarding mobility. A new mobility biography survey tool has been developed from conceptual framework to administration. This includes an innovative approach to mapping mobility biographies and life events as part of an online survey. This survey has recently been rolled-out on the island of Ireland and initial results will be presented at the conference. The survey will be complemented by an in-depth desk study of policy and transport infrastructure developments. Survey results will be plotted against observable structural changes in the Irish transport system and policy landscape, with a view to connecting individuals' biographies and wider structural changes, including policy transformation and shifts in transport systems. Outputs of this research will include recommendations for Irish transport policy which focus on life and mobility events to improve sustainability.

**Keywords:** mobility; sustainable transport; lifecourse; mobility biography

## 94. Use of Sphagnum moss as a New Growth Medium in Advanced Life Support (ALS) Systems

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On long duration space missions such as the colonisation of Mars, humans will require a continual food, water and air supply. As it is not practical to re-supply from Earth, the development of integrated energy efficient technologies to produce food, purify water and scrub air is paramount, all while operating under restrictions of minimising volume, mass, and labour. The use of *Sphagnum* moss in a hydroponic/resource-recovery system for this purpose, was investigated. *Sphagna* leaves are nerveless, lack vascular tissue and are composed of two cells, ‘living’ narrow green cells and inflated colourless ‘dead’ cells which are responsible for Sphagna’s enormous water holding capacity. *Sphagnum cuspidatum* was selected based on its resilience to nutrient fluctuations. A plant trial using lettuce cv. Flandria was run over 28 days with sphagna as the growth medium. Five trays were set up: Rockwool control +½ Hoagland’s; Sphagna ‘living’ +½ Hoagland’s; Sphagna ‘dead’ +½ Hoagland’s; Sphagna ‘living’ + Urine Simulate & Sphagna ‘dead’ + Urine Simulate. Sphagna’s ability to buffer lettuce against nutrient overload was measured in both nutrient solutions, while ‘living’ Sphagna versus ‘dead’ performance and nutrient content in all plant tissue was determined. Lettuce in all four test trays with Sphagna showed healthy growth and nutrient concentration within the tissue was higher than that observed in the control. The urine simulate test trays exhibited a higher nutrient load than the Hoagland’s, with some leaf burning of the lettuce evident as the trial proceeded. ‘Dead’ sphagna plants performed similar to ‘live’, making it a suitable choice for space flight, as it can be dehydrated before flight to reduce weight and rehydrated for use.

**Keywords:** advanced life support, ALS, sphagnum moss, sphagna, hydroponic resource recovery, regenerative life support

**95. Genetic manipulation of Irish marine cyanobacteria for overproduction of UV-screening compounds, mycosporine-like amino acids (MAAs)**

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Cyanobacteria are Gram negative, oxygenic prokaryotes, one of the most primitive life forms on Earth. Having evolved during a time when the stratospheric ozone layer was absent, these organisms developed evolutionary mechanisms in the form of biosynthesising UV-screening compounds; mycosporine-like amino acids (MAAs) to protect against UV induced intercellular damage. An investigation was initiated with the aim of identifying best producers of MAAs and explore further their inherent machinery for maximum production of MAAs through genetic manipulation. The preliminary study began with screening 50 cyanobacterial isolates from the Shannon ABC biobank and identified nine promising cyanobacteria. Total MAAs content ranges from 0.2-0.3 mg/g fresh weight biomass. Specific types of MAAs by LC-MS analysis is in progress. For genetic manipulation of Irish cyanobacteria, two genes were chosen, namely DHQ synthase and O-methyltransferase, which produce the core structure of MAAs, 4-deoxygadusol in *Anabaena variabilis* ATCC 29413. Our bioinformatics analysis identified the homologs of the above genes in *Anabaena* sp. PCC 7120. We therefore PCR amplified these homolog genes from *Anabaena* sp. PCC 7120 and successfully cloned them using the shuttle plasmid pAM505 to overexpress them from native promoters in the model cyanobacterium *Anabaena* sp. PCC 7120 (control expression) as well as in the best MAAs producer (test expression in marine cyanobacteria) identified during our preliminary screening. Our genetic transformation approach included transferring of the cloned shuttle plasmid to *Escherichia coli* AM1359 and then to cyanobacteria via bi-parental conjugation. Cyanobacterial transformants will be selected on antibiotic (neomycin) plates and PCR confirmed before the re-analysis of MAAs content by LC-MS.

**Keywords:** Cyanobacteria, UV-screening, MAAs, genetic manipulation, biotechnology

**96. A Simulated Population approach to estimating the value of achieving good ecological status in Irish water catchments**

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An important element of the EU Water Framework Directive (WFD) is that it calls for a consideration of the economic costs and benefits of improvements to ecological status in catchment management plans, along with the introduction of full social cost pricing for water use. Hence, benefits play an important role in the assessment of the proportionality of costs in the implementation of the WFD. This paper presents the results of a contingent valuation exercise where the value to the Irish general public of achieving good ecological status (GES), as specified in the WFD, is estimated. The results from the contingent valuation analysis are then used in combination with a spatial microsimulated model of the Irish population to estimate the value of achieving GES within individual water management units across Ireland. The estimated values from this function based transfer approach are compared against the results from a previous primary valuation study that was carried out in one Irish river catchment.

**Keywords:** Choice experiments, water valuation, public's revealed preferences

## 97. Economic impacts of angling events in Ireland

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Recreational angling and inland fisheries are recognised to have considerable socio-economic benefits, not only for anglers but for others in both local and wider communities. In this study the value of Irish recreational angling events was estimated using the travel cost method. A survey of recreational anglers who had participated in Irish angling events over the course of the 2013 angling season was undertaken; this survey yielded a sample of 314 complete questionnaires for analysis. Poisson, negative binomial and generalised negative binomial models were then compared to estimate the average angler's consumer surplus for these events. The negative binomial model adjusted for on-site sampling performed relatively well in the study. An average consumer surplus figure of €252 per day was estimated using this model. The overall willingness to pay indicated by anglers who took part in angling events was estimated to be €2305 per angler per trip. The study demonstrated that anglers who participate in Irish angling events place a very high value on them; this corresponds with the theory that where individuals specialise in a certain form of recreational activity they tend to invest more heavily in these activities in correlation with their degree of specialisation.

**Keywords:** Recreational Angling Events, Ireland, Economics

## 98. Efficiency in Irish Nephrops fisheries

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The socioeconomic impact of rising fuel and input costs on fishing communities has been significant in recent years. It is therefore becoming increasingly important for fishing vessels to utilise inputs as efficiently as possible to remain commercially viable. This paper is concerned with the efficiency of Nephrops fishing vessels in Irish demersal otter trawl fisheries. Using stochastic frontier analysis (SFA), satellite based vehicle monitoring systems (VMS) data and routinely collected recordings of live-weight Nephrops catches, this paper analyses the disparity in efficiency across vessels in the Nephrops fishing fleet. Once efficiency-heterogeneity was identified within the fleet, discrete choice econometric methods were used to determine which characteristics across vessels (e.g. vessel length, engine power, vessel value, fishing location decision etc.) partially determined differences in efficiency. Given the portion of input cost attributable to fuel costs (estimated at 76%), the act of choosing where to fish, at which speed to travel and maintaining an engine's fuel efficiency were all deemed to be key in achieving an efficient input output ratio. In addition to analysing the key determinants of overall vessel efficiency, the paper also seeks to determine whether efficiency is constant over time across vessels, and thus the result of skipper skill, or is variable over time, and therefore the result of "luck" or chance. The results indicated that because fishing location choice is highly relevant in determining overall fuel consumption (and output), it is this variable that will determine long-term efficiency performance of a vessel. A policy shift focused on increasing vessel efficiency in terms of how inputs are utilised so as to improve fishery rents without altering output is required (since output is usually heavily subject to quota and therefore largely inalterable as a way of bolstering fishery rents in the short term).

**Keywords:** Efficiency, Stochastic Frontier Analysis, Fisheries

**99. Using contingent valuation and value transfer to estimate the value of achieving Good Environmental Status under the MSFD in EU Atlantic states**

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This paper presents a valuation exercise combining the contingent valuation method (CVM) and value transfer (VT) to estimate the value of the non-market benefits associated with the achievement of good (marine) environmental status (GES) as specified in the EU Marine Strategy Framework Directive (MSFD) for northeast Atlantic member states. The increased use of geographic information systems (GIS) in VT means that many VT exercises now include spatial elements such as allowing for substitute sites, distance decay and population density. This paper explores the manner in which distance decay is modelled and the appearance of the modifiable area unit problem (MAUP) when population density is included as an explanatory variable. These issues can have a large effect on a VT estimate. In this study the overall value for achieving GES for Atlantic MSs varied between €1,250 million and €2,000 million depending on how distance decay was specified. It was also found that mean VT error was lowered by adjusting the spatial scale at which population density is measured in an effort to overcome the MAUP.

**Keywords:** MSFD, Value Transfer, Distance Decay, MAUP, CVM

**100. The importance of a robust and transparent methodology in determining materiality for corporate sustainability reporting**

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Sustainability reporting has become a priority for many global multinational organisations. This is associated with ever-increasing expectations from key stakeholders for organisations to be transparent about their strategies, activities and management with regard to sustainability issues. The Global Reporting Initiative (GRI) encourages organisations to only provide information on the issues that are critical in order to achieve the organisation's goals for sustainability and manage its impact on the environment and society. However, a key challenge for most reporting organisations is how to identify relevant issues for sustainability reporting and prioritise those material issues in accordance with organisational and stakeholder needs. This research provides an in-depth analysis of the approaches used by a number of international sustainability leader corporates to identify key sustainability issues. The research methodology involves performing a detailed analysis of sustainability report content of up to 50 companies listed on the 2014 Dow Jones Sustainability Indices (DJSI). Preliminary research indicates significant gaps in the information disclosed in corporate sustainability reports versus the indicator content specified in the GRI Content Index. Most companies give only a brief explanation on how material issues are defined, identified and ranked. Data on the identification of key stakeholders and the degree and nature of engagement for determining issues and their weightings are lacking. The research indicates that most companies lack a rigorous and thorough methodology to systematically determine the material issues of sustainability reporting in accordance with company and stakeholder needs. These deficiencies have the potential to discredit sustainability reporting unless the shortcomings described are rectified.

**Keywords:** Identification of key stakeholders, Material issues, Sustainability reporting, Transparency

**101. Sustainable Planning for the Environmental Impacts of Tourism in Ireland: A Local Authority Perspective**

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A content analysis approach was utilised to investigate and analyse every Irish Local Authority County Development Plan (CDP) to identify the current provision of sustainable environmental planning for tourism. Results show that Local Authorities are mindful of the strong reputation Ireland's environment has both nationally and internationally when it comes to tourism. Significant numbers of Local Authorities acknowledge this relationship by supporting area protection measures. Some supplement this further by utilising camping and caravan regulations developed by Failte Ireland within CDPs. However, further analysis reveals that CDPs suffer from a lack of robust and detailed tourism policies, strategies, budgets and guidelines. This can make it difficult to facilitate the implementation of these legally required five year plans. Also, it was found that Local Authorities still do not exhibit a clear understanding of the importance of sustainable tourism indicators as viable tools in the sustainable planning process for tourism. The assessment criteria utilised in this study may be used in the future in the context of a possible longitudinal study.

**Keywords:** Sustainable Planning, Tourism, Environmental Impacts, Local Authorities, Ireland

**102. The Intergenerational Transfer of the Irish Family Farm: Underestimating the Importance of Symbolic Capital?**

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Intergenerational family farm transfer is increasingly of interest to researchers and agricultural industry bodies, as it is seen as crucial to the survival and continuity of the family farm and future prosperity of the agricultural sector. Similar to what is occurring on a global scale, Irish agriculture is largely populated with an older generation of farmers, which is regularly viewed as a quandary, necessitating a more appropriate policy response. A review of the existing research however highlights that financial incentives encouraging succession and retirement from farming have engendered little change in attitudes amongst elderly farmers. Recognising the limitations of focusing on financial enticements encouraging this process, as is currently the case in Ireland, there is a growing acknowledgement that attention should be paid to addressing the underlying emotional forces determining family farm transfer, in an effort to guide future policy. Answering these questions from a geographical perspective, this research seeks to address this gap in knowledge by investigating the deep-rooted connection older farmers have with their farm and occupation. The theoretical framework underpinning this unexamined phenomenon of family farm transfer research is Pierre Bourdieu's concept of symbolic capital. Symbolic capital refers to the resources available to an individual on the basis of honour, prestige or recognition (Bourdieu, 1986). Adopting this concept enables the development of structural reference points in respect of the human factors involved in the succession and retirement process. This research adopts a multi-method triangulation design approach to determine the underlying forces influencing farm transfer. The research instruments used to procure data; farmer surveys and in-depth interviews, embody both quantitative and qualitative elements. Preliminary analysis of fieldwork data carried out reveal that the possession of symbolic capital plays a key role in deterring the process, as it shown to account for the emotional aspects of the farming occupation.

**Keywords:** Family Farming, Succession, Retirement, Symbolic Capital, Rural Sustainability

### **103. The application of functional soil management to support sustainable intensification on Irish farms**

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Sustainable intensification in the agricultural sector is crucial to ensure food security for an expanding global population and to satisfy the requirements of increasingly stringent environmental legislation in the EU. Functional soil management (FSM) comprises a novel land management approach to support sustainable intensification through the provision of soil based ecosystem services (soil functions). The multi-functional capacity (MFC) of a soil refers to its capacity to simultaneously perform each of the five key agronomic functions (production of food, fibre and (bio)fuel, water purification, carbon sequestration, biodiversity and recycling of external nutrients). FSM capitalises on the soil's MFC by matching the nature/degree of farming activity to the soil type, which is best at "supplying" the preferred suite of functions. This project aims to further develop and support the concept of FSM by assessing the influence of soil moisture status and agricultural land use type on the MFC of soil. Based on a comprehensive literature review, conceptual frameworks were developed to illustrate the variation in the capacity of the soil to perform each individual soil function. A FSM matrix was compiled, which visually presents the combinations of different categories of land use and soil drainage that optimise the MFC of soil. Moderately drained soils conceptually appear to have the highest overall MFC and, thus, provide the best opportunity to achieve sustainable intensification. Although certain soil types have a low MFC, they still may have a high capacity for individual soil functions. For example, poorly drained soils are less productive but they have the highest capacity for water purification (by denitrification). All soil types contribute to the goal of sustainable intensification due to their overall MFC and/or their capacity to perform individual functions. It is anticipated that FSM will serve as a useful tool to support future policies on agronomic land management.

**Keywords:** soil ecosystem services, soil functions, sustainable intensification, land use management

#### **104. The spatial and temporal variation of ambient atmospheric ammonia concentrations in Ireland**

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Ambient atmospheric ammonia ( $\text{NH}_3$ ) concentrations were measured in a network of 25 monitoring stations across Ireland. The 13 month campaign started in June 2013 and ran until July 2014. Atmospheric ammonia concentrations were determined using passive samplers, exposed in triplicate at each monitoring site. Ammonia was collected on an absorbent acid layer within the sampler. The samplers were exposed at a sampling height of 1.2 m and replaced on a two-week cycle. Ammonia amounts, determined from each passive sampler by spectrophotometric analysis, were converted to an air concentration value ( $\mu\text{g m}^{-3}$ ). Laboratory blanks and travel blanks were used as controls. The results show both spatial and temporal variation across the country. There are distinct and separate trends of increasing ammonia concentrations towards the northeast midlands and the southeast. Temporal variations indicate increasing concentrations from winter to autumn and reflect agricultural activity. The station with the lowest mean concentration of  $0.48\mu\text{g m}^{-3}$ , was Mace Head, Co. Galway while the highest mean, at  $2.96\mu\text{g m}^{-3}$  was Leiter, Co Cavan. The average level of  $1.72\mu\text{g m}^{-3}$  from all 25 sites is below the  $8\mu\text{g NH}_3\text{ m}^{-3}$  critical level recommended by the Convention on Long Range Trans-boundary Air Pollution (CLRTAP). Some sites registered much higher than the background, for example a maximum of  $10.50\mu\text{g m}^{-3}$  was recorded at Carrickmacross during one exposure period. Recent studies suggest that the current critical level in Europe has been set too high and should be dramatically reduced to avoid impacts to sensitive receptors. High atmospheric ammonia levels resulting in subsequent ammonium deposition may cause soil acidification and leaching of soil nutrients, and also contribute to eutrophication and groundwater pollution. The aim of this study is to monitor ambient atmospheric ammonia air concentrations across Ireland and to improve the understanding of its spatial and temporal variability.

**Keywords:** ambient atmospheric ammonia, eutrophication, critical level

**105. Effects of lime application on the active soil microbial community during a barley growing season**

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Much of the soil throughout Ireland, due to its acidic nature, requires amendment with lime or other alkali products in order to provide soil at an optimum pH for crops. Sub-optimal pH has severe implications for crops including slow growth, limited productivity and increased susceptibility to disease. Previous studies have shown positive effects of liming on soil microbial biomass and activity (respiration), and revealed that acidic soils often limit biological processes such as nitrogen fixation. However, microbial communities have yet to be deeply characterised in this context. To address this knowledge gap, this study employed Next Generation Sequence analysis to reveal the impact of improved soil pH, via lime application, on the soil microbiome. The overall aim of the study was to provide a more in-depth understanding of the method of action of these widely used lime based products, from the micro-level up to the plant level. A field-based study was carried out, during which samples were collected in order to determine the effect of lime application on barley productivity, health and growth rates, as well as on the native soil microbial community. An acidic agricultural soil was treated with increasing concentrations of a new-to-the-shelf lime product (GrowMax), ranging from 0 kg ha<sup>-1</sup> to 950 kg ha<sup>-1</sup>, with each treatment replicated in four randomised plots. Throughout the 20 week study soil pH, plant growth and health were monitored. For microbial community analysis, two treatments were chosen (zero and high lime) which were sampled at three time points correlating to different growth stages of the barley (stem extension, heading and ripening). DNA and cDNA were co-extracted from rhizome associated soil for 16s rRNA amplicon Illumina analysis. Overall, improved crop yields and health were observed with increasing soil pH and these could be correlated with changes in the soil microbiota.

**Keywords:** soil microbial community, lime application, pH, soil

**106. Assessment of novel ι-carrageenan hydrogel blends as environmentally friendly seed coating agents for durum wheat seeds**

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A green technology that can increase crop production while maintaining low pollution is essential for sustainable agriculture. This project focuses on the development of new environmentally friendly hydrogels for seed coating applications. Two hydrogel blends – agar/ι-carrageenan (Blend 1) and xanthan/κ-carrageenan/ι-carrageenan (Blend 2) – were synthesised for their biodegradable non-toxic sugar based natural composition as well as their excellent water absorbing/holding capability. These hydrogels based on ι-carrageenan were characterised by swelling studies and rheological analysis. Addition of agar into ι-carrageenan increased the gel strength and improved the water holding capacity from 39.6 % to 67.3 % after 72 hr of incubation at 30 °C. The addition of xanthan/κ-carrageenan into ι-carrageenan improved the water absorbing capacity from 117.9 % to 139.1 %. The life-span of the hydrogel increased from 6 hr to 24 hr in excess water. The gel strength also increased from 108.4 Pa to 267.98 Pa. The effect of hydrogels on the germination and coating process were examined using durum wheat seeds (*Triticum durum* Desf.). The pure ι-carrageenan hydrogel gave a significant increase in the germination percentage and the speed of germination under optimum conditions. Treatment with Blend 1 hydrogel increased the seed length and seed vigour when compared to pure ι-carrageenan hydrogel. The difference in coating appearance and coating thickness between spray and pan coated seeds were examined under digital microscope and scanning electron microscope. It is anticipated that this work will be extended to the coating of different seed varieties to promote healthy seed growth with minimum environmental impact under extreme climate conditions.

**Keywords:** hydrogel characterisation, seed germination, sustainable agriculture

**107. The use of bioassays to assess the effect of different rehabilitation strategies on biological properties of bauxite residue**

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Bauxite residue is a waste product of the Bayer process, whereby alumina powder is refined from bauxite ore using hot, concentrated sodium hydroxide. Bauxite residue is characterized by high pH, sodicity and salinity with poor nutrient status and fertility. The unstable surface substrate is prone to water and wind erosion, making re-vegetation necessary. Successful re-vegetation requires amendment of the residue to neutralise pH and improve chemical properties, usually through the application of gypsum and organic compost. Samples of rehabilitated bauxite residue were collected from two rehabilitated field sites at Aughinish Alumina Ltd. These sites were amended with compost (100 t/ha) and gypsum (90 t/ha) with varying time since rehabilitation (1 year and 15 years). Samples of unamended residue were collected and amended in the laboratory with varying concentrations of compost and gypsum and then leached. Residues were analysed to determine their physicochemical properties and bioassays were used to examine the response of three plant and two animal species to the residues. The germination and early growth of the monocot *Sorghum saccharatum* and dicots *Lepidium sativum* and *Sinapis alba* was examined using the Phytotoxkit F<sup>TM</sup> microbiotest. The avoidance response of *Eisinea fetida* and *Folsomia candida* to the residues was examined using avoidance chambers. Germination of *L. sativum* and *S. alba* was highly inhibited in unamended residue. Germination of all plant species was successful in all amended treatments. Root and shoot growth were highly inhibited for all plant species in unamended residues, improving in amended samples. *F. candida* exhibited an avoidance response to unamended residues and laboratory amended treatments but not for field amended samples. *E. fetida* showed complete avoidance of unamended residue and laboratory amendments in favour of the field samples and control soil. The results suggest that these rehabilitation strategies were effective for improving the biological function of the residues.

**Keywords:** bauxite residue, rehabilitation, bioassay

### **108. Identification, characterisation and comparison of bacterial xylanases for industrial applications**

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Bacterial and fungal species provide an important role in carbon cycling within the environment. They are known degraders of lignocellulosic materials, for example compost and leaf-litter, and carry out this role through the production of targeted enzymes. Thermophilic microorganisms are important in a number of industrial applications such as biofuel, paper and pesticide production, as they naturally thrive at higher temperatures and produce thermotolerant enzymes capable of degrading these plant cell components. Xylanases are one such family of enzymes capable of degrading the xylan component of hemicellulose. This research focuses on the characterisation of xylanases by thermophilic bacteria and comparing their native and recombinant forms to commercially available enzymes. Two thermophilic bacteria have been selected based on BLAST sequencing using a xylanase protein sequence from a thermophilic fungal source. These bacteria have been propagated and their genomic DNA has been isolated. Current research is focusing on the amplification of the xylanase genes within the bacterial DNA using polymerase chain reaction techniques followed by molecular cloning into *E. coli* expression hosts. Several commercially available xylanases have also been characterised by measuring their activities and stability over various pH values and temperatures. The comparison of these native, recombinant and commercial xylanases will allow for the determination of their potential use in downstream applications such as biofuel production, environmentally friendly biobleaching of paper, and enhancing animal feed and brewing.

**Keywords:** thermophilic bacteria, xylanase, lignocellulose, characterisation, molecular cloning

**109. Comparing the resource efficiency practices of large-scale building projects to small-scale building projects on selected case studies in Ireland**

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Resource efficiency (RE) has been selected by the European Union (EU) as one of its seven flagship initiatives for its 2020 strategy. The aim of the EUs RE strategy is to increase economic opportunities, lower costs, improve productivity, boost competitiveness and support a low carbon economy. Research was carried out to assess and compare the RE practices on a number of small and large scale projects through the use of participatory action research. Through the use of an RE audit tool shortcomings were identified with current RE practices on all the case study sites and a number of solutions were suggested and implemented to improve practices. It was found that improving RE practices on the small scale project has the potential to make greater savings; 0.5 per cent of the project value vs. 0.4 per cent of the project value for the large scale project. The total savings identified on the case study sites also indicate that the small scale project can increase the profit margin by a larger percentage; 17.67 per cent of the total profit for the small scale project vs. 14.65 per cent for the large scale project. The small scale project produced less waste; 0.031 tonnes of waste per m<sup>2</sup> of floor area while the large scale project, produced 0.0388 tonnes per m<sup>2</sup> (an increase of 25.16 per cent). The small scale project was also able to reduce waste management costs by a larger percentage, for example, skip void space for the small scale project was 15.9 per cent on average per skip vs. 31.09 per cent for the large scale project. With regards to the wider area of RE, the large scale project scored higher with an overall RE audit score of 4.83 vs. 4.67 for the small scale project. The study concluded that all the case study sites are able to make improvements to their RE performance, reduce costs and increase profit margins.

**Keywords;** resource efficiency, sustainable construction, case study, SME, construction organisation

### 110. Methane yields and assessment of pathogen removal via co-digestion of pig manure and food waste

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Three semi-continuous laboratory-scale anaerobic digestion systems were established in order to assess the methane yields, process stability, and biosafety of the digestate generated from the co-digestion of pig manure and food waste. Each anaerobic digester had an effective volume of 7.5 l and was seeded with anaerobic biomass taken from a full-scale digester treating cattle manure. This biomass was acclimated to high ammonia content. Digestion was carried out at 40°C. Feedstock comprised 85% pig manure and 15% food waste [mixed on a volatile solids (VS) basis]. The organic loading rate was maintained at 1 gVS/l/d with the hydraulic retention time maintained at 40 days. Methane yield was analysed daily. The pH, volatile fatty acid concentrations, alkalinity and ammonium concentrations of the digestate were analysed weekly. Once the steady state was achieved, the efficacy of the digestion was analysed in terms of VS destruction and the reduction in total coliforms, *E. coli*, enterococci and anaerobic sporeformers. The digestion systems were stable after 45 days of operation, as evidenced by the stabilization of methane generation, VFA concentrations and pH values in the digestate. Upon reaching the steady state, average methane yields were found to be 331±72 ml CH<sub>4</sub>/l/d. Compared to fresh feedstock, anaerobic digestion resulted in a reduction in total coliforms from 6.79 ± 0.01 log<sub>10</sub> CFU/ml to 5.06 ± 0.11 log<sub>10</sub> CFU/ml (P = 0.002), a reduction in *E. coli* from 4.3 ± 0.02 log<sub>10</sub> CFU/ml to 1.7 ± 0.3 log<sub>10</sub> CFU/ml (P = 0.005), and a reduction in enterococci from 4.49 ± 0.04 log<sub>10</sub> CFU/ml to 2.78 ± 0.1 log<sub>10</sub> CFU/ml (P = 0.001). However, there was an increase in the number of anaerobic sporeformers (from 5.02 ± 0.03 log<sub>10</sub> CFU/ml to 5.56 ± 0.1 log<sub>10</sub> CFU/ml (P = 0.014)). At the steady state, VS removal efficiencies were up to 55±9%. The methane yield, process stability and VS removal results indicate that the digesters have been started successfully and a steady state has been achieved. Counts of enteric indicator bacteria demonstrated that pathogens, if present, should be removed during digestion. Moreover, the digestate complied with microbiological limits set out in the draft Irish digestate quality standard, as *E. coli* counts were <1000 (3.0 log<sub>10</sub>) CFU/ml.

**Keywords:** anaerobic digestion, biogas, biosafety, digestate, organic waste, pig slurry

**111. Comparison of composting and vermicomposting as compost maturation treatments – effect on end product quality and plant growth parameters**

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Immature compost can have negative plant and soil effects such as phytotoxicity, soil N immobilisation, and reduced plant growth, especially when used in horticultural applications e.g. as a growing medium. This study investigates the use of vermicomposting as a post-treatment method to increase the maturation rate of composted horse manure. It also looks at three grades of particle size (ungraded, >3 mm and <3 mm), and increasing rates (0, 10, 20, 50, and 75% vol/vol) of the compost and the vermicomposted compost on lettuce plant and root growth. Compared to composting, vermicomposting reduced the pH, C/N ratio, particle size of the compost, and increased electrical conductivity and nutrient content. Mean shoot fresh and dry weights were significantly higher in plants grown with vermicompost, compared to compost. Shoot fresh and dry weight were significantly higher in the 10 and 20% amendment concentrations than all other concentrations, and 50 and 75% was significantly higher than the 0% concentration. Shoot water content responded differently with increasing concentration of vermicompost and compost amendments. The addition of amendments increased root fresh and dry weight, and reduced root water content significantly. The different amendment grades affected shoot dry weight and shoot water content. Vermicomposting increased the rate of maturation, resulting in significantly larger plants, with reduced conductivity stress and increased root/shoot ratio, especially at higher amendment concentrations.

**Keywords:** composting, vermicomposting, phytotoxicity, growing medium, maturation

## 112. The influence of metal selection for catalysts employed to hydrogenate biomass derived chemicals

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Over the past decade there has been an increase in research utilising biomass as a start material due to the depleting stocks of fossil fuels. The production of fine chemicals is one of the many research areas to stem from this broad topic. Furfural is a functional by-product produced naturally from biomass in the biofuel industry. It has a large number of derivatives including furfuryl alcohol which is used extensively in the chemical manufacturing industry. Furfuryl alcohol is produced by the catalytic hydrogenation of furfural in liquid or vapour phase. Copper chromite catalysts are used for this process but pose severe environmental threats creating a significant research emphasis on attaining a suitable alternative. Precious metal catalysts were produced using copper, nickel, platinum or palladium supported on SiO<sub>2</sub>. The catalysts were hydrogenated in the liquid phase after which a comparison was conducted between each catalyst for the conversion of furfural and the selectivity to furfuryl alcohol. Two solvents, ethanol and toluene were employed to establish the influence of solvent on the reaction while one catalyst was exposed to additional temperatures to investigate any influence. Experimental work highlighted platinum as the superior metal with high selectivity to furfuryl alcohol although this is also dependent on the solvent selection with the use of an alcohol resulting in interactions between the reactant and the desired product affecting the overall production of furfuryl alcohol. Further analyses of these results deemed selectivity and conversion to be independent of temperature and dependent only on solvent and catalyst selection with further work focused on the impact of bimetallic platinum based catalysts on the hydrogenation reaction.

**Keywords:** biomass, catalysis, hydrogenation, furfural, furfuryl alcohol

### 113. Methane to methanol – A renewable solution for alternative fuels

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A “dream” reaction of modern heterogeneous catalysis is the quantitative direct partial oxidation of methane to methanol. Methanol is a flexible key component for several alternative fuels and can be obtained from renewable sources through anaerobic digestion of organic matter. Methane is very symmetric which results in extremely high C-H bond stabilities. Activating these bonds requires high activation energies. Stopping the oxidation and releasing the formed methanol from the catalyst surface are challenging problems. Currently, methanol is synthesized via an indirect selective two-step process using syngas, which is costly and energy consuming. In nature, the C-H bond in methane can be oxidized in mild conditions using methane mono-oxygenase enzymes. One of these enzyme families contains a di-copper complex. The aim of this project is to develop a new catalytic method for this reaction and mimic this highly active di-copper complex. Indeed, from current reported literature, copper catalysts supported by zeolites seem to be relatively promising for this partial catalytic oxidation reaction. For this work different copper catalysts supported by zeolites, such as ZSM-5 and Mordenite, were prepared through an aqueous ion exchange procedure using copper acetate as the metal precursor salt. Atomic absorption was used to measure the exchanged metal content of the prepared catalysts. X-ray Photoelectron Spectroscopy was used to determine the oxidation states of the catalyst metals before and after interaction with methane. The experiments were performed on a catalysis gas rig using an on-line mass spectrometer device for monitoring the desorbing gases. To desorb methanol from the catalyst surface, a wet helium stream was introduced via a saturator. Low temperature and pressure conditions were used for the process. It was found that the catalytic performance of the methane to methanol oxidation is influenced by factors such as catalyst preparation and diverse pre-treatment steps.

**Keywords:** methane, catalyst, oxidation, methanol, zeolite, copper

#### **114. The effect of vehicle efficiency improvements and electric vehicle penetration on the energy sector in Ireland**

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Transport is the most energy intensive sector in Ireland at 33% of total primary energy demand in 2013, 43% of which was from private cars. European Union legislation has laid down mandatory emissions reduction targets for car manufacturers whereby new cars must meet average emissions of 130 gCO<sub>2</sub>/km by 2015 and 95 gCO<sub>2</sub>/km by 2021. Ireland's current car stock has exceeded its 2015 target however research on the potential of efficiency improvement of internal combustion engines indicates that meeting the target for 2021 may be unfeasible for manufacturers. In parallel, Ireland has adopted a new target for the penetration of 50,000 electric vehicles by 2020. This presentation uses a model of the private car stock to explore whether car manufacturers supplying Ireland will be capable of meeting the emissions reductions levels laid down by EU legislation and, if not, what effects this will have on the average emissions in the transport sector in Ireland. It also explores the effect of electric vehicle penetration on the total average emissions level in Ireland: this may be a concern due to the current relatively high emissions intensity of electrical generation (135.7 gCO<sub>2</sub>/km) compared to petrol (70 gCO<sub>2</sub>/km) and diesel (73.3 gCO<sub>2</sub>/km). All modelling is carried out using the CarSTOCK model developed in UCC: this is a sectoral simulation model, which projects the car fleet in Ireland to 2050 and disaggregates the private car stock by fuel type, engine size and vintage.

**Keywords:** Vehicle Energy Efficiency Improvement; Electric Vehicles; Emission Intensity

## 115. Overcoming the Barriers to SME Engagement in the Smart Grid Market in Ireland

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Electricity is the fastest-growing element of total global energy demand. The requirement to meet this demand in a cost effective, secure and sustainable way is driving the development of a high growth market for smart grids. ‘A smart grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power systems with low losses and high levels of quality and security of supply and safety.’-Council of European Energy Regulators. Ireland is well positioned to lead in the deployment of the smart grid. Key energy sector actors are already engaged and looking to benefit from the application of a smart grid. However, unprecedented change will be required to develop Ireland’s energy infrastructure to support the development of smart grid and a low carbon economy. The scale of investment being made today and over the next 10-20 years in smart grid infrastructure globally is enormous, generating huge opportunities for new products and services. It is recognised that while there are significant opportunities for Irish SMEs in this market, there are also risks associated with the level of ongoing commitment to develop new products and services. High risk makes investors apprehensive and can discourage SMEs entering into the market. Helping industry develop a supply chain to deliver the needs of the smart grid market in the face of such uncertainty is a sizable challenge. This research focuses on looking at how to ensure SMEs are supported in this growing smart grid market to find significant opportunities to develop new products and services for the Irish and international markets. It is vital that SME’s have clear visibility on how to access supports and address the barriers to market entry.

**Keywords:** smart grid, small and medium enterprises (SME’s), barriers, engagement



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## POSTER PRESENTATION ABSTRACTS

(Listed by theme)

- **Biodiversity (B)**
- **Marine and Coastal (MC)**
- **Climate Change (CC)**
- **Wastewater Management (WWM)**
- **Water Quality and Resources (WQR)**
- **Energy (E)**
- **Invasive Species (IS)**
- **Environment and Human Health (EH)**
- **Nanotechnology (N)**
- **Sustainability and Roads (SR)**
- **Sustainable Agriculture (SA)**
- **Sustainability and Research Innovation (I)**
- **Environmental Socioeconomics (ES)**
- **Waste Management (WM)**

**B1. Ecological Functions of Slug Mucus: Understanding the Behaviour of the EU Protected Kerry Slug, *Geomalacus maculosus***

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Terrestrial gastropods exude mucus for locomotion, protection against desiccation and locating home areas or possible mates. All terrestrial gastropods are believed to be hermaphroditic and are capable of self-fertilisation or out-crossing with a mate. Outcrossing is preferential because self-fertilising can incur fitness costs via increased energetic investment and inbreeding depression. Thus simultaneous hermaphrodites should possess mechanisms to locate mates, and to locate mates of the correct species. The mating system of the Kerry slug remains unknown. We tested whether mucus may be used as a chemical signal in communication between slugs. As it is possible that chemical communication may attract attention from non-target species, we tested whether or not the generalist beetle *Pterostichus niger* can ‘eavesdrop’ on chemical signals in mucus trails, and use this information to locate and prey upon the Kerry slug. Additionally, we investigated the behavioural response of the Kerry slug to residual chemical cues from *P. niger* to determine whether the slug can detect a perceived predation threat. Experiments were performed in 21cm<sup>2</sup> arenas, sectioned into test and control zones. Test zones were covered either in slug mucus or residual chemicals from beetles, and behaviour was recorded using Ethovision software. Slugs were more active and spent more time in zones treated with conspecific mucus. Beetles showed increased activity and spent more time in mucus-treated zones. Furthermore, slugs exhibited greater latency to approach beetle-exposed zones, and increased turning rates within these zones. Preliminary results from these behavioural experiments are consistent with the idea of chemical-based, olfactory communication within and between these species, and shed light on the trophic interactions between slugs and predatory carabids. Future work will use mating and predation data, as well as field data, as parameters in predictive models of the population dynamics of the EU protected Kerry slug.

**Keywords:** Rare Species, Zoology, Behavioural Ecology, Evolutionary Ecology, Predator-Prey

## **B2. Mushrooms & Fungi, Functional & Life Enhancing Reservoirs**

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In many parts of the world throughout history the use of mushrooms and Fungi in both nutrition and traditional remedies is commonplace. The position of mushrooms and fungi therefore within the Pharma-Nutritional interface is well established. It is widely accepted that mushrooms are a source of beneficial nutrients and bioactive compounds. In Ireland however this potential bio-resource is relatively underused and there is little research carried out into detailed nutrient profiling or bioactive components of wild edible Irish mushrooms. This project aims to address this deficit and create a detailed data base on numerous species of wild edible Irish mushrooms. This database will emphasise the biodiversity of mushroom species collected from similar habitats. Crude compositional information such as crude fat, moisture content, nitrogen and carbohydrate analysis will be collated. In depth fatty acid profiling, polyphenol, sterol, and vitamin analysis through the use of HPLC, GCMS and LCMS will also be carried out. Bioactivity of each of the specimens will be ascertained through various assays carried out with wild mushroom extracts. Antioxidant activity will be quantified by the use of ORAC and Frap protocols. Extracts will be tested against selected bacterial and fungal strains to determine and quantify anti-microbial activity. Enzymatic activity will also be assessed to identify cholesterol and blood pressure lowering properties. A data base of nutritional information and bioactivities within 28 samples of Irish mushrooms will be compiled in order to ensure that this resource is not overlooked and to emphasise their importance as a potential reservoir of bioactive and beneficial compounds.

**Keywords:** Mushrooms, HPLC, LCMS, Bioactivity, GCMS, Antioxidants

### **B3. The Role of Micro-arthropods in the Sequestration of Carbon in Grassland Soils**

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As agriculture is the leading source of greenhouse gas emissions in Ireland, it is vital to determine the role of the agricultural soil communities in the sequestration of carbon while also maintaining the soils economic value for agriculture. Micro-arthropods i.e. mites and Collembola, play a vital role in grassland soil systems; in decomposition, nutrient cycling, and regulation of microbial communities. The aim of this research project is to ascertain the role that these micro-arthropods play in the sequestration of Carbon in the soils of grassland systems in Ireland. In this study we will compare soil fauna diversity under different management intensities and soil types in a large field scale study, and identify the key biota involved in carbon sequestration. Specifically, this will be achieved by a) comparing species and functional group community composition in intensively and non-intensively managed grassland systems, b) using mesocosm experiments to determine the role of micro-arthropods in carbon and nitrogen dynamics, and c) using food web models applied to the functional groups identified in a field study to determine carbon flow through the system and to make comparisons between management intensities and soil types. A preliminary study of the micro-arthropods in intensively and non-intensively managed grasslands with three soil types has been carried out using soil samples from some of the potential sampling sites. The results of this showed that there were significant differences between intensively and non-intensively managed systems, both in terms of population size and composition. Based on these results further sites have been selected, sampled and sorted for the food web analysis. The mesocosm experiments will be carried out on one of the soil types and will involve measuring both CO<sub>2</sub> and Nitrogen from soil under intensive and non-intensive management conditions, from which carbon and nitrogen cycling can be determined. The aim is that the food web analysis will validate the results obtained from the mesocosms and will therefore give an indication of the role micro-arthropods play in carbon sequestration.

**Keywords:** Carbon sequestration, micro-arthropods, soil, grasslands

**B4. The Impact of Forest Clear-felling on Kerry Slug (*Geomalacus maculosus*) populations**

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*Geomalacus maculosus* is listed as a protected species in both Annex II and Annex IV of the EU Habitats Directive (92/43/EEC). Due to its protected status, the presence of the species in commercial conifer plantations in the south-west and west of Ireland has the potential to severely impact on forestry operations. The lack of knowledge regarding the impacts of clear-felling on the species needs to be addressed to better inform management practices in forests where *G. maculosus* is present. The aims of this study are to: a) determine the impacts of clear-felling on the species and b) identify Kerry slug food preferences. Four sites were selected between west Cork and Kerry for this study. Mark-recapture methods were used to compare *G. maculosus* populations in: a mature forest; a clear-felled area; a mature plantation before and after clear-felling; and on adjacent open blanket bog. Preliminary results indicated consistently lower population densities in clear-felled areas compared to mature forest. Further data collection will reveal the extent of changes to populations in mature plantations felled during the course of the study. The second aim of this project will examine, using Ethovision XT 10 behavioural software, the food preferences of the species in forest stands. Given that *G. maculosus* has preferences for particular lichen species, this information will inform the development of practical mitigation strategies for the species in commercial forests.

**Keywords:** commercial forestry, *Geomalacus maculosus*, population analysis

**B5. Genetic Analysis of the Native Irish Honeybee (*Apis mellifera mellifera*)**

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*Apis mellifera mellifera* (European dark bee), which is one of the 28 subspecies of *Apis mellifera*, is the native Honeybee of Ireland. Its original habitat has stretched from Ireland to central Europe but due to a variety of reasons such as importation of other breeds, cross breeding and parasitism, their numbers have dropped significantly, to the point that there are no confirmed feral Honeybee colonies in Ireland. The aims of this study are to determine, by genetic analysis, the current state of the native Irish Honeybee with regards to level of hybridisation and the extent of the population of the native Irish honey bee in Ireland so as to maintain the genetic diversity of domesticated species and to preserve biodiversity. The process involves the extraction of DNA from the hind legs of Honeybees by Chelex extraction, followed by PCR amplification, and digestion by the DraI enzyme, of the COI-COII intergenic region of the mtDNA. The resulting fragments will be compared against those of *Apis mellifera mellifera* and other subspecies to determine the level of hybridisation. This study also aims to facilitate the future selection of pure native strains enabling the improvement of breeding and conservation programmes. Effective identification of the subspecies and degree of hybridisation of the Irish population and the hives of individual beekeepers will allow for purified strains to be bred for commercial and ecological benefit. It will also enable the selection and breeding of honeybees that are naturally passive and easy to work with and prevent the breeding of aggressive hybrid species.

**Keywords:** *Apis mellifera mellifera*, hybridisation, mtDNA, population genetics

**B6. Plant species of conservation concern have very variable coincidence with designated areas**

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Vascular plant distribution data was collated and mapped for the island of Ireland. Records of species of conservation concern were extracted from tetrad-scale (2km x 2km) data supplied by the Botanical Society of Britain and Ireland (BSBI), from the National Parks and Wildlife Service of Ireland (NPWS) and from the Northern Ireland Environment Agency (NIEA). We extracted 6078 distribution records of 176 species of conservation concern and mapped them at the tetrad scale. We considered species listed in the Red Data Book, Flora Protection Order, Northern Ireland Priority Species List and Northern Ireland Wildlife Order. We investigated the extent to which tetrads with records of species of conservation concern overlapped with designated areas (Natura 2000, Natural Heritage Areas, Areas of Special Scientific Interest). The coverage provided by these data was not complete and contains many gaps. Species of conservation concern were recorded in 2117 of the 22 449 tetrads in Ireland, and a conservative estimate suggests that many of these tetrads do not overlap with designated areas (22% – 40%). The coincidence of individual species with designated areas ranged from 0% to 100% (mean = 79%). For example, for 22 of 139 Red Data Book species,  $\geq 50\%$  of the tetrads in which they occurred had no overlap with designated areas. These results highlight the importance of both designated areas and the (non-designated) wider countryside for biodiversity conservation.

**Keywords:** conservation, plants, Red Data Book, designated areas, Natura 2000

## **B7. Enhancing and Maintaining Biodiversity on Intensively-managed Farming Systems**

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The Common Agricultural Policy reform has introduced three “Greening” measures to increase agricultural sustainability – crop diversification, maintenance of permanent grassland and the allocation of Ecological Focus Areas (EFAs). The EFA measure requires 5% (rising to 7% in 2017) of eligible arable land be managed as ecologically beneficial landscape features and has the potential to be the most ecologically beneficial of these measures. However, it may also have the greatest impact on farmers. It is unclear what percentage of Irish farmland currently qualifies as EFA. This study will undertake a farm-based habitat survey to determine the proportion of farm area currently under semi-natural habitat cover on intensively managed farms in Ireland. The survey will include habitats that are eligible under current EFA guidelines and those that are not. Semi-natural habitats are vitally important for maintaining and enhancing biodiversity and halting farmland biodiversity loss will contribute towards achieving sustainability and environmental targets (e.g. Biodiversity Strategy 2020, Water Framework Directive, Climate Change Strategy). This study will also include a questionnaire on farmer attitudes towards the environment and their perception of the cost of agri-environment options on their farms. This should provide an insight into the attitude of intensive farmers towards the environment and their likelihood of adopting specific biodiversity measures. Finally, a review of the cost-effectiveness of potential measures aimed at creating or enhancing EFAs will be undertaken. This will combine biodiversity, attitudinal and cost-effectiveness data in a single database supporting the evaluation of the applicability and environmental impact of these measures on intensively managed systems in Ireland. This study will provide information to policy-makers regarding the targeting of appropriate management prescriptions aimed at the conservation of species and habitats on intensively managed agri-systems.

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

**B8. Motorway attenuation ponds make a significant contribution to the landscape biodiversity of mobile aquatic insect groups.**

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Attenuation ponds, constructed along motorways in Ireland, function to drain road runoff before being filtered and allowed to enter natural water courses. These new aquatic habitats potentially make a significant contribution to the landscape biodiversity as farmland ponds are under threat. Constructed to hold water periodically and seeded with different plants, these ponds range in water depth and permanency and vegetation composition presenting a particularly suitable habitat for highly mobile insect groups. This study sampled five attenuation ponds along the N7/8 motorway to determine what Coleoptera, Heteroptera and Odonata were using these aquatic habitats and the environmental factors affecting these communities. Multi-habitat kick-sweep samples were collected in each of the five ponds. Activity traps were placed in three vegetation types in two of the ponds to assess how each macrophyte species contributed to the beetle diversity. The ponds supported a diverse aquatic invertebrate community, dominated by mobile insect groups. Just over 40 Coleoptera species were recorded in these five ponds. Dytiscids were the most diverse family, with representatives of 13 genera recorded. Some rare species and new arrivals to Ireland were also recorded. The vegetation strongly influenced the beetle species, with *Carex rostrata* and *Sparganium erectum* supporting the greatest diversity. The environmental factors affecting the aquatic insect groups are presented and recommendations are discussed to promote the value of attenuation ponds as new aquatic habitats in the Irish landscape.

**Keywords:** Coleoptera, Aquatic Beetles, Macrophytes, Odonata, Corixidae, Heterogeneity, Water Quality, Activity Traps, Constructed Ponds.

### **B9. Insights into the Culturable Microalgal Biodiversity from the northwest of Ireland**

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As primary producers, microalgae play an important role in sustaining complex and resilient community dynamics in the face of environmental change. They contribute toward the functional diversity of ecosystems via important roles in the cycling of carbon, nitrogen, oxygen and other elements. Characterising microalgal communities from diverse environments allows for the monitoring of environmental quality as well as facilitates the bioprospecting of high value natural products. Knowledge gaps exist regarding the diversity, ecology and evolutionary history of microalgae. This is partially due to the difficulty in quantifying the great diversity of species that interact within naturally complex communities. Microalgae are a polyphyletic group of eukaryotic and very often photoautotrophic organisms, which have colonised most aquatic, terrestrial and anthropogenic habitats. In this study, microalgal cultures were generated from isolates sampled in the northwest of Ireland from a number of freshwater, marine and terrestrial habitats. Samples were collected using plankton hauls and discrete sampling with sterile bottles where blooms were visible. Water samples were also collected from a number of substrates such as rock pools, bog pools, plastic containers, buckets and animal drinking water faucets. Samples were observed under inverted microscope and individual cells isolated to generate monocultures. Cell isolates were supplemented with defined media (eg. f/2, IMR, BG11) and maintained in an illuminated incubator at 15°C on a 14:10 light dark cycle. Due to the specific environmental preferences of particular microalgae, it was only possible to maintain a selection of the species present in the samples under our culturing conditions. This work reviews from a morphogenetic point of view the microalgal species which were successfully brought into culture from a number of local habitats from the northwest of Ireland.

**Keywords:** microalgae, biodiversity, light microscopy, morphogenetics.

### **B10. Fecundity of Northern Pike, *Esox Lucius* (L. 1758), in Lakes, Rivers and Canals**

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The northern pike, *Esox lucius*, is a keystone piscivore found in Irish waters and others throughout its global range. This species can tolerate a wide range of environmental conditions and is often introduced to waters as a sport fish. It also plays a vital role in regulating the balance of fish populations in fisheries. This study, part of a project funded by Inland Fisheries Ireland, investigated the fecundity of female pike from a selection of lakes, canals and rivers across Ireland between September 2010 and March 2012. This is the first study on fecundity of pike in Irish waters since 1969. A total of 80 fish were available for the analysis covering a range of fish sizes (fork length = 30 to 88.1cm). Fecundity was determined by routinely applied gravimetric methods. Preliminary absolute fecundity (AF) estimates ranged from 1,836 to 157,741 eggs and was, as expected, significantly related to the length and weight of the fish. Relative fecundity (RF) was determined as  $15.6 \pm 5.6$  eggs g<sup>-1</sup> total body weight. Egg diameter ranged from 0.8 to 2.33mm, the smaller size was from October samples. A significant difference in AF was detected between pike from lakes and rivers and canals combined, those from the lakes had lower fecundity. There were no differences in fecundity between pike from rivers and canals. This paper also presents possible reasons for the observed results.

**Keywords:** *Esox lucius*, fish, spawning period, sexual maturity length, ovary, Ireland.

### **MC1. Spatial and seasonal variation in pigments in edible red algae from Western Ireland**

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In addition to chlorophyll a, red algae (Rhodophyta) contain proteinaceous phycoerythrin and phycocyanin, carotenes and several xanthophylls as accessory pigments. Red algal pigments are generally influenced by environmental conditions including climate change and anthropogenic effects. These impacts are important to investigate as they could affect algal diversity and nutritional composition of seaweeds that may be used as food or food additives. Phycobilins are widely applied as natural food colorants and have more recently been used in the pharmaceutical industry as novel anti-inflammatory and anti-oxidant agents. As part of a larger investigation into bioactives in red seaweeds for food applications, this project examines the spatial and seasonal variation in pigments as well as fatty acids and MAAs in three species, *Palmaria palmata*, *Chondrus crispus* and *Porphyra dioica*. Such information will then be used to optimise the species' bioactivities through cultivation experiments. Typically pigment concentrations and composition are affected by ambient light and nutrients, but water temperature and salinity can also have an impact. Lower irradiances have previously been found to result in higher levels of phycobilins in *Porphyra* species whilst chlorophyll a and total phycobilins concentrations in *C. crispus* have been shown to decrease in colder water. Here samples were collected at six to eight weekly intervals from three sites around Galway Bay that represented different intertidal environments. Concentrations of chlorophyll, carotenoids and phycobilins varied on a seasonal basis, between species and sampling locations. Generally phycoerythrin increased from July to November, coinciding with the time of year when ambient light levels and temperature decreased. During this period, lowest chlorophyll a to total phycobilin ratios were observed at all sites in *Palmaria palmata*, and highest ratios in *Porphyra dioica*. Results suggest that small-scale environmental impacts may have potential implications on the nutritional quality of seaweeds.

**Keywords:** Rhodophyta, pigments, seasonal variation

## **MC2. Current methods of algal polysaccharide extraction : analysis and optimisation**

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Marine algae are an untapped source of bioactive compounds that have been reported to possess anti-tumor, anti-viral and anti-cancer properties. The prebiotic health potential of seaweed-derived polysaccharides such as fucoidans, alginates, laminaran and many others are also increasingly being studied. However, extracting and isolating large amounts of pure and structurally homogenous algal polysaccharides has proved a difficult task. The bioactivity of algal polysaccharides is related to molecular weight, composition and structure, which are impacted by the extraction methods. Currently, there are no standardised extraction or purification procedures for polysaccharides; each polysaccharide type requiring different extraction procedures. Ideally, the industry would prefer a single, well-defined, mild extraction process that optimally extracts phycocolloids regardless of type and source. Intensive efforts are therefore necessary to develop cost-effective, food grade and eco-friendly methods. Analysis has been performed on historical and current literature on conventional and alternative extraction technologies. Methods encompass chemical degradation of the cell walls using mild acid/base solvents at relatively high temperatures for extended periods of time. Not only can distinct structures be isolated using different conditions, polysaccharides also vary between species, harvest location, harvest season and developmental conditions, making their extraction more problematic to optimise as a single procedure. Novel processes include biological techniques such as enzyme extraction, chromatographic separation of polysaccharides or microwave technologies, which may prove too costly for industrial adoption but hold significant potential for the future. Polysaccharide extraction methods have been evaluated with the purpose of optimising procedures to assist future research and advance industrial processes.

**Keywords:** seaweed, extraction, polysaccharides, methods

**MC3. Development of GC-MS protocols to detect reference standard fatty acids from biological sources**

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The development of various oils for food applications has resulted in the need for reference fatty acid standards to measure new and existing food products. Biological samples as a source of fatty acid production for the use as food standards address sustainability issues from an environmental and raw material perspective. Fatty acids can be detected by liquid chromatography-mass spectrometry (LC-MS) or gas chromatography-mass spectrometry (GC-MS) detection methods. The use of GC-MS technique requires the trans-esterification of lipids prior to injection and detection of fatty methyl esters (FAMES). In the present study, an analytical GC-MS method to detect essential fatty acids obtained from a biological source was developed. Using this protocol, methyl myristate (C14: O) and methyl palmitate (C16: O) were identified as the dominant fatty acids of the tested samples. Other essential fatty acids from biological sources will be identified according to this protocol validating the identification with standard fatty acids.

**Keywords:** Gc-MS, biological sources, food applications, fatty acid standards, FAME's

#### **MC4. Serum Amyloid A and its use as an Indicator of Environmental Pollution**

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Serum Amyloid A (SAA) is a major acute phase protein that can be found in most vertebrates. There are two types of SAA; Acute phase Serum Amyloid A (A-SAA) and Constitutive phase Serum Amyloid A (C-SAA) and of these only A-SAA increases in concentration when a stressor is present. In farmed fish, these stressors may include the fish habitat (size and type), competition for food, population size, disease, harmful chemicals or pollutants. This study aims to test the hypothesis that A-SAA can be used as a biomarker for environmental pollution in aquaculture. Using farm bred *Oncorhynchus mykiss* (Rainbow Trout) as the initial test species, mRNA was extracted from various organs to determine where the highest concentrations of A-SAA could be found. The organs (Liver, Reproductive Organs, Heart and Fatty Tissue) that showed the highest A-SAA concentrations have become the primary focus of the study. The mRNA samples were converted to cDNA and run using RT-PCR to test for the presence of A-SAA and  $\beta$ -actin before proceeding to Quantitative PCR (qPCR). From these tests A-SAA and  $\beta$ -actin were successfully detected. Before qPCR can be carried out on unknown mRNA samples, a standard curve needs to be constructed and optimised using *Oncorhynchus mykiss* DNA samples of known concentrations. Once optimised, the qPCR assay will be used to amplify the A-SAA gene in *Oncorhynchus mykiss* and gene expression levels in the various organs examined for biochemical levels of stress under different environmental conditions. Once the A-SAA levels of *Oncorhynchus mykiss* have been determined, it is hoped that this technique can be adapted to other fish species.

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

### **MC5. A Smart City needs a Smart Bay**

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Interest is growing in the concept of Smart Cities i.e. urban areas instrumented with a network of sensors reporting data with high temporal and spatial resolution with data being used for more efficient planning and management of services and infrastructure. A high profile example is the SmartSantander project which boasts 2000 connected devices measuring air-quality, traffic intensity, and parking space availability among others. The concept is taking off in Dublin with a number of high profile technology companies announcing projects in recent months. There has however to date been a notable lack of integration of water related parameters. The SmartBay Dublin project consists of the instrumentation of a number of strategic locations in Dublin bay and its rivers. These include two estuarine sites, two freshwater sites and one fully marine site. A typical installation measures a range of parameters including water quality (e.g. Dissolved oxygen content, salinity, pH, chlorophyll) and physical measurements such as depth and flow at a sampling interval of 15 minutes. Data is transmitted wirelessly via GSM/GPRS to a Cloud Database and can be viewed online, down loaded or used to feed live models for flood prediction or pollution alerts.

**Keywords:** Smart City, Wireless sensor networks, Water quality

**CC1. Preliminary assessment of forest mineral soil bulk densities for estimating organic carbon stocks**

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Forests can act as carbon (C) sinks, and forest mineral soils represent important terrestrial organic C stocks. Mineral soil was sampled from Irish forests under the CForRep project. Sampling of soil horizons was performed using 100 cm<sup>3</sup> coring rings from a hand-dug soil pit, in order to obtain a measure of bulk density (soil mass per volume), which is required for estimating the organic matter (OM) and organic carbon (OC) of a soil horizon on an areal basis. Accounting for coarse fraction (> 2 mm diameter) is known to be important for stony soils, such as dryland soils, because it can influence the bulk-density values. We present how the removal of coarse fragments with > 2 mm diameter (by sieving) can substantially influence the bulk density and the areal-based OM values, and therefore also the areal-based OC estimations, for Irish forest mineral soils. The preliminary results (two sites) showed that accounting for coarse fragments can result in up to 62 % difference in bulk density, and in up to 506 g m<sup>-2</sup> OM difference calculated for 1 cm of soil horizon thickness, which justifies the soil bulk-density sample processing presented here.

**Keywords:** forest, soil, bulk density, organic C stock

**CC2. Preliminary assessment of forest organic-layer densities for the purpose of estimating organic carbon stocks**

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Forests can act as carbon (C) sinks, with organic layers (forest-floor, peat) representing an important part of forest C-stock. Organic layers from Irish forests were sampled as a part of the CForRep project. Sampling of organic layers (with measured thickness) was performed using a 25 cm × 25 cm frame, required for estimating the amount of organic matter (OM) and organic carbon (OC) of a layer on an areal basis. The density (layer mass per volume) of the upper organic layers can be affected by the presence of living photosynthesizing plants incorporated with the non-living organic material, while stones (> 2 mm diameter) can be mixed with and masked by the organic material in the lower organic layers. Although a complete removal of living plant material is usually not possible, an attempt was made to separate it prior to sample drying; stones were removed manually (by sieving) after sample drying. We present how the removal of photosynthesizing live plant material and stones can substantially influence the organic-layer density and the area-based OM values, and therefore also the area-based OC estimations. The preliminary results (three sites) showed that accounting for photosynthesizing plant material and stones can result in up to 25 % difference in density, and up to 286 g m<sup>-2</sup> OM difference calculated for 1 cm of layer thickness, which justifies the organic-layer sample processing described here.

**Keywords:** forest, organic layers, density, organic C-stock

**CC3. An investigation into the environmental impact of carbon trading mechanisms in the cement sector: Brazil and Europe**

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The aim of this project is to investigate the compatibility of carbon trading mechanisms in Europe and Brazil. It considers the effectiveness of these schemes as tools to improve environmental quality through the reduction of greenhouse gases from one of the largest emitters in the industrial sector – the cement manufacturing sector. An ex post evaluation of the European Union Emissions Trading Scheme (EUETS) was initiated in order to identify the impact of the scheme on the environment and on the cement sector in Europe. Using the design principles of the European scheme a preliminary model was developed for Brazil to determine the environmental impact of an Emissions Trading Scheme (ETS) if implemented for the cement sector in that country. In global terms, Brazil is the 5th largest producer and the 4th largest consumer of cement and still has significant capacity to increase production to meet projected demand for housing (approximately 6.3 million new houses) and infrastructure development (such as ports, airports, roads and sanitation). Brazil's National Climate Change Policy (PNMC) has set out to promote emissions reduction through various strategies by establishing different sector plans. The cement sector is included in the Industrial plan. The design and implementation of the plan stem from measuring, reporting, verifying and reducing emissions from industrial activity by 5% per annum from 2012 to 2020. The model developed as part of this research combines existing data from relevant European and Brazilian stakeholders with projections on carbon allocation and trading mechanisms based on the EUETS. The main conclusion of this research is that the ETS as modelled would have a positive environmental impact through reduced carbon emissions but that further research is required in relation to the economic impact of the proposed scheme.

**Keywords:** EUETS, carbon trading, cement sector, Brazil

## **WW1. Phycoremediation Potential of Indigenous Microalgae in Landfill Leachate Treatment**

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The use of microalgae in the remediation of effluents (phycoremediation) has been researched extensively and in recent years focus has also turned to landfill leachate. This type of effluent contains very high levels of dissolved salts, ammonia and various organic substances that can potentially serve as a source of nutrients for certain species of microalgae consequently improving the quality of the landfill leachate. While this has been demonstrated at higher temperatures and light intensities, these conditions are not prevalent in Irish climate. This research seeks microalgae strains suitable for temperate climates. In this study, a number of 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 number of stress experiments carried out in multiwell microplates. In these experiments, the modified commercial media and a number of leachates of varying strengths were used, representing a selected range of conductivities and ammonia concentrations. This screening process indicated a number of strains with the ability to survive and grow. 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. In order to evaluate the ability of microalgae to reduce ammoniacal and oxidised nitrogen and phosphate in landfill leachate, a number of prospective strains were used in batch experiments. The results showed a range of outcomes, highlighting for some strains the ability, under specific circumstances, to successfully remove ammonia and phosphate from the landfill leachate.

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

## **WW2. Impact of Landfill Leachate Loading on the Performance of Three Wastewater Treatment Plants**

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Leachate is the product of water that has percolated through waste deposits that have undergone aerobic and anaerobic microbial decomposition. In the EU, landfill leachate is normally held in lagoons located on-site, before being transported to wastewater treatment plants (WWTPs) for final treatment. Transport and treatment costs are considerable and in addition, many conventional activated sludge WWTPs are not designed for shock loads of leachate. In addition, there are concerns over its impact on the biological sewage treatment process and the quality of the sludge generated. Limited work has been carried out on the co-treatment of landfill leachate with municipal wastewater at pilot or larger scales. This paper describes the results of a study conducted to examine the impact of landfill leachate on WWTP performance at field-scale in three operating WWTPs. Three conventional activated sludge WWTPs with different operating capacities (population equivalents), receiving leachate from different landfill types (lined or unlined) at different loading regimes (i.e. drip-feed versus shock loading), were selected and monitored for between 10 and 50 days, depending on plant performance. The results of this study show that landfill leachate can be treated using conventional activated sludge WWTPs; however, high ammonium-nitrogen (NH<sub>4</sub>-N) influent leachate concentrations may pose a risk of elevated NH<sub>4</sub>-N effluent concentrations in both drip-feed and shock load systems. Current best practice in Ireland is to ensure that <4% by volume of influent of leachate enters the plant. The current study supports these findings. However, there is a need to examine the % by contaminant loading (e.g. NH<sub>4</sub>-N), as this may be more meaningful in capturing the range of leachate strengths found in Ireland. For example, in one of the three study sites, leachate NH<sub>4</sub>-N was equal to approximately 22% of the total load received at the WWTP but only represented 0.4% of hydrological load.

**Keywords:** Wastewater Treatment, Ammonium, Landfill, Leachate, Landfill Directive

### **WW3. The effect of the wastewater treatment process, in particular UV treatment on pathogenic virus removal.**

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Human pathogenic viruses of concern include Norovirus (NoV) as outbreaks of ‘winter vomiting bug’ can have significant health and economic impacts. Little is known about the removal of NoV in wastewater treatment plants (WWTPs) as the virus lacks a suitable tissue culture and so infectivity cannot be assessed. This project investigated the use of FRNA bacteriophage as (i) a potential surrogate for norovirus response/behaviour and (ii) a model to determine the fate of viruses through a municipal wastewater treatment plant. The project also evaluated the efficacy of membrane filtration (microfiltration and ultrafiltration) as a pathogen removal method and two ultraviolet-based technologies; pulsed UV and low pressure UV as pathogen disinfection methods. The potential impacts of parameters such as organic carbon, metals and suspended solids, (typically present in wastewater) on the investigated pathogen removal processes were also analysed. The key findings of the study included: •Due to the high resistance properties of bacteriophages to UV treatment and its morphological similarities to norovirus, the use of this virus as a potential surrogate has value. This option may currently offer the most effective method of determining the efficiency of disinfection processes (in particular UV) in achieving norovirus reduction. •The impact of suspended solids on pathogen removal via UV varied widely between samples and wastewater treatment facilities tested. The implementation of batch tests prior to installation of new UV systems would be useful to inform design and system range requirements such as the site-specific impacts of hydraulic residence times and wastewater characteristics (e.g. organic carbon and suspended solids). Furthermore, continuous commissioning, via periodic verification trials of installed UV systems may enable operators to ensure optimal operation of existing systems. •The operation efficiency of the treatment plant as a whole should be taken into consideration when selecting a particular tertiary treatment system as a poor performing plant may impact significantly on UV disinfection processes. •Biofouling control of membrane filtrations systems poses a significant maintenance and operational challenge. Further work could focus on design, operational and cost challenges that may be encountered when such technology is deployed on-site.

**Keywords:** Wastewater treatment, pathogenic virus removal, tertiary treatment, UV

**WW4. Agricultural runoff pollution control by a grassed swale coupled wetland detention pond system: a case study in Taihu basin, China**

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Vegetation interception technology is one of the recommended best management practices (BMPs) for nonpoint source pollution (NPS) control. The performance of a grassed swale coupled wetland detention pond system was monitored in terms of agricultural runoff pollution control. The system was located in an agricultural science and technology park in Jintan city, Taihu Lake basin, Jiangsu, China. The system consisted of two-pitch grassed swales (760 m<sup>2</sup>) and two-pitch wetland detention ponds (960 m<sup>2</sup>). The performance of the system was monitored under four typical rainfall events. The results indicated that average removal efficiencies of 83.5%, 65.3%, 91.6% and 81.3% for TSS, COD<sub>Cr</sub>, TN and TP, respectively, can be achieved. The grassed swales played an important role in removing TSS and TP and acted as a pretreatment process to prevent the clogging of the subsequent wetland detention ponds. Particle size distributions (PSDs) analysis indicated that coarse particles larger than 75µm accounted for 80% by weight of the total particles in the runoff. Grass swales can effectively reduce coarse particles in runoff, while its performance in reducing fine particles was lower, especially for particles smaller than 25µm. The wetland detention pond can remove particles of all sizes by sedimentation. Its removal efficiency of particle sizes smaller than 25µm was significantly higher than the grass swale. The length of grass swales is a key factor in its performance. In addition, wetland detention ponds can improve water quality due to their buffering and dilution capacity during rainfall as well as their water treatment ability during dry periods between rainfall events. Overall, the ecological system of grassed swales followed by wetland detention ponds is an effective system for agricultural runoff pollution control.

**Keywords:** agricultural runoff, grassed swales, wetland detention ponds

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**WW5. Evaluation of Wastewater Treatment and Electricity Generation in a Vertical Flow-Horizontal Subsurface Flow Constructed Wetland System Incorporating Microbial Fuel Cell Technology**

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In recent years, integrating constructed wetlands (CWs) with microbial fuel cell (MFC) technology has emerged as a new research field for simultaneous wastewater treatment and bioelectricity generation. Although the CW-MFC is in its infant stage, a few studies have demonstrated its novelty and potential. In this study, a two-stage CW-MFC is operated and evaluated in terms of system efficiency and potential for scale-up. The system consisted of a vertical flow CW-MFC as the first stage followed by a horizontal flow CW-MFC. The effluent of the first stage flows into the second stage under gravity. Dewatered alum sludge cake (derived from Liffey water treatment plant) was used as the main wetland substrate. The electrodes of the MFC consisted of granular graphite wrapped in a stainless steel mesh. In the second stage the anode electrode was buried in the alum sludge, while the cathode was semi-submerged and functioned as an air-cathode. The system was fed with domestic wastewater and operated for 180 days at room temperature (20 °C ~ 25 °C). The wastewater treatment efficiency of the system was evaluated in terms of SS, COD, TN, NO<sub>2</sub>-N, NO<sub>3</sub>-N, NH<sub>4</sub>-N, TP, RP and SRP removal efficiencies. The electrical performance of the system was assessed by alternating the external resistance and determining the redox potential at the electrodes and the maximum power density of the system. The trial has demonstrated that the aerobic environment of the semi-submerged cathode electrode in the horizontal flow wetland results in greater electricity generation efficiency than the traditional two-stage vertical flow CW-MFC.

**Keywords:** vertical flow–horizontal subsurface flow CW, MFC, alum sludge, domestic sewage

## **WW6. Practices of Ecological Landscape under the Integrated Constructed Wetland Concept**

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With the rapid development of urbanization, environmental problems associated with water pollution and sewage increases while vegetation cover decreases. Constructed wetlands (CWs) are considered an effective ecological system for wastewater treatment. Further to that, the integrated CW (ICW) concept promotes the use of CWs not only for wastewater treatment but also to enhance biodiversity, landscaping and educational opportunities etc. This study explores design principles and case studies of CW systems in consideration of the surrounding environment to create a pleasing landscape, thereby extending the traditional CW system for wastewater treatment to a multi-functional ICW. It is expected that this study can give water scientists and engineers a better understanding of the ICW concept while promoting CW technology to landscape planners in order to achieve wider and wiser application of CWs for the dual goals of pollution control and the creation of aesthetically pleasing landscape.

**Keywords:** Ecological Landscape, integrated CW, Wastewater treatment

## **WW7. Impact of landfill leachate loadings on the performance of three wastewater treatment plants**

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Leachate is the product of water that has percolated through waste deposits that have undergone aerobic and anaerobic microbial decomposition. In the EU, landfill leachate is normally held in lagoons located on-site, before being transported to wastewater treatment plants (WWTPs) for final treatment. Transport and treatment costs are considerable and in addition, many conventional activated sludge WWTPs are not designed for shock loads of leachate. In addition, there are concerns over its impact on the biological sewage treatment process and the quality of the sludge generated. Limited work has been carried out on the co-treatment of landfill leachate with municipal wastewater at pilot or larger scales. This paper describes the results of a study conducted to examine the impact of landfill leachate on WWTP performance at field-scale in three operating WWTPs. Three conventional activated sludge WWTPs with different operating capacities (population equivalents), receiving leachate from different landfill types (lined or unlined) at different loading regimes (i.e. drip-feed versus shock loading), were selected and monitored for between 10 and 50 days, depending on plant performance. The results of this study show that landfill leachate can be treated using conventional activated sludge WWTPs; however, high ammonium-nitrogen ( $\text{NH}_4\text{-N}$ ) influent leachate concentrations may pose a risk of elevated  $\text{NH}_4\text{-N}$  effluent concentrations in both drip-feed and shock load systems. Current best practice in Ireland is to ensure that <4% by volume of influent of leachate enters the plant. The current study supports these findings. However, there is a need to examine the % by contaminant loading (e.g.  $\text{NH}_4\text{-N}$ ), as this may be more meaningful in capturing the range of leachate strengths found in Ireland. For example, in one of the three study sites, leachate  $\text{NH}_4\text{-N}$  was equal to approximately 22% of the total load received at the WWTP but only represented 0.4% of hydrological load.

**Keywords:** wastewater treatment, ammonium landfill leachate, landfill directive

### **WQ1. Micro-Plastic Pollution in Irish Freshwater Systems: Sources, Impacts and Fates**

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The increase in global use of plastic over the last 30 years has culminated to an estimated global annual production of 280 million tonnes. This combined with its high durability and overall poor rates of recycling have resulted in the introduction of large amounts of plastic to aquatic environments. Micro-plastic is plastic which is < 5mm in size and is derived from land based sources such as Industry and urban waste waters along with the fragmentation of larger plastics previously introduced to the aquatic environment. Apart from the physical obstructive risks of micro-plastic to biota, it contains and sorbs contaminants and can act as a vector for exotic species and pathogens. Over the last 10 years, many studies have been carried out on the distribution and effects of micro-plastic pollution within the marine environment showing a distribution as far as the polar regions. However, there has been a disproportionately low amount of research carried out on the effects of micro-plastic pollution in freshwater systems. This study aims to identify potential sources of micro-plastic pollution within Ireland, to assess its pollution load and to identify potential impacts to human health along with priority freshwater species and habitats. Catchments with high potential exposure will be identified with reference to environmental pressures such as the presence of industry and urban centres. Pollution load from these sources will be estimated with reference to current international understanding. Abundances and characteristics of micro-plastic along with associated pollutants will be assessed in the surface waters, sediments and biota of the Corrib catchment area. Environmental fate will be assessed in catchments with identified high exposure potential through the development of a conceptual model of transport, retention and re-suspension of micro-plastic particles. Recommendations resulting from this study will contribute to policy development on micro-plastic pollution.

**Keywords:** Micro-plastic, Plastics, Freshwater pollution

## **WQ2. In-Package Atmospheric Cold Plasma Treatment of Textile Waste waters Containing Direct Dyes**

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In-package atmospheric cold plasma (ACP) was generated in a dielectric barrier discharge reactor. As an advanced oxidation process, the degradation studies of model dyes such as Bromothymol blue and Oil Red O (lipophilic) were studied as a function of treatment time (0-120 sec), applied voltage (30,40 & 50 kV). In-package ozone concentrations measured immediately after treatment for all three dyes ranged from 1600-1750 ppm operated at 50 kV for 120sec treatment time. Decrease in peak absorbance of the dyes and pH was observed as a function of treatment time and ozone concentration. Optical emission spectroscopy of the discharge revealed generation of excited nitrogen and reactive oxygen species which is responsible for degradation of organic dye. The electrical characterization revealed the operation of the discharge in stable filamentary regime. Kinetic models viz. first-order, Gompertz models were fitted to the experimentally observed data to numerate the model parameters. The results of kinetic modelling revealed that the dye discolouration followed a first order kinetic model with regression coefficients ( $R^2 > 0.96$ ) and the rate constants are proportional to the treatment time. Dye degradation also followed Gompertz model but only at smaller voltage and treatment times.

**Keywords:** Cold plasma, bromothymol blue, oil red o(lipophilic), first order kinetic model, Gompertz model

### **WQ3. Characterisation of Reference Conditions for Unusual or Rare River Types (RARETYPE)**

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Under the Water Framework Directive, all Member States are required to achieve at least “good” status for all surface water bodies. To accurately assess the ecological status of waterbodies it was necessary to develop a river typology upon which type-specific reference conditions could be established. The ecological status of a water body is then determined based on the degree of deviation from the reference condition defined for that specific river type. Using a permutational-based approach 12 national river types were defined in Ireland by the RIVTYPE project based on the abiotic factors of geology and slope in 2005. However, four unusual river types were identified as being omitted from this process: 1) low conductivity, naturally acidic rivers, 2) highly calcareous rivers with calcium precipitation, 3) groundwater-dominated rivers, and 4) rivers strongly influenced by lakes, i.e. lake outlets. Each of these groups presents potentially challenging environmental conditions for aquatic biota and so may host different communities to those expected according to type-specific reference conditions. This project commenced in January 2014 and aims to characterise the biological communities of these river types in order to determine if they represent distinct river types or sub-types. The effectiveness of current water quality metrics in determining their ecological status will also be assessed.

**Keywords:** Water Framework Directive, Typology, Ecological Assessment, Reference conditions

#### **WQ4. Next Generation Analytical Platforms for Environmental Sensing**

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The current state-of-the-art for autonomous environmental instruments monitoring the chemical and biological status of our water is based on flow systems that employ conventional approaches to sample/liquid handling, which makes them prohibitively expensive (often >€20K per unit) in terms of up-scaling deployments. The EU FP7 NAPES project will investigate ways to deliver revolutionary advances in liquid/sample handling combined with new approaches to performing sensitive in-situ analytical measurements. In this project, we will combine advances in nanomaterials science and microfluidics field to address the key building blocks of future instruments and analysers with dramatically improved performance characteristics. TelLab is working on the implementation of the first step in this multistage sampling strategy; the development of a filtering and pre-concentration unit. TelLab has designed a reverse osmosis (RO) system to remove bulk contaminants and provide a degree of pre-concentration of different sample components (metal ions, nutrients, charged surfactants etc.). In RO, pressure is applied to drive the water in the reverse direction, generating almost pure water in one fraction or flow, and concentrating the impurities in a second fraction or flow. In this simplified design, a simple thin film composite membrane filter prevents dissolved components, salts and bacteria from crossing into the purified fraction. The impurities are concentrated in a second fraction that is diverted into a side exit. With this technology we achieve a concentration enhancement suitable for subsequent analysis using microfluidic systems. Through this concentration enhancement, trace levels of analytes in water may now potentially be detected using portable analytical systems.

### **WQ5. Development of Portable Systems for in-situ Analysis of Pollutants in Water**

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Water is a precondition for human, animal and plant life as well as an indispensable resource for the economy. The protection of water resources is therefore one of the cornerstones of environmental protection in Europe and throughout the world. In order to facilitate effective water monitoring, continuous in-situ analysis is essential. However, current commercially available systems have limited deployment capabilities, mainly due to their large physical size, high power consumption and reagent requirements. Therefore, it is not typically feasible or cost-effective to use macro-scale systems for continuous monitoring, and portable systems must be developed. T.E. Laboratories is a multi-divisional company based in Tullow, Co. Carlow. The company operates within the environmental, fuel and oil and chemical manufacturing sectors. R&D within the environmental sector plays a key role within the company. Currently, TelLab are a partner organization within seven EU FP7 projects, six of which relate to water analysis. Tellab's contribution within these projects ranges from project coordinator, to assisting in design and development, to providing validation of novel sensors. Through collaborations associated with these projects, TelLab have recently developed an autonomous analytical system for water analysis based on microfluidics and colorimetry. This device is capable of in-situ nutrient analysis in water and may be deployed in various water matrices. This poster will highlight the importance of in-situ analysis and real-time data when considering the protection of water quality and resources. In addition, TelLab's portable analytical device will be highlighted in detail.

**Keywords:** in-situ, microfluidics, nutrient analysis, portable

### WQ6. Ireland's Lithium Resources

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Lithium is a key geo-political resource for the industrialised West. Its innovative use in medicine since the 1940's as a mood-stabiliser is quantitatively trivial compared to its actual and anticipated use in Li-ion batteries as the chemical energy accumulator that will power the electronic devices and electric vehicles for our immediate future. Ireland has been hiding a mineral deposit of lithium buried deep within the Blackstairs mountain region. The lithium was discovered during geological surveys conducted in Ireland during the 1970's (Geological Survey Ireland) but was deemed at the time to be of low economic value. Modern demand for lithium fuelled by the rising cost of oil and falling price of Li-ion batteries has driven up the price. The increased demand means that this deposit of lithium is becoming economically worthwhile to extract. Lithium reacts readily with water, in consequence, Carlow water should theoretically be chock-full of lithium., This study will measure the concentration of Lithium lithium in ground and surface water in the region to answer such questions as: What is the concentration of lithium in surface and ground waters of the region? Can we identify the lithium bearing rock by measuring lithium levels in ground water? By tracking other metals (Fe, Mg, Zn) can we identify co-occurrences and correlations that predict lithium levels? Can we create a geochemical map of the county and identify trends and clines in the titres of these metals? We will access the subterranean by drawing ground water samples from domestic wells. Surface waters will be collected from rivers in the area. The measurements of the metal concentrations will be determined by spectroscopy. No research of this kind has been carried out in the area and apart from the historical investigation of the 1970s no new data is publicly available.

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

## **WQ7. Nitrogen Mediated Discharges of Dissolved Organic Carbon from Irish Blanket Peatlands: Space-time Events in Fluvial Distribution Networks**

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The role of nitrogen in Irish blanket peatlands has been recently recognised as a significant factor affecting the carbon dynamics of these peatlands. This study investigates the pathways of nitrogen mediated dissolved organic carbon (DOC) in Irish blanket peatlands and the pathways of subsequent space-time events in fluvial network discharge. Data suggests an increase in the rate of DOC discharge to streams draining mountain blanket peatlands in Ireland since the 1990s. DOC is defined as carbon that passes through a 0.45 micron filter and is usually composed of high molecular weight humic substances (e.g. humic, fulvic acids and humin) with variable carbon to nitrogen ratios and surface charges. This study advances a mechanistic paradigm relating nitrogen enrichment, peatland soil structure, water saturation levels and throughflow pathways with DOC dynamics. Nitrogen enrichment has been associated with both enhanced and reduced levels of DOC production in peatlands but this is a spatio-temporal phenomenon highly dependent on peat profile characteristics. The preliminary outcomes of this model construct suggest that DOC levels should be strongly related with nitrogen concentrations and depth in the profile. The model is constructed as a series of two dimensional representations of the peat profile using a cell based approach incorporating a finite difference relationship to generate values for the efflux of DOC. Variable throughflow characteristics are assigned to the peat dependent on depth. This simulation facilitates exploration of nitrogen interaction pathways which both inhibit and promote DOC and relates these to structural characteristics that control hydrological flow. Results suggest that outputs aid understanding and communication of the relationship between nitrogen enrichment, peat structure and fluvial dynamics in controlling the DOC efflux rate. Therefore this work facilitates research addressing the challenges of land use management and nutrient control as they relate to the carbon sequestration profile of Irish blanket peatlands.

**Keywords:** carbon cycle, nitrogen cycle, DOC, peatlands, climate change

### WQ8. Miniaturization of *Pseudokirchneriella subcapitata* bioassay

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The release of ecotoxicological pollutants into aquatic ecosystem has increased since the industrial revolution, causing concomitant potential risk to fauna and flora. Our current state of knowledge of the ecotoxicological effects of aquatic pollutants is modest compared with the large number of chemicals in existence. One test used to assess the aquatic toxicity of chemicals is the *Pseudokirchneriella subcapitata* algal test. Algae are often used to quantify possible effects in aquatic ecosystem as they are basis of most food chains, thus, perturbations on algae caused by pollutants can cause a bottom-up effect. The classic algal phytotoxicity flask assay (ISO 8692:2012) requires large amounts of glassware and chemicals. In order to maximise higher throughput toxicity testing, the miniaturization of this phyto-toxicity test was modified to replace the classic test, using 96 microwell plates instead of 50 mL Erlenmeyer flasks. The advantages of miniaturization include less space and automation using a plate counter. Geometric series of five concentrations (0.1, 0.5, 1, 5 and 10 ppm) of 3,5-Dichlorophenol and Potassium Dichromate were prepared in 10 mL volumetric flask, using Jarwarski's medium as the diluent. In this miniaturized test, 100 µL of *Pseudokirchneriella subcapitata* (1x10<sup>4</sup> cells/mL) were inoculated in each well of a 96 well flat bottom microplates. 300 µL of each concentration of analyte was also added to each well. All experiments were conducted in triplicates. The absorbance of the plates was measured at the beginning and at the end of the experiment using a multi plate reader @ 490 nm. The inhibition of growth was determined and the modified miniaturised test IC<sub>50</sub> values were within the 95% confidence limits stipulated in the ISO standard (ISO 8692:2012). The R<sup>2</sup> value between the classic and modified miniaturised test was 0.98.

**Keywords:** miniaturization, *Pseudokirchneriella subcapitata*, toxicity

### **WQ9. Photodynamic Inactivation – A Novel Approach to Water Disinfection**

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Water is our most precious commodity and the interest in finding an alternative process to eradicate waterborne pathogens is growing in the past few years. The photodynamic process (PDI), also called photosensitization, relies on the activation of a photosensitiser by visible light, generating cytotoxic species which kill cells. The technology has long been used in the medical area and recently has been investigated for environmental application as the light source used can be sunlight. It is an interesting alternative approach to traditional disinfection techniques used for water such as chlorination, ozonolysis and irradiation with UV light because it does not induce bacterial resistance, mutagenicity or genotoxicity and is cost effective. The aim of this project was to investigate novel photosensitisers, in particular porphyrins, to use in water photodisinfection. The experiments were performed in glass Petri dishes (60x15 mm) which were irradiated with two different multi-LED lamps, one green at 525nm and one white (400-700nm). Microbial numbers were monitored using the plate count technique. All samples were analysed in triplicate and dark and positive controls were performed. The porphyrin, 5,10,15,20-tetrakis(N-methyl-4-pyridyl)-21H, 23H-porphine (TMPyP), showed very efficient microbial deactivation when tested against pure cultures at a range of concentrations. Overall, the results were very competitive when compared with the literature, TMPyP and the multi-LED lamps were shown to be effective in the photoinactivation process, with promising application for water disinfection.

**Keywords:** water, porphyrin, photoinactivation, disinfection.

### **WQ10. High Status Water bodies: Managing and Optimising Nutrients**

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The principal objectives of the WFD are to maintain 'High' and 'Good' ecological status in water bodies where it exists and to achieve at least 'Good' status for all waters by 2015. However, the EPA has noted a decline in the numbers of high status sites over the past twenty years. Most of these sites are located in upland areas, clustered along the western seaboard with a high proportion of peat soils in their catchments. Agriculture in these areas is not typically extensive; however, poor management of nutrient on farms can cause a significant pressure in such sensitive catchments. Farmers living in these areas will require nutrient management strategies that take account of the soil and topographical constraints within the landscape. Furthermore, a strong participatory approach to nutrient management from the farming community is necessary if mitigation strategies are to be adopted and successful. This collaborative project will integrate agri-environmental research with socio-economic tools to provide evidence-based measures for nutrient management that are cost-effective and acceptable to the farming community in these catchments. This project will characterise the catchment characteristics and assess the current nutrient management practices in case-study catchments. New agronomic and hydrology research will address the nutrient efficiency and hydrological constraints on nutrient management in sensitive catchments. A list of potential measures will be proposed, and a socio-economic evaluation of their cost-effectiveness and likelihood of adoption will be made across the farming community.

**Keywords:** Water Framework Directive, water quality, agriculture, nutrient management

**WQ11. The optimisation of an autonomous phosphate sensor for remote continuous monitoring**

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There is a growing demand for improved sensing capabilities for phosphorus in water. Phosphorus is a growth limiting nutrient. When levels are elevated, excessive growth of algae occurs, leading to hypoxic or anoxic waters, and the subsequent death of aquatic animals. Real time, continuous monitoring is essential for effective management of nutrient levels in a catchment, by both the detection of pollution events and the identification of point and diffuse pollution sources. Low cost sensors increase capacity for the deployment of sensor networks for diffuse pollution source identification by providing increased spatial data. A low cost, autonomous sensor with wireless communications has been developed for the detection of phosphate. It is capable of 12 month long deployments. It consists of a waterproof casing, a sample inlet, a filter to remove particles, pumps for fluid manipulation, a microfluidic chip for mixing of water sample and reagents, an LED and photodiode for optical detection, a microcontroller and communications system for wireless communication of data. A key challenge in terms of nutrient monitoring is the detection limit required. This work shows the optimisation of the autonomous phosphate sensor in terms of sensitivity and the limit of detection. Optimal wet chemistry and a long optical path length enabled improved sensitivity and detection limit.

**Keywords:** Phosphate, limit of detection, water monitoring, sensor

### **WQ12. Optical Sensors for Water Quality Monitoring**

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Worldwide appreciation of the importance of the environmental monitoring has been growing in recent years. Environment encompasses both biotic and abiotic factors. Among abiotic factors, water is considered as vital component. Thus, water quality monitoring is a large multi-faceted domain that attracts significant attention. The main water contaminants have been identified, and strict regulations on their concentrations have been imposed [1]. Sensors, particularly optical sensors have been the subject of substantial research activity for several years. They have been widely used in many applications to sense physical-related parameters such as temperature, pressure, flow rate; humidity etc. Optical sensors can play an important role in water quality monitoring. There is a significant need in the water industry to develop cost effective, real-time, field-deployable monitors for detection and identification of chemical pollutants and bio-threats [2-4]. We present a review of recent developments in the field of water quality monitoring with the help of optical sensors. A novel methodology for fabrication of low cost optical sensors for qualitative detection of pollutants in water is presented and compared with sensors currently in use.

**Keywords:** Optical Sensors, Water Monitoring, Water Quality

### **WQ13. DairyWater: Sustainability and resource efficiency for the Irish dairy processing industry**

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The abolishment of milk quotas in 2015 is expected to result in a 50% increase in milk production in Ireland by 2020. This increase in the volume of milk being processed along with stringent measures on emissions from the industry and growing commercial drive for operational efficiencies is driving the need for innovative technological and operational solutions within the dairy processing industry. In this context DairyWater, a new multi-stakeholder research project, is developing innovative solutions for the efficient management of water consumption, wastewater treatment and the resulting energy use within the country's dairy processing industry. This project has the potential to position Ireland at the forefront of European, or indeed international, research in this sector as it strives to make the Irish dairy processing industry more efficient and environmentally sustainable by reducing carbon footprints, energy and water use. This will, in turn, lead to greater potential for exports, increased international competitiveness for Irish products and stimulate job creation. The primary goal of the study is to efficiently and effectively treat wastewater effluent from dairy processing plants using a range of innovative biological, nanometerial-based and disinfection technologies. In parallel, the efficient use of water (and resulting energy costs) within the plants is also being explored. Therefore, the project can be divided into three main research areas: •Dairy wastewater treatment technologies; •Water re-use and rainwater harvesting; and •Environmental life cycle assessment (LCA). DairyWater has the potential to position Ireland at the forefront of European, or indeed international, research in this sector. The project strives to make the Irish dairy processing industry more efficient and environmentally sustainable, which will lead to greater potential for exports and increased international competitiveness for Irish products, along with stimulating job creation. For further details and to follow the progress of the project, log onto: [www.dairywater.ie](http://www.dairywater.ie) or follow the project on twitter: @dairywater.

**Keywords:** dairy, environmental life cycle assessment, milk processing, wastewater treatment, water re-use

## **E1. An investigation of the economic potential of Short Rotation Forestry for fibre and fuel in Ireland**

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Woody biomass represents a renewable resource with multiple industrial applications. To respond to the increasing demand for fibre products and renewable fuel for energy, it is expected that there will be an increase in short-rotation forests in Ireland. Forest policy is already promoting afforestation for fibre and fuel through targeted support measures. Short Rotation Forestry (SRF) involves planting single stemmed fast-growing trees at high density over rotations of 8 to 20 years on agricultural land or suitable forest land. Despite the potential of SRF, there are difficulties to convince farmers to convert their land to SRF due to uncertainties about its economic sustainability. In particular, it is not yet known if SRF should be financially managed to allocate a range of assortments to diverse markets or supply a single market only. This study aims to investigate the potential financial value of SRF in Ireland and give indications on how to optimise it. SRF stand data are being collected and the markets' requirements for fibre and energy from SRF plantations in Ireland will be assessed. Different units for quantifying and valuing biomass will be identified and a methodology to convert different wood units will be developed. These three inputs will be introduced to VALMAX, an optimal log-making algorithm and scenarios will be tested to determine the potential value of SRF plantations under market conditions in Ireland.

**Keywords:** Short Rotation Forestry, renewable energy, forest biomass, market survey, economic sustainability, value optimisation

## **E2 Investigating the drying rates of softwood firewood outdoors under Irish climatic conditions**

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A firewood storage trial was established at the Carriganore West Campus of Waterford Institute of Technology. The aim was to determine the best condition for drying firewood under 10 treatments outdoors in the Irish climate. Each treatment was made up of combinations of 3 variables: covering the firewood with a tarp or leaving the firewood exposed; splitting the firewood or leaving it round; and length of each piece of firewood (25cm, 45 cm or 3 m). In total, 30 pallets of firewood (circa 1 m<sup>3</sup> each) were installed on the site – 3 replicates of the 10 treatments. The change in moisture content over time was determined by gravimetric method – weighing the pallets regularly with a load cell on a pallet truck. In addition to the drying rate, the bulk volume (ratio to solid volume) and waste generated were defined for each treatment. It was found that all treatment types lost moisture rapidly at the beginning of storage. The lowest moisture contents were maintained throughout the trial by the 3 m logs (both covered and uncovered). Uncovered treatments gained a lot of moisture during the winter while their covered counterparts were less affected by periods of rain. 25 cm, split firewood produced the most waste. Producing firewood with a firewood processor is more wasteful than producing it with a chainsaw and sawhorse. Split firewood assortments occupied a greater bulk volume than round assortments.

**Keywords:** firewood storage, drying rates, softwood, Sitka spruce

### **E3. Effect of Commercial Enzyme Preparations on the Bioconversion of Energy Crops**

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Second generation biofuel produced from lignocellulosic biomass including energy crops can be a major source of sustainable energy. Fast growing energy crops are likely to be important contributors to the future renewable energy mix as they can mitigate GHG emissions both through fossil fuel substitution but also through carbon sequestration. Bioconversion of lignocellulose is a five step process which involves pre-treatment of the recalcitrant feedstock and enzymatic hydrolysis of the cellulose to fermentable monomeric sugars. Interest in the bioconversion process has increased over the years, particularly in the enzymatic hydrolysis of cellulose, the main constituent of biomass. This has led to extensive studies of the cellulolytic enzymes produced by microorganisms, bacteria and fungi. Currently, most of the commercial cellulases (including  $\beta$ -glucosidase) used are produced by filamentous fungi, *Trichoderma* species (in particular *T. reesei*) and *Aspergillus* species. Selection of the most effective and efficient enzyme for enzymatic hydrolysis can often be problematic due to varying enzyme activities and dosage rates which can have a significant impact on downstream processing. This study examines the effect of three commercial enzymes (*T. reesei*) on the bioconversion of energy crops: willow, miscanthus and hemp. The study establishes a comparative analysis of the *T. reesei* enzymes based on hydrolysate yields following analysis using an ICS 5000 Ion Chromatograph. Enzyme activity assays and appropriate dosage rates are also described in the comparative report.

**Keywords:** *Trichoderma reesei*, energy crops, ion chromatography

#### **E4. Advancement of GIS-based Method for Evaluation of Biomass Potential**

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Ireland currently imports 88% of its fossil fuels, which puts the country in a vulnerable position should there be disruption to supply due to geopolitical reasons. Bioenergy has the potential to reduce Ireland's dependency on such importations. This study examines how biomass resources such as animal wastes, energy crops and organic waste from human activity can be utilised for bioenergy production, by investigating how these resources are distributed across the country. A computer model, which integrated a geographical information system (GIS) approach, was developed to determine the distribution of biomass resources and how bioenergy plants can be strategically located in order to capitalise on these resources. The model was formulated with anaerobic digestion (AD) plants in mind, whereby the potential location and design of a plant was driven by the requirement to meet several criteria, such as examining the local topography and soil conditions to ensure that the plant had a potential supply of suitable feedstock and considered critical infrastructure such as roads and gas pipelines in relation to reducing transport costs, minimising energy demands and ensuring a supply network for potential gas generated as part of the process. The model integrated the technical requirements for the plant in order to calculate the net energy balance once all parasitic energy demands of the plant were met, which included transporting feedstock to the plant and the energy associated with running the plant. A case study of the Limerick region generated the potential location and sizing for the construction of an AD plant which, using a combination of cattle slurry, grass silage and brown bin waste, could produce sufficient electricity and thermal energy for 1475 and 647 homes, respectively. Alternatively, the plant could potentially produce 1.5 million m<sup>3</sup> of biomethane per annum, for use in powering 90 public buses over 110,000 kilometres.

**Keywords:** Biomass, Bioenergy, Geographical Information Systems, Anaerobic Digestion, Fuel Security

### **E5. Ventilation Heat Recovery in Commercial Seaweed Bath House**

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In line with Ireland's National Energy Efficiency Action Plan (NEEAP) on delivering a 20% reduction in energy demand by 2020 it is incumbent on all energy users to adopt an energy efficient ethos. The Voya Seaweed Bath specialise in providing a high quality spa and health treatment service to their customers. This service requires a significant energy input to heat the water used in the seaweed baths. The CREST research focused on investigating the existing water and energy use at the facility and investigating feasible clean energy strategies to realise both cost and energy savings. The investigation identified 2 main heat recovery solutions: drain water heat recovery and ventilation heat recovery. The ventilation heat recovery option was chosen as the optimal solution at this time due to reduced capital costs and less complex integration with existing systems. A compatible heat recovery proposal which could be easily integrated into the seaweed bath operation was designed and commissioned by Eurotech Group for on-site testing and performance monitoring. The process involves recovering heat from bathroom extract air, which is then upgraded using heat exchangers, to preheat the mains water supply to the existing hot water system, thereby reducing energy input from the oil burners. The heat recovery system is now operational and monitoring for overall performance is ongoing. The objective of the monitoring is to establish the energy cost per bath with and without the heat recovery system, in order to identify the economic payback period.

**Keywords:** Energy efficiency, heat recovery

**E6. Study on the key regulatory enzymes in diatoms for enhanced lipid production with suitable fatty acid profile for biodiesel applications**

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Renewable sources for biofuel production are pivotal due to decreasing fossil-oil reserves. Microalgae as an alternative for biofuel have received priority as they are more efficient than vascular plants at turning free sunlight and minimal nutrients into valuable biofuel ingredients. Diatoms (the microalgae of Bacillariophyceae) are among the most productive and environmentally flexible eukaryotic microalgae on the planet. Diatoms possess high content of lipids and fatty acids (e.g., 10-39% lipids and 4-28% fatty acids of dry weight biomass). However, diatoms are underrepresented in the development of microalgal biofuels. The main aim of this on-going project is to evaluate the potential of marine diatoms of Irish habitats as an alternative source for the sustainable production of biofuels. This study was initiated with the collection and isolation of diatom samples from Irish coasts such as Ballybunion, Kilkee, Tralee and Spanish Point. The growth conditions of some isolates were optimised for sustainable cultivation, while other isolate's growth optimization is in progress. One model diatom *Phaeodactylum tricornutum* CCAP 1052/1B was selected as the control strain for this study. In this poster, the biochemical content data of *Phaeodactylum tricornutum* - including fatty acids profile - under various growth conditions are presented. Future studies will examine the response of key regulatory enzymes of lipid metabolic pathways under various growth conditions. The four selected enzymes are glucose-6-phosphate dehydrogenase (G6PDH), malate dehydrogenase (MDH), iso-citrate dehydrogenase (IDH), and ATP citrate lyase (ACLY), whose enhancers and inhibitors will also be tested. Understanding the response of these enzymes under various growth conditions and their corresponding lipid content would help regulate (by specific growth condition, inhibitors or enhancers) lipid production in diatoms for biodiesel applications.

**Keywords:** Biofuel, Diatoms, Microalgae, Lipid Metabolism, Biodiesel, Bioethanol

**IS1. Invasive species, climate change and pollution: investigating human mediated impacts on ecological systems using functional responses**

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Aquatic systems are under continuing and increasing pressure from a multitude of invasive species, the influence of climate change and water pollution, threatening the integrity of food webs through altering the strength of predator-prey interactions. This is possibly causing systems to become biologically impoverished, both in terms of biodiversity and abundance, leading to local species extinctions. The functional response is the relationship between prey density and predator feeding rate. FRs broadly exist in three types, Type I a linear relationship, Type II a decelerating curve and Type III a curve with an inflection point at low prey densities proceeding to a decelerating curve at higher prey densities. Deriving functional responses of predator and prey combinations can resolve interaction strengths. Snapshots of interactions can be built up using functional responses, allowing insight into how relevant context-dependencies change interactions and alter food web structure. We investigated how oxygen levels (50% and 80% saturation corresponding to high and low oxygen levels at 12°C), altered the predatory impacts of *Gammarus pulex* (invader) and *Gammarus duebeni celticus* (native) on two common prey species. Overall the invader consumed more prey than the native at both oxygen levels for both prey types. In both cases reduced oxygen levels caused a reduction in feeding rates. However, the feeding rate of the native consumer was reduced by a greater degree than the feeding rate of the invader. This is indicative of increased ecological impact of an invasive species on a native prey population in low water quality conditions. Revealing these differences in impact by invasive species compared to native species under environmental change using functional responses can aid legislators and stakeholders to make informed decisions regarding water quality minimum standards and to maximise conservation efforts.

**Keywords:** Invasive Species, Environmental Change, Biodiversity

**IS2. Deer exclusion in *Rhododendron* cleared sites promote the recovery of plant communities and invertebrates in the oak woodlands of Killarney National Park**

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The management of invasive species is recognised as a priority in the conservation of natural ecosystems. Multiple alien invasive species require the simultaneous implementation of control efforts to achieve native woodland restoration. Large areas of the Killarney National Park invaded by *Rhododendron* was cleared but grazing pressure from the invasive sika (*Cervus nippon*) and native red deer (*Cervus elaphus*) has so far inhibited the regeneration of native vegetation. Large deer proof enclosures, of variable size, were installed in Ullauns wood after *Rhododendron* control to give the native seed bank a chance to regenerate. Three fenced sites and adjacent control sites (unfenced) were selected and the vegetation and invertebrates were assessed. The vegetation was surveyed by selecting 20 (4m x 4m) plots in each site and each species was recorded. Moths were sampled using 15W Heath moth traps placed randomly in the centre of each fenced and unfenced site on three consecutive nights. Specimens were identified to lowest taxonomic level. On average, fenced enclosures displayed two times greater vegetation cover than sites which were subject to grazing pressure. *Quercus petraea* and *Ilex aquifolium* seedlings show significantly greater densities in fenced sites, and all seedlings including *Sorbus acuparia* and *Betula pubescens* show significantly greater average height in enclosures. Results of community analysis indicate significant differences in species assemblage between sites. While some individual species benefit from removal of grazing pressure, others are seen to decrease in abundance indicating the need for greater understanding of browsing pressures. Preliminary analysis of results indicates that moth taxon richness is significantly greater in enclosures than adjacent unfenced sites. Significant differences were found between sites, but not all fenced sites were significantly different to unfenced controls.

**Keywords:** *Rhododendron ponticum*, deer exclusion, Lepidoptera, oak woodland, ecological restoration

**IS3. Predicting the impacts of the Ponto-Caspian round goby *Neogobius melanostomus* using comparative functional responses**

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The round goby *Neogobius melanostomus* is one of several Ponto-Caspian species currently invading central and Western Europe, and has previously impacted on native communities via significant consumption of benthic macroinvertebrates. Despite steadily expanding throughout European freshwaters in recent decades, it has yet to arrive in the United Kingdom and Ireland, and urgent prediction of its impact in these areas is, therefore, essential to inform pro-active management strategies. To assess the potential for impact on native macroinvertebrate communities, we measured the functional responses (resource consumption rate as a function of resource density) of *N. melanostomus* towards two benthic macroinvertebrate species (the isopod *Asellus aquaticus* and the amphipod *Echinogammarus berilloni*) and compared these with those of a trophically similar native species, the European bullhead *Cottus gobio*. In line with hypotheses, consumption of both macroinvertebrate species was significantly higher for the invasive *N. melanostomus* than for the native *C. gobio*. Both fish species consumed significantly more of *E. berilloni* than of *A. aquaticus* possibly due to the latter's increased ability to take refuge in the corner of experimental arenas. Finally, there was a significant 'predator species x prey species' interaction, as the consumption of *A. aquaticus* by the invader diverged further from that of the native compared to consumption of *E. berilloni*, indicating that *A. aquaticus* is more likely to experience impact. Further study should consider the effects of inter/intra specific interactions on per capita impact of *N. melanostomus*, as time devoted to aggressive behaviours among hetero/con-specifics may reduce the amount of prey consumed and/or promote stability to prey populations by altering the functional response.

**Keywords:** round goby; *Neogobius melanostomus*; European bullhead; *Cottus gobio*; functional responses; invasive species; conservation; biodiversity

**IS4. Asian Clams in hotwater: invasive *Corbicula* downstream of Lanesborough Power Plant**

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The invasive Asian clam, *Corbicula*, has become established at a number of sites across Ireland. A population at the hot-water outflow from the ESB's Lough Ree peat burning power station at Lanesborough, on the Shannon River, has recently been discovered. This presented the unique opportunity to compare an early stage aquatic invasion exposed to an anthropogenically elevated temperature regime, with an ambient temperature Irish river population. Field sampling efforts were carried out in October of 2014 to quantify the size and makeup of the Lanesborough population. A range of environmental and biological measurements were gathered including numbers and biomass/m<sup>2</sup>, individual shell dimensions and weight and ash-free dry weights. Length frequency analysis revealed a distinct population structure at the Lanesborough site significantly different from other Irish sampling sites. A mean density of 4938/m<sup>2</sup>, with a mean biomass of 1.7kg/m<sup>2</sup> was recorded. Distinct age cohorts were not evident at the Lanesborough site, possibly due to sustained recruitment throughout the year. We developed a tool for the estimation of individual clam weight from shell length measurement using a fitted power equation. This will allow managers to rapidly estimate biomass from shell length measurements. A Mann–Whitney U comparison of the ratio between shell length and weight for the River Barrow and Lanesborough sites, as derived from the power equation, revealed a statistically significant difference ( $p < 0.05$ ) between the two populations.

**Keywords:** recruitment, Asian clam, invasion, elevated temperature

### **EH1. Microalgae as an alternative renewable source of omega-3 fatty acids**

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Microalgae are considered a promising source of various high value products with health benefits. In this context, this project focuses on microalgal lipids as an environmentally friendly, renewable alternative to fish oil production. Investigations are underway to determine how environmental factors and culture conditions can influence growth performance and lipid production. Of particular interest are long-chain polyunsaturated fatty acids (LC-PUFA), as microalgae synthesize and produce large amounts of both eicosapentaenoic (EPA, 20:5 n-3) and/or docosahexaenoic (DHA, 22:6 n-3) acids. Algal species were selected based on their potential for favourable EPA and DHA production ratios. Samples were batch-cultivated in triplicate under four different temperatures (8, 14, 20 and 26 °C), with constant light (60  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ), and over a period of 15 days. Growth optical density and biomass dry weight, nitrate uptake and medium pH were monitored each 3-5 days, pigments assessed spectrophotometrically, and fatty acid methyl esters (FAME) analysed by Gas Chromatography Coupled with Flame Ionisation Detector (GC-FID) after direct transmethylation of the algal-biomass. Results indicate species-specific optimal growth temperatures and a diminution of total pigment content over time, regardless the temperature. By contrast, in most species, the highest LC-PUFA level (i.e. EPA and DHA) was obtained at low temperature. Through batch-cultivation, algae were also successively exposed to stress by increasing light due to cell dilution and nitrate starvation after  $\square$ 10 days, resulting in a major increase in total fatty acid (TFA) content compared to initial levels, but with lower proportions of EPA and DHA. Despite this, the highest EPA and DHA content, expressed as percentage of biomass dry-weight, was obtained at this stage due to the accumulation of lipids containing substantial levels of the both LC-PUFA. Future experiments will aim to achieve an optimum balance between different factors controlling the ratio of TFA and EPA production.

**Keywords:** microalgae, fatty acids, environment, alternative resource

## **EH2. Smart Algae**

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There is an increased public awareness towards the use of natural products that can improve human health and Marine biotechnology is leading technology development in this area. Following exposure to extreme factors such as high oxygen and radical stress, microalgae have the ability to accumulate carotenoids (beta-carotene, astaxanthin or lutein ) to mediate UV cell damage . Carotenoids are natural; fat soluble pigments and are known to have strong antioxidant and protective properties against UV-oxidation damage in the skin and retina, however only a minority have been commercially exploited delivering products to the market. Original, environmentally friendly, renewable, bio-production pathways for improved high added-value, bio-active carotenoid productions from a number of microalgae species, will be developed. High light intensity and spectral content utilising LED lighting technologies will be explored to increase yield levels of carotenoids. The results of this research will also lead to the development of novel extraction methods allowing for non-solvent based green extraction and product stabilisation using a novel combination of Super Critical CO<sub>2</sub> (SCFE) and Molecular Imprinting Technology (MIP).

**Keywords:** Microalgae, Carotenoids, Marine Biotechnology, Human Health, Natural

### **EH3. Investigation into the Medicinal Bioactive content of Wheatgrass Shoots**

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Wheatgrass is the name given to the young grass shoots of the common Wheat plant (*Triticum aestivum* L.). Its anecdotal healing properties are believed to be due to high antioxidant activities, giving rise to its use in functional food products. Current anticancer research focuses on the mechanisms of these antioxidants. Free radical production is linked to many diseases such as cancer. Antioxidants prevent damage to cellular components occurring as a result of free radical activity and therefore are essential in healthy diets. This project aims to investigate the potential antioxidant activity in the Wheatgrass. The main aim will be to determine the health benefits which may be within the products especially in the area of cancer treatment, by the following investigations: germination optimisation, growth optimisation, bioactive extraction optimisation and characterisation, testing against human cancer cell lines and testing for antimicrobial activity. Hydroponic growth of the plants will be employed to determine if alternative growth conditions can enhance the antioxidant variety and activities and in turn improve the health benefits.

**Keywords:** Wheatgrass, Antioxidant, Anticancer, Hydroponics

**EH4. Chicken as a source of antimicrobial resistant E. coli in the Irish retail market.**

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Antimicrobial resistance has emerged as a major public health problem. The role that food plays in the dissemination of bacteria carrying antimicrobial resistance is an area of increasing concern. The aim of this study was to examine retail meats on sale on the island of Ireland for the presence of antimicrobial resistant *Escherichia coli*. Between November 2013 and September 2014, 600 samples of raw meats were purchased from retail outlets across the island of Ireland, comprising equal numbers of beef, chicken, and pork. These were screened to detect the presence of antimicrobial resistant *E. coli* (AREC) using broth supplemented with cefotaxime (0.5mg/L), ciprofloxacin (0.06 mg/L) or meropenem (0.25mg/L), which were then streaked onto TBX agar. All AREC isolated were subsequently screened for susceptibility to 13 antimicrobial agents by disk diffusion. In total, 600 meat samples yielded 496 isolates of *E. coli* of which 467 (94%) were resistant to one or more antimicrobial tested whilst 143 (27%) were ESBL producers (chicken 130, pork 12, beef 1). Ciprofloxacin resistance was seen in 110 (22%) AREC, of which 16 were also ESBL producers. Two isolates were resistant to ertapenem. Based on resistance to 2 or more classes of antimicrobial agents, 442 (89%) isolates were multi-drug resistant (MDR). Our data demonstrated that most chicken sold in retail outlets in Ireland harbours antimicrobial resistant *E. coli*. It is noteworthy that significant proportions of the AREC isolated were ESBL producers (27%) and/or resistant (22%) to ciprofloxacin. Given the significance of these resistances to human health, further research into the source of these organisms is warranted.

**Keywords:** Chicken, antibiotic resistance, *E. coli*

## **N1. Bioinspired design: Replication of Natural Antifouling Solutions for Marine Applications**

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The issue of marine biofouling continues to provide demand for novel antifouling solutions. Biofouling, the colonisation of a surface submerged in an aqueous environment, can be detrimental to the functionality of marine structures. Its impact on marine water quality monitoring is of primary interest to this study. Effective antifouling technology would extend the effective deployment periods of water quality sensors, prevent or reduce the impact fouling organisms have on data quality and reduce maintenance cost of sensor deployment. In the development of new technology, inspiration often can be found in nature. Inspiration for this potential antifouling comes from a number of marine organisms from the crab species *Cancer pagurus* to macroalgae *Saccarhina latissimi* that appear to utilize rough surface topography with surface chemistry to reduce fouling of their own surfaces. The focus of this study is to replicate the use of topography and antimicrobial chemistry to develop an effective antifouling material for marine sensors. Sol-gel chemistry provides simple methods to produce rough, optically clear and durable coatings with suitable surface roughness; the chemistry also allows the incorporation of antimicrobial material such as silver nanoparticles. A second matrix under investigation is Araldite epoxy which is capable of casting the nano scale surface roughness found in natural antifouling surfaces, the antimicrobial content comes from doping antifouling material extracted from macroalgae into the surface. The results of this study could reduce the maintenance cost of water quality monitoring and advance the field of antifouling.

**Keywords:** antifouling, biofouling, nanotopography, natural products, nanoparticles, marine sensing

## **N2. Miniaturisation of *Daphnia pulex* Bioassay for Improved Throughput**

### **Toxicological Assessment**

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The standardised ISO 6341:2012 *Daphnia magna* bioassay was adapted to a 6 well plate format and subsequently miniaturised to a 24 microtitre plate format using *Daphnia pulex* to allow higher throughput toxicological assessment of pollutants and toxicants of aquatic ecosystems. The test volumes were reduced from 40mL per treatment as per the classic test to 10mL per treatment in the miniaturised test format, i.e. a reduction of 75%. The miniaturised format assay was validated using the reference chemical potassium dichromate (K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>). Although differences in IC<sub>50</sub> values were detected, given the degree of biological variation typical in bioassays of this type, good correlation was found within 95% confidence limits between the ISO format and the miniaturised format. The valid range for 24h IC<sub>50</sub> for K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> as stipulated by ISO 6341:2012 is between 0.6mg/L and 2.1mg/L. All tests fell within the prescribed range. The 24 hour IC<sub>50</sub> for K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in classic, 6-well and 24-well formats were found to be 1.444mg/L, 1.788mg/L and 1.483mg/L respectively. The miniaturised format offers advantages of faster counting, easier visualisation and agitation of the *Daphnia pulex* to assess immobilization. The reduced test volumes requirements also offers advantages for the toxicological screening of expensive analytes or analytes of limited availability. The miniaturised format was then used to assess the toxicity of okadaic acid, (a product of harmful algal blooms affecting bivalve mollusc and oyster aquaculture causing diarrhetic shellfish poisoning and other deleterious effects in humans) on *Daphnia pulex*. The 24 hour IC<sub>50</sub> for okadaic Acid was found to be 1.680µg/L. Okadaic acid was then treated with pulse UV light and subsequently reassessed. The toxicity of okadaic acid post pUV treatment resulted in a 15 fold reduction in toxicity to *Daphnia pulex* assessed by 24 hr IC<sub>50</sub>.

**Keyword:** *Daphnia pulex*, okadaic Acid, miniaturised, toxicology.

**N3. Novel method for the detection of cyanobacterial toxin microcystin-LR using a centrifugal microfluidic (Lab-On-A-Disc) sensing system**

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Globally, the most prevalent cyanobacterial toxins, in blooms from fresh and brackish waters, are the cyclic peptide toxins of the microcystin family. The need for on-site algal-toxin monitoring has become increasingly urgent due to the amplified demand for fresh-water and for safe, ‘toxin-free’ shellfish and fish stocks. Along with routine testing of shellfish stocks for biotoxins including microcystin, the EU also require routine monitoring for the presence of the causative algal species. Herein, we describe a novel, Lab-On-A-Disc (LOAD) platform which has been developed to assess microcystin toxin levels in-situ. Using recombinant antibody technology, the LOAD platform combines immunofluorescence with centrifugally driven microfluidic liquid handling to achieve a next-generation disposable device for high throughput sampling. A low-complexity, ‘LED-Photodiode’ based optical sensing system was tailor-made for the system, which allows the fluorescence signal of the microcystin-specific reaction to be quantified. This system can rapidly and accurately detect the presence of microcystin in less than 10 minutes with minimum user interaction and maximum reproducibility. This method provides a low cost diagnostic alternative to the current laborious and costly methods used for toxin monitoring.

**Keywords:** Microcystin, toxin detection, Microfluidics, Lab-On-A-Disc, LOAD, recombinant antibody technology, immunofluorescence detection, low cost diagnostic device

#### **N4. Green Biosynthesis of Plasmonic Nanoparticles.**

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Work on synthesis of the plasmonic nanoparticles and particularly gold and silver have become highly important in recent years. A coupling of the plasmon on the surface of metal nanoparticles with an incident photon enhances a broad range of useful optical phenomena, such as resonant light scattering (RLS), surface plasmon resonance (SPR) or Raman scattering. These unique optical properties of plasmonic nanostructures have a great potential for application in medicine and biosensing as well as electronics and catalysis. Several products based on colloidal silver and gold are already being mass produced. Various chemical and physical processes for the synthesis of nanostructures have been explored, their mechanisms postulated and methods developed to produce nanoparticles of precise sizes and shapes, the parameters determining physiochemical qualities of nanostructures and, therefore, their potential applications. However, these methods are expensive, utilise toxic substances or vast amounts of the energy provoking a growing interest in the development of alternative environmentally friendly and sustainable technologies. Environmentally benign methods of synthesis utilising a variety of microorganisms have been explored. Microbes are advantageous for nanoparticle synthesis as their use for synthesis is easily scalable. The greatest challenge of microbial synthesis of the nanoparticles lies in the achievement of the monodispersity of their size. This work evaluates a number of microorganisms for the ability to produce nanostructures, and aims to develop robust sustainable method for their synthesis.

**Keywords:** nanoparticles, microorganisms, green, bioreduction, stabilisation

**N5. Effect of coated ZnO nanoparticles on *Lemna minor***

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Nanoparticles are particles that have at least one dimension in the range of 1~100 nm. Engineered nano-ZnO have been applied in many areas (transportation, cosmetics, etc.). Functional coating materials have been added to nano-ZnO for specific uses and better performance in applications. This study has investigated the effect of silane coupling agent (KH550) coated nano-ZnO on *Lemna minor* and compared the effects of coated and uncoated nano-ZnO. Results show that at pH = 4.5 and in half-strength Hutner's growth medium: 1) Coated nano-ZnO had better dispersion and smaller hydrodynamic diameter than uncoated nano-ZnO; 2) Release of Zn ions was slower for coated nano-ZnO compared to uncoated nano-ZnO; 3) Significant differences in toxicity between coated and uncoated nano-ZnO were found on biomass growth rate and photosynthetic efficiency at pH 4.5. It is concluded that the coating of nanoparticles must be considered when assessing environmental risks.

**Keywords:** silane coupling agent, nano-ZnO, toxicity, *Lemna minor*

### **SRI. Runoff Coefficients**

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The aim of this project was to test the runoff from various surfaces under Irish weather conditions. The surfaces chosen were Concrete Pavement (CP), Tarmac Pavement (TP), Concrete Tile (CP) and Slate Tile (ST) all of which are typically used in urban developments in Ireland. In addition an Extensive Green Roof (EGR) and an Intensive Green Roof (IGR) were included to assess their potential particularly in terms of SUDS applications. Six pilot scaled test surfaces were constructed (all with a surface area of approx. 1m<sup>2</sup>), and were tested for 21 weeks. The runoff analysis investigated the Runoff Coefficient (RC) values, flow vs. rainfall depth, time taken for runoff to appear, RC's vs. rainfall depth, RC's vs. rainfall intensity, total runoff flow (TRF), peak runoff flow (PRF), time to peak and impact of antecedent dry weather periods (ADWP). The average RC values were 0.713 (CP), 0.68 (TM), 0.769 (CT), 0.823 (ST), 0.392 (EGR) and 0.307 (IGR). The Green Roofs (GR) showed a time delay of 15-50 minutes, when compared to the ST. The EGR and IGR reduce the TRF by (0%-42%) and (15%-59%) respectively, when compared to the ST. The EGR and IGR reduced the PRF by (0%-54%) and (7%-70%), respectively, when compared to the ST. The most significant rain event recorded during the test period was 22.4mm of rain in just four hours (slightly greater than a 1 in 2 year return period). The average RC values for this test were 0.785 (CP), 0.735 (TM), 0.792 (CT), 0.847 (ST), 0.458 (EGR) and 0.310 (IGR). The maximum RC values recorded during the testing period were 0.902 (CP), 0.949 (TP), 0.952 (ST), 0.918 (CT), 0.884 (EGR) and 0.698 (IGR).

**Keywords:** Runoff Coefficients; Test Surfaces; Runoff Analysis; SUDS

### SA1. Profiling phosphorus pools in Irish grassland soils

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The Food Harvest 2020 strategy promotes increases in sustainable grass production for beef and dairy production. High fertilizer costs and their impact on environmental ecosystems are leading agronomic research to an improvement in the nutrient cycling in agricultural soils. Phosphorus (P) cycling in soils is a dynamic system involving biological and chemical processes between organic and inorganic phosphorus compounds. Plants and microbes play a central role to maintain the phosphorus turnover by mineralization of organic P into inorganic P. A large proportion of P in grassland systems occur in organic forms, in association with the organic matter content, although the biological P cycle in these systems has been ignored as a potential source. This project will identify and quantify P pools in grassland soils and determine the degree to which P cycling contributes to available P. Phosphorus sequential fractionation coupled with enzymatic hydrolysis and microbial P measurements will be used as an approach to describe P pools in Irish grassland under different management scenarios of intensive and extensively managed soils. Five inorganic P fractions (H<sub>2</sub>O-Pi, NaHCO<sub>3</sub>-Pi, NaOH-Pi, NaOH-Sn-Pi and HCl-Pi) and five organic P fractions (H<sub>2</sub>O-Po, NaHCO<sub>3</sub>-Po, NaOH-Po, NaOH-Sn-Po and HCl-Po) will be measured. The component of each fraction will be submitted to hydrolysis by phosphatases (H<sub>2</sub>O-Pphos, NaHCO<sub>3</sub>-Pphos, NaOH-Pphos, NaOH-Sn-Pphos and HCl-Pphos) and microbial P will be measured in the most labile fractions (H<sub>2</sub>O-Pmic, NaHCO<sub>3</sub>-Pmic and NaOH-Pmic). Enzymatic hydrolysis of the organic P pool will allow us to determine the potential hydrolysable organic P and their distribution within the soil P fractions. Performing the microbial P coupled to the fractionation procedure will reveal the microbial pool linked to different P lability range. This data will allow us to characterize phosphorus pools and their distribution in Irish grassland systems.

**Keywords:** organic phosphorus; grassland soils; phosphorus soil pools; phosphatase hydrolysis; sequential fractionation

**SA2. Gain in nitrogen yield from grass-legume mixtures is robust over a wide range of legume proportions and environmental conditions**

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Global food security requires sustainable intensification through more efficient use of nitrogen (N) and increased protein self-sufficiency through home-grown crops. In a continental-scale field experiment conducted over three years, we compared the amount of total nitrogen yield ( $N_{\text{tot}}$ ) and the gain in N yield in mixtures to grass monocultures ( $N_{\text{gainmix}}$ ). The mixtures comprised four-species grass-legume stands (two  $N_2$ -fixing legumes and two non-fixing grasses) with greatly varying legume proportions. The amount of  $N_{\text{tot}}$  of mixtures was significantly greater ( $P \leq 0.05$ ) than that of grass monocultures at the majority of sites in all three years.  $N_{\text{tot}}$  and thus  $N_{\text{gainmix}}$  increased with increasing legume proportion up to one third of legumes. With higher percentages of legumes,  $N_{\text{tot}}$  and  $N_{\text{gainmix}}$  did not further increase. Thus, across sites and years, mixtures with one third proportion of legumes had 57% higher  $N_{\text{tot}}$  than grass monocultures and attained ~95% of the maximum  $N_{\text{tot}}$  acquired by any stand. The relative N gain in mixture ( $N_{\text{gainmix}}/N_{\text{tot}}$ ) was most severely impaired by minimum site temperature ( $R = 0.64$ ,  $P = 0.010$ ). Nevertheless,  $N_{\text{gainmix}}/N_{\text{tot}}$  was not correlated to site productivity ( $P = 0.500$ ), suggesting that, within climatic restrictions, balanced grass-legume mixtures can benefit from comparable relative gains in N yield across largely differing productivity levels. We conclude that higher N output ( $N_{\text{tot}}$  or forage protein per unit area) can be achieved with grass-legume mixtures than with grasses alone for a given amount of N fertilizer applied; conversely, the same N output can be achieved by mixed swards with less input of N.

**Keywords:** nitrogen, yield, mixtures, monocultures, sustainable intensification, legume

### SA3. Resistance of four grassland forage plants to experimental drought conditions

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Increased variability in rainfall is predicted to be a major component of global change, and a serious threat to grassland production. We investigated drought resistance of four grassland plant species with different functional traits and hypothesized that deep-rooting species would be more resistant to drought due to water up-take from deeper soil layers. In May 2012 at Johnstown Castle, Co. Wexford, 3m x 5m plots were sown with the species: *Lolium perenne* (shallow-rooting grass), *Cichorium intybus* (deep-rooting forb), *Trifolium repens* (shallow-rooting legume) and *Trifolium pratense* (deep-rooting legume). Plots were fertilised at a rate of 130 kg ha<sup>-1</sup> yr<sup>-1</sup> of nitrogen and aboveground biomass was removed five times annually at a height of 5 cm. In July 2013 an experimental drought lasting 10 weeks was applied using ‘rain-out’ shelters. Biomass was harvested: mid-way through and at the end of the drought treatment, and drought resistance (kg ha<sup>-1</sup> DM) was calculated as the difference in biomass between drought and control plots. At the mid-drought harvest, only *L. perenne* yield was negatively affected. At the end-of-drought, there was a strong negative effect on yield of all species. *Trifolium pratense* and *Trifolium repens* had the lowest resistance (-1001.5 and -1476.0 kg ha<sup>-1</sup> DM respectively) while *C. intybus* had the highest resistance (-460.1 kg ha<sup>-1</sup> DM). The higher resistance of deep-rooting *C. intybus* supported our hypothesis, but the low resistance of the other deep-rooting species; *Trifolium pratense* did not. These results highlight the complexity of individual species responses to drought stress, and the importance of drought duration and intensity. This work is on-going.

**Keywords:** functional plant diversity, grasslands, drought, climate change, stress resistance

#### **SA4. Impacts of Agricultural Systems on Biodiversity cannot be ascertained from farm-scale Surveys only**

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Consumers are becoming increasingly concerned about the environmental impacts of their purchasing choices and of the food that they consume. In response, different actors involved in the food sector and policy-makers are engaged in developing instruments, such as food-labelling schemes, to provide more reliable support to consumers' choices for sustainable products. The FAO Livestock Environmental Assessment and Performance (LEAP) Partnership was founded in 2012, with the aim of providing guidance on how to account for impacts in the livestock sector and, consequently, to improve the environmental performance of livestock supply chains. In sustainability assessments of livestock systems, biodiversity has not received as much attention to date as other environmental issues (e.g. climate change, management of nutrients, carbon and water). One reason is that generic sectoral recommendations on how to measure and assess biodiversity still remain vague, and the integration of biodiversity into policy instruments remains a challenging issue. Nevertheless, the quantitative assessment of biodiversity in livestock and other sectors is an emerging area of work that meets a growing demand to expand sustainability assessments to include biodiversity. As a priority issue for the comprehensive assessment of biodiversity in livestock food chains, the impact of off-farm feed production should be included. We provide a case study of how imported livestock feed can represent a significant, albeit indirect, share of a farm's land use and therefore of its biodiversity impacts. Thus, understanding and managing the ecological effects of agriculture requires a life-cycle perspective that transcends the area occupied by an individual farm. Ecological studies that are focused on improving agricultural sustainability could adopt such life cycle perspectives, and a qualitative hotspot analysis can identify the most important supply chain stages for biodiversity impact, including off-farm stages.

**Keywords:** Life Cycle Assessment, agriculture, biodiversity, assessment, off-farm feed, land use

**SA5. Estimating the critical level of plant available phosphorus for ryegrass production in organic soils under controlled conditions**

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Current phosphorus (P) recommendations for grassland in Ireland are well established for mineral but not for high organic matter soils. These types of soils are known to have poor P retention capacity due to competitive sorption reactions between P anions and the organic acids for soil sorption sites. Thus, a need arises for assessing the agronomic P optimum in these soils, but taking into account environmental concerns. In this way, P applied in excess of the ‘critical P’, a point at which maximum grass production is achieved, may increase the potential for P losses. This value can be determined by measuring the relationship between grass yield and different Morgan’s P levels through an asymptotic response curve. The aim of this research is to conduct a growth chamber experiment under controlled conditions to evaluate the fate of, and response to, applied inorganic P on low P organic soils sown with ryegrass. Fifteen treatments of soluble P fertiliser ranging from 0 to 100 kg P ha<sup>-1</sup> will be applied to the soils that have previously been treated with a basal nutrient solution of nitrogen and potassium. Six cuts of ryegrass will take place at one month intervals over the duration of the experiment and the dry matter amount, as well as herbage-P concentration for each cut, will be estimated. At the end of the experiment, P soil fractions and Morgan’s P levels will be determined. The results derived from this research will enhance our knowledge of P uptake in these soils. We hope to establish the critical P value at which P is optimised and the maintenance P required for replacing the P removed in the pasture production.

**Keywords:** Critical P value, ryegrass production, organic soils

**SA6. Sustainable development of Greenways: improving their function as ecological networks and corridors**

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Greenways have the potential to deliver positive recreational, health and economic benefits, 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 and clean environment. Prior to development however, these disused corridors are often regained by wildlife, allowing the return of semi- naturalness and species transit. Undisturbed, these conduits may serve an important role in the landscape, providing habitat connectivity. Research in Europe and North America suggests that although termed ‘Green’way, such developments permeating various landscape features may serve as potential predator, exotic and invasive species conduits, causing potential disturbance to the local fauna and flora. Ireland is now moving forward with a national cycle network, which will see an important development of Greenways. This project is researching the interactions between Greenways and the natural environment, in order to investigate their potential roles as ecological corridors and networks. A baseline map of habitats and ecological corridor is being digitised using ArcGIS using existing data and satellite based imagery. It will be validated through targeted field studies along the proposed route of the Sligo, Leitrim, Northern Counties Railway (SLNCR) rail to trail (Greenway) project. This will build an understanding of the proposed route’s ecological structure and function. The project will also examine the Great Western Greenway as an in depth case study together with other best practices observed in Europe. Through the case study analysis of existing examples and ecological assessment of the proposed Greenway route, recommendations for the development of the proposed Greenway will be made to ensure the complementary integration within its natural surroundings, and serve as best practice for other similar projects. The research presents a European trans- frontier opportunity given that the proposed Greenway links counties Sligo (ROI) and Fermanagh (UK).

**Keywords:** Greenways, sustainable development, ecological corridors

### SA7. Infrared Spectroscopy of Soils

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In order to meet the challenging targets set by Food Harvest 2020, Ireland's pig, dairy, beef and sheep farming is becoming more intensive. Output volume in these areas is set to increase by 50, 50, 20 and 20 %, respectively. Soil fertility and quality will be key to the achievement of these goals. Soil fertility and quality are monitored by testing for parameters such as; Morgan's Phosphorus (P), pH, % OM, Al, Fe and Ca. The Nitrates Directive, which protects water quality, also requires soil testing for P. This is because over-applied fertiliser containing P has the potential to run-off in heavy rain-fall and cause eutrophication in surrounding water bodies. However, current disadvantages of traditional soil testing methods are; they are time consuming, they are costly and they produce a lot of chemical waste. Also, farmers often just sample a few fields, due to the expense of sampling the whole farm. This project aims to explore the application of infra-red diffuse reflectance spectroscopy (DRIFT) in combination with chemometrics, to predict indicators of soil fertility and quality, specifically, P buffering and P sorption capacities. Both of these parameters are good indicators of soil's ability to take up P. The application of DRIFT has the potential to predict various soil properties using just one soil sample. This new technique will be less time consuming, inexpensive and it will hopefully act as a surrogate for extractive and digestive techniques traditionally used in soil analysis. The proposed method for this research is to: 1. Build reference laboratory data using conventional methods. 2. Carry out spectral analysis of soil samples, relating the results back to the reference data and 3. Predict soil properties from unknown samples using modelled data.

**Keywords:** sustainability, agriculture, soil testing, soil fertility, soil quality, phosphorus, P buffering capacity, P sorption capacity, chemometrics

**SI1. Recent development of novel Zr-oxide based binding gels in diffusive gradients in thin films (DGT) for measurements of bioavailable chemicals in the environment**

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The technology of diffusive gradients in thin films (DGT), as a passive sampling method, has received increasing attention for its applications in measurements of bioavailable chemicals (both cations and anions) in soils, waters, and sediments. It has significant advantages over traditional methods: *in-situ* measurement, time averaged concentrations and high spatial resolution. The advantages of DGT significantly promote the collection of “true” information of the bioavailable or labile forms of chemicals in the environment. This presentation provides a summary of recent development of a new DGT variant using Zr-oxide based binding gels. 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 development of several types of mixed binding gels based on the Zr-oxide gel. More functions are being examined with this technique for measurements of other analytes.

**Keywords:** Diffusive gradients in thin films (DGT), Zr-oxide gel, Bioavailability, Phosphorus; *in-situ*

**SI2. Mining of Fungi found in Irish habitats for industrially important enzymes and pharmaceutical compounds**

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One of the aims of this project is to search for biologically active compounds which can act as lead compounds in the development of new drugs. Fungi are one of the most important sources of these biologically important compounds. The 1.5 million fungal taxa that have been described are estimated to be only approximately 5% of the world's fungi making them an enormous reservoir for the discovery of novel, biologically active secondary metabolites. Another aim is to screen Irish fungi for industrial enzymes. Fungi are also a major source of valuable enzymes that can be used for degrading harmful dyes from textile industries as well as waste from pulp and paper, agriculture, and food industries. Fungi are the most versatile microorganisms that can be carefully cultivated and sustained for industrial applications resulting in an ease in downstream processing. A collection of fungi has been established from Irish woodlands. This collection was used to create a bio bank which houses all the different fungi sequenced using their 18S ribosomal DNA for phylogenetic identification. A literature search on the identified fungi led to an assembled list of samples that haven't been studied widely for their bioactivities. Selected fungi have been screened for anti-biotic, anti-oxidant activities and enzyme production. Isolates with desirable anti-biotic and enzymatic activity will be subjected to further genetic studies. Such screening could provide sustainable active ingredients for pharmaceutical, cosmetic and nutraceutical industries.

**Keywords:** Fungi, Bio-activity, Sustainable novel compounds

**SI3. Purification and Characterisation of a  $\beta$ -1,4-xylanase from the Thermophilic Fungus *R. thermophila* with Potential in the Baking Industry.**

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Thermophilic fungi are a sustainable source for many industrial thermostable enzymes. Xylanases randomly cleave the  $\beta$ -1,4 linkages in the structural polysaccharide xylan, found in plant cell walls, liberating xylo-oligosaccharides of varying lengths. A novel extracellular, thermostable xylanase (RtXyl) was produced in submerged liquid cultures of the thermophilic fungus *R. thermophila* using sorghum as inducing substrate. The xylanase was purified by centrifugal filtration, size exclusion chromatography and cation exchange chromatography, and subsequently characterised. RtXyl hydrolysis of various complex xylans liberated a range of xylo-oligosaccharides with xylotriose and xylobiose being the predominant products after 24 hour reactions. Incorporation of RtXyl in a basic wheat bread recipe at low dosages (0.297 XU/g) has shown that RtXyl is successful in improving several bread characteristics because of its mixed specificity towards soluble and insoluble xylan as well as its release of dough viscosity enhancing xylo-oligosaccharides. Future research in this project will involve molecular cloning of RtXyl with a view to developing an expression system for the recombinant protein. Additional applications for thermophilic xylanases include bio-ethanol & xylitol production, food & beverage production and paper & textile manufacturing.

**Keywords:** Xylanase, Thermophile, Fungi, Purification

#### **SI4. Identifying Sustainable By-Product Potentials for Compressed Waste Tyre Bales**

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Construction and engineering works account for a significant percentage of natural resource consumption in Ireland and mainland Europe. The potential for the compression of post-consumer tyres into tyre bales for use in soft engineering applications is highlighted as a sustainable alternative to mitigate the environmental burdens posed by primary aggregate extraction. A re-use approach also seeks to mitigate waste disposal problems and associated environmental impacts resulting from illegal stockpiling of waste tyres. CREST research focused on evaluating the feasibility of applying a variety of post-consumer applications which complement the Irish waste tyre policy framework and management systems in place. The performance characteristics associated with such applications are reviewed to include water absorption capacity, unit weight, shear strength, deformation, compressibility, as well as thermal and hydraulic conductivity properties. Potential environmental risks associated with leaching of chemicals and compounds as well the triggering mechanisms for exothermic oxidation reactions are explored and presented in the research. The appraisal of dissolved contaminant concentration levels for specific conditions including freshwater, marine and peat bog environments are reviewed with findings presented to highlight short, medium and long term anticipated risk levels. The use of tyre bales (above and below ground) for new road construction is presented to include best practice recommendations for excavation, alignment, filling, drainage and settlement control. Methods to combat the detrimental effects of storms and prolonged periods of flooding on coastal and river embankments are also investigated. The CREST research seeks to present strategic post-consumer waste tyre bale applications for a variety of soft engineering scenarios and to highlight the various barriers and benefits associated with such applications.

**Keywords:** Waste Tyre by-product, Coastal & and River Erosion Control, Civil Engineering.

### **SI5. Exploiting the By-Product Potential for Waste *Crassostrea gigas* Oyster Shells**

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The predominant oyster producing species in Ireland is the *Crassostrea gigas* species (Pacific Oyster) with an annual production of approximately 7,300 tonnes from 130 oyster farms around the Irish coast. Donegal Ocean Deep Oysters Ltd harvests their oysters for export predominantly to the French market. Mortality rates for this species are influenced by a variety of factors that can lead to significant waste shell accumulations for the oyster growing community. The ability of the Irish shellfish sector to identify and develop new higher added value by-product opportunities for waste oyster shell has been identified as an opportunity for the industry. The by-product opportunities to be explored range from specialist niche markets that exploit the significant Calcium Carbonate (CaCo<sub>3</sub>) content of oyster shells to produce alternative high end products such as health supplements, to potentially low-risk products that could be realized with a minimal level of investment. The chemical composition of oyster shells is >90% Calcium Carbonate (CaCo<sub>3</sub>) and offers a significant environmental and organic advantage when used as a substitute to conventional mineral fillers. The CREST research focused on outlining the long term environmental and economic advantage of adopting a “waste to product” approach in tackling the problem of waste shell accumulations so that shell residues are not discarded to landfill. Specific “free from flesh” and “technical low risk” opportunities including landscaping, drainage and pollution control uses to more specialist “category 3 animal by-product” opportunities using powdered shell have been explored in terms of economy of scale, production costs, technical plant and machinery as well as adherence to Animal By-Product Regulations (ABPR).

**Keywords:** Oyster shells, waste to product, environmental sustainability

### **SI6. Investigating the potential for the production of sheep wool insulation in Ireland**

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Buildings are responsible for 40-50% of Europe's energy use and the largest share of which is heating. European legislation aimed at reducing energy consumption is driving increased installation of insulation through harmonisation of building standards up to the levels of the most ambitious Member States. This legislation, coupled with fluctuating energy prices, increased new-build activity, drives to refurbish older properties, increasing awareness of insulation benefits, and government grants to encourage installation, is resulting in a rise in demand for innovative insulation products. Sheep's wool is a sustainable bio-product that possesses many physical attributes including strength, hydrophobic and hydrophilic characteristics, thermal & fire resistance performance, and the natural ability to regulate temperatures. As an insulator its crimped nature allows the wool to retain its structure and thickness and traps air in tiny air pockets thereby restricting convective heat transfer. Its use as an ecological building insulation material within the built environment has become popular on the merits of its performance and is now a highly specified insulating material in modern day construction and retrofit projects. The research by CREST research carried out a comparative study on the performance capabilities and environmental benefits of a sheep's wool insulation product compared to common alternatives in the market. This work involved investigating a manufacturing process that could be successfully integrated into the existing Irish yarn industry to create an alternative economic and ecological value-added product stream. The research focus is to investigate the feasibility of implementing scaling-up factors to the existing Irish yarn industry to develop an Irish based alternative ecological insulation product from wool.

**Keywords:** Sheep wool, Ecological bio-insulation product, manufacturing.

**SI7. Applied environmental research in sustainability for behavioural change and life-long learning**

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The Rediscovery Centre is an environmental social enterprise which actively participates in applied environmental research in the areas of sustainability to bring about behavioural change and to support life-long learning. Humankind's natural ability to learn is directly linked to constant interaction with the environment. Utilizing the built environment as a pedagogical tool to enhance teaching and learning can be confirmed through the development of a prototype 3D textbook for life-long learning in education for sustainable development. Funded by the EU Life+ programme the Rediscovery Centre's WISER (Working with Industrial Spaces to Exemplify Reuse) project is providing a test bed for the development and implementation of this concept. The potential for practical skills training and applied learning to drive behavioural change has already been demonstrated by the Rediscovery Centre through the development and delivery of a FETAC level 9 course and analysis of student feedback. In addition, the 3D textbook will be populated by reuse enterprises to form an ecocluster demonstrating best practice waste reuse and redesign. Current research being carried out by the Rediscovery Centre, has developed a series of metrics to measure key social, economic and environmental benefits of reuse enterprises. These metrics are being employed to determine the benefits of ecoclusters such as enhanced operational efficiencies, visitor engagements and carbon savings. In order to maximise the impact of reuse ecoclusters, barriers to reuse, such as a consistent supply of waste resources are also being identified. This research will produce an overall framework for waste reuse, with specific protocols for various materials, enabling behavioural change in the general public and the implementation of the circular economy model.

**Keywords:** Sustainability, behavioural change, life-long learning, 3D textbook, reuse, ecocluster

### **SI8. Polyphosphate Removal in Archaea and its application in Biological Phosphorus Removal**

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Alongside exponential population growth, the 21st century has seen the depletion of many essential resources, including phosphorus, approaching global crisis status. Phosphorus is a vital nutrient for crop growth and its depletion is coinciding with an increased demand in food production to meet the requirement of a rapidly growing population worldwide. Globally the agricultural sector absorbs 90% of mined phosphorus year upon year, in the form of inorganic phosphate as a major component of synthetic fertilizer. Phosphate recovery from wastewater streams has proven an indispensable player in counteracting the eminent depletion of mineable phosphorus, predicted to peak in 2035. The soaring price of phosphate from €148 in 2002 to €478 in 2012 is attributed to the scarcity of the remaining mineable phosphate which is of lesser accessibility and lower quality. In addition, phosphorus loss in the environment must be avoided since its introduction leads to ecosystem eutrophication. Indeed, as a limiting growth-nutrient, its overuse and misuse due to improper adherence to spreading regulations has had catastrophic consequences on nearby waterway ecosystems, representing unnecessary phosphate loss, and a huge environmental issue. Due to the natural low level of phosphate present in the environment, microorganisms have evolved to scavenge and store phosphorus very efficiently. This microbial capacity has been harnessed in the context of aerobic wastewater treatment, which is now recognized to be unsustainable. The anaerobic digestion of wastewater represents a very attractive alternative but very little is known about the ability of the archaea, prevalent in anaerobic digestion systems, to accumulate phosphorus. This project will address this knowledge gap and will investigate the potential for phosphate recovery from wastewater during anaerobic digestion, in order to provide a seamless loop between wastewater phosphate and a recoverable high value commodity.

**Keywords:** phosphate; depletion; recovery; anaerobic reactor; archaea; polyphosphate accumulation

**SI9. Gender and Sustainability – the role of intersectional analyses in understanding behaviour and practices**

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Human behaviour, practices and culture constitute a significant factor in the achievement of more sustainable consumption and production patterns. The interactions between technologies, practices and norms lock us in to certain patterns of (often inefficient) resource use. However in order to change such behaviour and practices, they must be understood, and this requires an in-depth understanding of the people involved. This presentation introduces the UCC-led H2020 project ‘ENTRUST’, which examines the human factor in the energy system. ENTRUST takes an intersectional approach to understand how human behaviour around energy is shaped by both technological systems and socio-demographic factors, in particular gender, age and socio-economic status. The mixed methods approach to be used in the project will be discussed and in particular the planned in-depth engagement and collaboration with a number of different communities across Europe will be presented. The presentation demonstrates how the role of gender is illuminated by intersectional analyses behaviour and attitudes and how this can be used to assess the way in which multiple identities and social positions, combine to shape practices. Finally the relevance of such approaches to the wider discussion on sustainability will be discussed.

**Keywords:** gender; sustainability; intersectional; research methods; human factor; sustainable consumption and production

**SI10. 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 filamentous fungus that is moderately thermophilic. It is known to express a complete set of thermostable cellulose and hemicellulose degrading enzymes and a wide range of pectin hydrolysis activities have also been identified. These enzymes are useful as active food ingredients and in processes such as the production of feed stocks destined for bioethanol. In industrial processes such as these, elevated temperatures are often useful to increase reaction rates and improve the efficiency of reactions. This makes *T. emersonii* a valuable but underutilised tool in industrial processing. This project's main focus is the design of a 'molecular toolkit' that will facilitate the transformation of *T. emersonii* with individual or multiple genes in research and development. This will be achieved in three phases. Phase 1 is the identification and testing of a range of selectable markers that will kill wild type *T. emersonii*. Selectable markers are essential for the selection of transgenic *T. emersonii* strains expressing the gene(s) of interest. Phase 2 will involve the construction of a range of vectors containing different homologous and heterologous regulatory sequences, and subsequently testing these vectors using green fluorescent protein (GFP) to ensure that adequate gene expression is achieved. Phase 3 is the development of an efficient transformation method for *T. emersonii*. Protoplasting and *Agrobacterium tumefaciens* mediated transformation methods will be optimised and transformation efficiencies compared.

**Keywords:** Fungus, Plasmid, Biofuel, Toolkit, industrial, enzyme

**SI11. Investigation of endogenous serine proteases in the basidiomycete *Coprinopsis cinerea***

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Basidiomycete fungi have a clear ecological role, where the depolymerisation of biopolymers is a key 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 many recalcitrant organic compounds in soil litter and the humic layer. Serine proteinases have been shown to be significant in both post-harvest spoilage of mushrooms and nutrient acquisition from compost. The ink cap mushroom *Coprinopsis cinerea* (formally *Coprinus cinereus*), has long been regarded as one of the best model systems for the study of basidiomycete fungi. Most attention in *C. cinereus* has been focused on processes such as mating type determination and also on meiosis. Little detail is known about the other aspects of the biology of this fungus such as the cellular mechanisms involved in the development of fruiting structures. This research seeks to fully elucidate the function of serine proteases in mushroom fruiting body development and nutrient acquisition through promoter profiling. A range of vectors will be constructed to contain the different *C. cinereus* serine protease promoters linked to efficient Green Fluorescent Protein (eGFP). These vectors will be transformed into *C. cinereus* and eGFP expression monitored through fruiting body development. Results to date include the identification of *C. cinereus* serine proteases promoter and gene sequences. Primers were designed to amplify the promoter sequences using PCR on genomic DNA. Plasmid pGFPi004 was digested with different restriction enzymes to generate plasmid backbones. Future work will focus on the ligation and cloning of the promoters into pGFPi004, with subsequent transformation of these vectors into *C. cinereus*.

**Keywords:** Basidiomycete fungi, *Coprinopsis cinerea*, Serine proteinases, Green Fluorescent Protein, Promoter Profiling

### **ES1. Water...what do you know?**

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The quality of Ireland's drinking water is continually improving. The aim of this survey was to assess what impact incidents such as the outbreak of waterborne cryptosporidiosis in Galway, 2007 have on the public's confidence in their water supply. A quantitative survey was designed and administered for 4 weeks (June 26th to July 23rd 2014). The survey was restricted to people living in a specific region of Ireland (Galway City and County). Data was analyzed using SPSS and Stata. Overall, 487 responses were recorded: 387(79.5%) drank water from their tap, 264(54.2%) were aware of what type of drinking water supply they were served by, and the predominant reason for not drinking water from the tap was concern about water safety, 158(32.4%) knew whether their water was monitored routinely for microbial contamination and 240(49.3%) of people reported having been previously subject to a boil water notice/restriction, 414(85%) remembered the 2007 waterborne outbreak of Cryptosporidiosis, 244(59.8%) reported having been directly affected in some way with the primary affect reported being "subject to a boil water notice" (212(43.5%)). Fifteen (3%) respondents reported a loss of earnings as a result of this outbreak and 128(26.2%) changed the way they used water as a direct result of this outbreak. Overall, there is a high level of trust in drinking water supplies in this region of Ireland. However, knowledge of where drinking water comes from and its monitoring appears to be lacking. Water quality incidents, such as the waterborne outbreak of cryptosporidiosis in Galway, 2007 have an impact on water use.

**Keywords:** Drinking water, microbial contamination

## **ES2. Estimating the Irish Public's Willingness to Pay for Sustainably Produced Salmon**

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The potential of aquaculture to contribute to reducing the environmental impact of global food demand while remaining economically competitive is a major policy issue. At the same time, aquaculture is often criticized for its impact on the marine environment. Critiques most strongly evolve round the use of fish-feed and antibiotics, as well as the spread of diseases and parasites to local wildlife. Integrated Multi-Trophic Aquaculture (IMTA) is an alternative to monoculture of finfish species, in which several species are combined in the production process. Integrating several species in the production process has a dual advantage; an environmental advantage as impact is lowered through nutrient cycling; and economic advantages that consist of increased efficiency, product diversification and a potential higher willingness to pay of consumers for more environmentally friendly produced seafood. Therefore, IMTA could stimulate the growth of the Irish aquaculture industry both sustainably and profitably, while facilitating reaching a Good Environmental Status (GES) of Irish waters. This poster describes the attitudes of Irish consumers' towards aquaculture and seafood, particularly Atlantic salmon (*Salmo salar*) farmed in Ireland. A choice experiment was conducted through an online survey in order to assess if consumers are willing to pay a premium for sustainably produced salmon.

**Keywords:** Sustainable Aquaculture, Choice experiment, Consumer Attitudes, WTP

**WM1. Biosurfactant production from agroindustrial substrate**

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Biosurfactants can reduce surface tension of liquids and form micelles between two different phases. Their commercial production has been limited due to the high cost of substrates and low yields. Bacteria and yeast is able to produce biosurfactant from many substrates. Biosurfactants have been tested in enhanced crude oil recovery, which it demonstrated to be effective in the reduction of the interfacial tension between oil and water. The present work reports the production of surfactin by *Bacillus subtilis*, grown on raw glycerol as the carbon source. The biosurfactant extraction was carried out through acid precipitation. Thin layer chromatography, using silica gel plates, was used to monitor the presence of biosurfactant. Chloroform/methanol (65:15) was used as the stationary phase and a mixture of chloroform, methanol and distilled water (65:15:1) as the mobile phase. The retention factor of the biosurfactant was compared with a standard surfactin. The dry weight of the crude biosurfactant reached a value of 0.68 g/L at 48 h. The cell free broth containing the biosurfactant reduced the surface tension from 72 mN/m to 60 mN/m. This work showed that raw glycerol may be used as an efficient carbon source for the production of surfactin by *B. subtilis*.

**Keywords:** biodegradation, surfactin, *Bacillus subtilis*

**WM2. Evaluation of microbial degradation of TBT into monobutyltin (MBT) and dibutyltin (DBT)**

Christopher Finnegan, Karen Browne, David Ryan, Anne-Marie Enright, Guiomar Garcia-Cabellos.

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Tributyltin (TBT) is an organotin compound that has been used as a biocide in marine antifouling paints to restrict the attachment of gastropods to hull surfaces. Widespread use of this anthropogenic pesticide has led to its release into aquatic environments, as a result, a global ban on the use of TBT has been enforced since January 2008. TBT molecules are predisposed to bind to solid matter and settle out of the water column. As such, sediments in harbours and estuaries have high TBT concentrations. The dumping of sediment dredged from harbour areas out at sea has been banned in several countries since the toxicity of TBT was highlighted, disposal is now largely land based. Laboratory studies were conducted to study the viability of a collection of TBT resistant microorganism strains from locations around the Irish coastline, to remediate contaminated sediments. This was achieved by spiking nutrient agar and TS agar plates with various concentrations of tributyltin chloride 98%. After growth and resistance of TBT was tested the strains ability to utilize TBT as a sole carbon source was examined using minimal medium plates. Furthermore microorganisms were isolated from a soil sample from a TBT contaminated site. Results show 22% of microorganisms from the marine collection and also a large number of microorganisms isolated from the contaminated soil sample have the ability to utilize TBT as a sole carbon source up to 4 mM, a concentration used in several studies. Results suggested that bacteria strains that were successful may have the ability to breakdown TBT into its less toxic species. This will be determined on an individual basis using bioremediation assays which will be analysed by GC-MS. The identification of a microbial strain or group of strains that could reduce or eliminate the potential risk posed by TBT would be of great value to both the marine and waste industries.

**Keywords:** Tributyltin, microorganism, bioremediation

### **WM3 Characterisation of Metal Concentrations in Treated Municipal Sludge in Ireland and Impacts on Runoff Water Quality Following Land Application**

M.G. Healy<sup>1</sup>, L. Morrison<sup>2</sup>, P.J. Forrestal<sup>3</sup>, D. Peyton<sup>1,3</sup>, G.T.A. Fleming<sup>4</sup>, M. Danaher<sup>5</sup>, D. Wall<sup>3</sup>, M. Cormican<sup>6</sup>, O. Fenton<sup>3</sup>

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The application of treated sewage sludge ('biosolids') to land as a fertilizer in agricultural systems has come under increased scrutiny due to increasing awareness regarding risks to the environment and human health. There is a potential risk of metal accumulation in the soil, in plants, or of transport to waterbodies, particularly if added in excess. The aim of this study was to examine if the metal content of treated sewage sludge was affected by the treatment method, exceeded permitted limit values, and if metals were present above regulated limits in runoff water following land application. Treated sludge was collected from 16 wastewater treatment plants in Ireland and was tested for a range of metal parameters. In the runoff experiments, three types of biosolids were applied to micro-plots, which were subjected to three successive rainfall events, and the surface runoff was characterized. The concentrations of the regulated metals were well under European Union regulatory limits. The treatment method employed to treat sewage sludge had an impact, with thermal drying producing sludge with metal concentrations, in general, lower than anaerobic digestion. The mean concentrations of metals measured in the surface runoff were well below the drinking water limits.

**Keywords:** Wastewater, sludge, land application, metals, biosolids

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#### **WM4 Development of a National Strategy for Utilisation of Fats, Oils and Grease (FOG) Waste from Food Service Outlets (FSOS)**

Thomas Wallace<sup>1</sup>, Michael O'Dwyer<sup>2</sup>, Thomas P. Curran<sup>1</sup>

<sup>1</sup>UCD School of Biosystems Engineering, University College Dublin, Belfield, Dublin 4, Ireland

<sup>2</sup>Evolution Environmental Services Ltd in partnership with Noonan Services Group, The Guinness Enterprise Centre, 8 Taylor's Lane, Dublin 8, Ireland.

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Fats, oils and grease (FOG) is a waste by-product of food production. It is produced on both a domestic and commercial level. If it enters sewers, it accumulates causing blockages and sanitary system overflows (SSOs); the cost of clearing these can be significant. In international studies, it is estimated that 50% of SSOs are caused by FOG build up. To prevent FOG waste from entering sewers, source control can be implemented by food service outlets (FSOs). There are two main streams of FOG waste produced by FSOs. These are used cooking oil (UCO) and grease trap waste (GTW). UCO is primarily from deep fat fryers and either of plant or animal origin. It is usually collected directly by permitted waste hauliers for biodiesel production or rendering. GTW refers to the waste removed from grease trapping systems (GTS) installed in FSOs to prevent FOG entering the drains. In areas with FOG programmes in place (such as Dublin City Council) the requirement for GTS is being enforced. The GTW retained in the GTS must be managed appropriately and is currently being collected by permitted waste hauliers for any one of multiple processes such as composting, incineration, anaerobic co-digestion, biodiesel production or even landfill. Based on international studies, GTW is a viable feedstock for anaerobic co-digestion, increasing biogas yield due to its high calorific value. FOG waste should be promoted as a resource, thus assisting Ireland in meeting its renewable energy needs as set out in EU 20-20-20 Policy Targets, thus avoiding substantial fines. The objective of this project is to integrate the resource data with GIS to evaluate the energy and revenue opportunities present in the management of FOG waste in Ireland, thus aligning very well with the sustainability theme of the conference. Further details of the research study are available at <http://ssu.ie/research/fog>.

**Keywords:** FOG Waste, energy potential, grease trap, used cooking oil

### WM5 Dry Co-Digestion of Food Waste and Pig Manure

Yan Jiang<sup>1</sup>, Conor Dennehy<sup>1</sup>, Peadar Lawlor<sup>2</sup>, Gillian Gardiner<sup>3</sup>, Xinmin Zhan<sup>1</sup>

<sup>1</sup>Civil Engineering, College of Engineering & Informatics, National University of Ireland, Galway, Ireland.

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The mono digestion of food waste (FW) is prone to inhibition caused by high volatile fatty acids (VFAs) concentrations, while the mono digestion of solid pig manure (PM) can be negatively affected by the high ammonia nitrogen concentration. Dry co-digestion of food waste and pig manure may provide a solution to these issues because of the buffering effects between VFAs and ammonia nitrogen. Dry digestion would also reduce the digester volume significantly and avoid post-treatment of liquid digestate. In this study, we investigated the effects of PM/FW ratios in feedstock during batch dry co-digestion at 37°C. The FW/PM ratios based on volatile solids (VS) were set at 0:100, 25:75, 50:50, 75:25 and 100:0. The feedstock to inoculum ratio was 50:50 based on VS. The total solids (TS) content in each digester was 20%. Each co-digestion system was conducted in duplicate in 1L or 2L digesters (Mono digestions of food waste and pig manure were conducted in 2L digesters). Relatively higher methane yields of 277 and 310 mL/gVS were obtained at FW/PM ratios of 50:50 and 75:25 compared with other ratios, which were 25.9% and 40.9% higher than that of mono digestion of pig manure. Food waste alone was not suitable for dry anaerobic digestion because of VFA- inhibition with the highest observed total VFAs and free VFAs concentrations up to 44,060 and 9,613mg/L, respectively. Lag phases increased from 8 to 50 day as FW/PM ratios increased from 0:100 to 75:25. Methane was produced after lag phases and total VFAs and free VFAs dropped to less than 30,000 and 150 mg/L, respectively. This study found that ammonia nitrogen was not an obvious inhibitor during dry co-digestion of food waste and pig manure. The ammonia nitrogen and free ammonia concentrations were about 4,400 and 1,100 mg/L, respectively, when the systems were stable.

**Keywords:** dry co-digestion, food waste, pig manure, VFA inhibition, ammonia nitrogen inhibition



Annual Review 2014



**CHAIRPERSON'S ADDRESS:**

**From Dr. Tom Curran**

There has been quite a lot of activities in which the ESAI has been involved over the past year since Environ 2014 both in terms of events and planning for the future. The highlights are as follows:

- Environ 2014 - 24th Irish Environmental Researchers Colloquium hosted by Trinity College Dublin, (Feb 26th-28th 2014).
- Natural Capital: Ireland's hidden wealth (April 28th -29th 2014, National Botanic Gardens, Dublin) with Trinity College Dublin
- Dooge Nash International Symposium (April 24th -25th 2014, Dublin Castle) with University College Dublin
- ESAI Postgraduate Researcher of the Year Award
- ESAI YouTube Research Competition
- ESAI Photography Competition

We had a large attendance at Environ 2014 along with the Careers Fair in TCD and this is reported separately. I would like to acknowledge Dr Laurence Gill and his team for hosting Environ and Dr Cara Augustenborg and Aoife Delaney and ESAI colleagues for organising the Careers Fair. ESAI provided administrative support and registration facilities for the Natural Capital conference and this was deemed a great success. Thanks to Cara Augustenborg and Sinead Macken for the smooth running of this collaboration. ESAI administrative support and guidance was again provided successfully through Sinead Macken for the Dooge Nash International Symposium.

Thanks to Dr Martina Prendergast for co-ordinating a new initiative "ESAI Postgraduate Researcher of the Year Award". The applications from postgraduates were evaluated according to the criteria: Scientific excellence and originality; Impact (economic/environmental/societal) and; Dissemination (conferences, outreach, media). Congratulations to the winner Richard Manton from the Ryan Institute at NUI Galway who is working on national cycle route guidance.

Another initiative was the ESAI YouTube Research Competition; thanks to Dr Kevin Ryan and Dr Frances Lucy for working on this. The theme was "Communicating Environmental Science" and it sought entrants who had a flair for communication and who could explain the value of environmental science research to a wide audience. Congratulations to the winner Tracey Lydon from TCD. The video can be viewed on <http://www.youtube.com/esaiweb/>.

The annual ESAI Photography Competition with the theme "Urban Green Infrastructure" was co-ordinated by Mark Nolan. Well done to the winners which are detailed elsewhere in 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 are welcoming on board an ESAI Liaison in each college. These staff members will act as a contact point for ESAI activities and information flow. We are also offering free membership to all undergraduates in relevant courses in each college. The list of third level environmental education programmes on our web site 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.

Another recent development is that we are reviewing our aims and objectives at the core of the ESAI. It is healthy that we should question how we serve our members and can we do things better or differently. Perhaps, the focus needs to be moved more explicitly to a research agenda as many of our members are involved in this area. Furthermore, our membership is also quite diverse in terms of discipline, which is a great strength of the organisation. We are depending on the voluntary efforts of our members, so we must be cognisant of what is possible to achieve effectively. As always, we welcome your input. Remember to keep in touch with ESAI through social media on Twitter, Facebook and LinkedIn.

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, the ESAI have decided to discontinue these activities to focus more 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/>.

A new initiative is being launched at ENVIRON called a “Grassroots” Workshop Support Scheme in order to assist researchers, particularly postgrads and postdocs at hosting specialist workshops. We are grateful to the EPA for providing funds which will be administered by ESAI. Details can be found on the back page of this book.

As I mentioned in the last edition of Environews, it marked the final ezine under the direction of Honorary Editor, John Wann. On behalf of the ESAI, I would like to thank him sincerely for his input. We are now moving to a new format of newsletter, which will be circulated in the coming months.

On the ESAI Council front, we are seeking new members as always but particularly representatives of our core members to come forward, i.e. 1 PhD representative and 1 Post Doc representative. Please attend the ESAI AGM on Thursday April 9<sup>th</sup> if you wish to become involved.

Many thanks to Emer Cosgrove who stepped in at short notice in the role of Treasurer of ESAI. We really appreciate this.

On behalf of the ESAI, I wish to say a sincere thanks to Dr Paul Bolger for his contribution to the association as he is stepping down from the ESAI Council after several years of service, including a period as Chairman, which has brought the organisation to a new level in terms of activities and benefits to members. I would also like to acknowledge the ESAI administrator, Sinead Macken, for her excellent work, dedication and support over the past year.

Best wishes to all for the year ahead.

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Dr Tom Curran is a lecturer in UCD School of Biosystems 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.

#### **ESAI GOALS AND OBJECTIVES 2014:**

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**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.



*Photographer: Micheal Yulo*

## **MEMBERSHIP:**

### **Make the most of your Membership**

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#### **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](http://www.esaiweb.org) – has now become a valuable resource for environmental professionals in Ireland. The new events area offers a snapshot of what is happening in the industry nationwide. The website is designed by AttikDesigns.

**Social Networking**

Network with the growing number of environmental science researchers and practitioners who have joined our online discussion fora on LinkedIn and Facebook. Updates from the ESAI and our members are posted on a daily basis advertising upcoming events, courses, career opportunities, links to matters of national and international interest to the environmental science community.

You can join us on:

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

 <http://www.facebook.com/esaiweb>

 [http://twitter.com/esai\\_environ](http://twitter.com/esai_environ)

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**2014 EVENTS:**

<p>Jan 16th</p>	<p><b>Public Lecture</b>                  ESAI ERI An Evening of Climate Change                  18:30 Western Gateway Building, UCC, Cork</p>
<p>Feb 26th-28th</p>	<p><b>Environ 2014 - 24th Irish Environmental Researchers Colloquium</b>                  Co-hosted by Trinity College Dublin &amp; ESAI,                  Museum Building, Trinity College, Dublin 2</p>

Feb 26th	<p><b>Workshops @ Environ</b></p> <ul style="list-style-type: none"> <li>· How to run a green campus?</li> <li>· Communicating Science</li> </ul>
Feb 27th	<b>ESAI YouTube Research Competition - Launch</b>
Feb 27th	<p><b>Public Event</b></p> <p>ESAI Career Expo at Environ 2014</p> <p>13:00-17:00, Burke Theatre Concourse, TCD, Dublin 2</p>
Feb 27th	<b>ESAI AGM</b>
Feb 28th	<b>ESAI Student Competition Prize Giving Ceremony at Environ</b>
Apr 24th-25th	<p><b>Conference</b></p> <p>Co-Sponsor; Dooge-Nash International Symposium in conjunction with UCD</p> <p>Dublin Castle, Dublin</p>
April 28th-29th	<p><b>Conference</b></p> <p>Co-Sponsor; Natural Capital: Ireland's Hidden Wealth</p> <p>National Botanic Gardens, Glasnevin, Dublin 9</p>
May 25th	<p><b>Conference</b></p> <p>Brownfield and Contaminated Land Conference</p> <p>15% Discount for ESAI members</p> <p>Belfast</p>
June 13th	<p><b>ESAI Postgraduate Researcher of the Year Competition</b></p> <p>Winner Announced</p>
July 31st	<p><b>ESAI 9th Annual Photography Competition Launch</b></p> <p>Open to all amateurs</p>
July 31st	<p><b>ESAI Ezine Environews Summer Edition</b></p> <p>Available Online <a href="http://www.esaiweb.org">www.esaiweb.org</a></p>
Aug 1st	<p><b>ESAI YouTube Research Competition</b></p> <p>Winner Announced</p>
Dec 31st	<p><b>ESAI 9th Annual Photography Competition</b></p> <p>Closing Date</p>

# Environ 2014

## ENVIRON 2014

The 24<sup>th</sup> Irish Environmental Researchers' Colloquium, ENVIRON 2014, was held on 26<sup>th</sup> to 28<sup>th</sup> February in Trinity College Dublin, organised jointly by the School of Engineering, School Natural Science and ESAI. Trinity College last hosted the Colloquium in 1993 and as one of the original hosts of this event, we were very pleased to welcome the colloquium back in 2014.



The theme of this year's *and Solutions* which provoked research either investigates human environment and/or the succession of winter that multidisciplinary approaches needed to address the challenges of environmental pollution, energy security and sustainability of natural resources.

The colloquium was *'Environmental Challenges* the delegates into considering how their contemporary threats to the natural and contributes towards finding solutions. With storms fresh in everyone's minds it is clear approaches from scientists and engineers are needed to address the challenges of environmental pollution, energy security and sustainability of natural resources.

The conference began on Wednesday, 26th February 2014 with two workshops during the afternoon on the following topics: *How to Launch and Run a Smart Sustainable Campus* delivered by Noel McCann, Joe Borza, Kieron McGovern, David Hackett and Michael Keigher from the TCD Buildings Office and Energy Elephant and; *Presentation and Technical Report Writing Skills* delivered by Bruce Misstear from the Department of Civil, Structural and Environmental Engineering. Many thanks to all those involved in the organisation of both these events.

Wednesday evening then featured a debate in the Science Gallery held around the provocative topic, *"Is green technology good for the environment?"* which attracted a good crowd of around 100 people. The energetic debate chaired by Dr Paul Butler of Enterprise Ireland, featured some brief initial thoughts from the panel of Prof. Pete Smith (University of Aberdeen), Bob Ursem (Delft University of Technology), Eamon Ryan (leader of the Green Party) and Rory O'Donnell (National Economic and Social Council) before the motion was opened to the floor. The focus of the debate was very much dominated by the issue of Climate Change (and not other contemporary issues of environmental concerns) which in itself is an interesting reflection.

The Colloquium was formally opened on Thursday morning by the Provost Dr Patrick Prendergast followed by keynote lectures by three speakers: Profs. Balz Kamber, Pete Smith and Bob Ursem. Balz Kamber, the Chair of Geology and Mineralogy in Trinity College Dublin, gave a fascinating talk on the use of trace elements and isotopes to identify aspects of changing climates in the past and previous land uses from work carried out in New Zealand and Australia. Pete Smith is the Professor of Soils & Global Change in the Institute of Biological and Environmental Sciences, University of Aberdeen as well as Science Director of Scotland's ClimateXChange, and a lead author on the recent IPCC report. His talk focussed on food security and climate mitigation, particularly in relation to the choices we make with respect to our diet and the resulting impact on land use and is Scientific Director of the Technology, specialising in the technology. His wide ranging, many different ideas and and develop new technologies, by mimicking and adapting their engineering disciplines.



greenhouse gas emissions. Finally, Bob Ursem Botanic Garden Delft University of application of plants in the development of thought-provoking presentation covered examples on how we can learn from nature both by using the plants themselves as well as processes for the materials science and

The parallel technical sessions then started which featured a total of 99 papers as oral presentations in addition to 45 poster presentations. The range, diversity and quality of the papers showed how interest in issues of environmental concern and incisive research in Ireland are flourishing. There were 7 prizes on offer this year, including the Best Oral

Presentation (€500) and Best Poster Presentation (€250) both in memory of Maximilian Von Sternburg who was a PhD student in the Herbarium of the Botany Department, School of Natural Sciences, TCD until he was killed in a road accident in his native Germany last year. The prizes were presented during lunch amongst the impressive marble columns in the spacious Victorian lobby of the Museum Building. The winner of the Best Oral Presentation was Fergus McAuliffe (University College Cork) for his presentation, *“The application of a commercial mycorrhizal inoculum in a willow wastewater treatment system”* whilst the winners of the Best Poster Presentation were Siobhan Atkinson and Charlotte Dennehy (University College Dublin) for their poster entitled, *“Rehabilitating aquatic macroinvertebrate and macrophyte communities after control of alien invasive plants using geotextile matting as a benthic barrier.”*

Running in parallel to the technical sessions on Thursday afternoon was the Environ Career Expo and CV workshop which proved to be very popular. Attendees met with representatives from NGOs, environmental consultancies, research institutes and semi-state bodies to discuss job opportunities; internships; post doctorate and PhD programmes; and also receive career advice. Many thanks to Cara Augustenborg and Aoife Delaney for organising this year’s event again. Finally, the conference dinner held in the Alexander Hotel on Merrion Square, featured the North Strand Kontra Band who’s Romanian / Bulgarian influenced, high energy infectious tunes got everyone up and dancing late into the night.

In general the Colloquium went very well and provided an opportunity for cross fertilisation of ideas between almost 300 delegates over the three days across their different fields of environmental related research. A big thank you to Ian Douglas (TCD) and Sinead Macken (ESAI) as well as the local TCD organising committee for all their efforts in organising the colloquium.

Laurence Gill, TCD ENVIRON 2014 Colloquium Convenor

### Student Prize Winners 2014

There were over 140 presentations in total made at the Environ 2014 colloquium and the ESAI ran their annual student competition, judging all student talks and presentations, making the difficult decision to find the best posters and talks. The ESAI would like to thank the many judges that assisted with the competition. The winning student presentations chosen by the ESAI were as follows:



**ESAI Best Overall Oral Presentation** went to Fergus McAuliffe, UCC for his talk *“The application of a Commercial Mycorrhizal Inoculum in a Willow Wastewater Treatment System”* (pictured above).

**ESAI Best Overall Poster Presentation** was awarded to co-presenters; Siobhan Atkinson & Charlotte Dennehy, UCD, with their poster entitled *“Rehabilitating aquatic macroinvertebrate and macrophyte communities after control of alien invasive plants using geotextile matting as a benthic barrier”*.

**Best Soils Presentation** went to Conor McGee, UCD for his talk on *“The dose dependent effect of nano and micro-sized silver particles on microbial community structure & function in grasslands soil”*. Erin Tiedeken, TCD, received the prize for

**Best Biodiversity Presentation** for her talk on *“The impacts of Rhododendron nectar toxins on Ireland’s bee population”*.

New prizes this year included; **Best Water Related Presentation** which was presented to Anna Rymaszewicz, UCD, for her talk on her research *“Challenging of Monitoring of Suspended Sediment Fluxes: Turbidity Surrogate Method”* and **E3 Prize for Best Presentation spanning Engineering, Energy and Environment**. This was awarded to Richard Manton, NUI Galway

with his talk entitled “Carbon Footprint of Travel to the Great Western Greenway; Lessons for the sustainable design of walking and cycling networks”.

Finally, **Best Waste and Resource Management Presentation** was awarded to Tara Duggan, UCC based on her talk “Amendment of peat based and peat reduced growing media with vermicompost: Effects of plant growth, development and fruit yields of tomato”.

Our sponsorship for prizes was greatly appreciated with €2,000 to present to students this year. Many thanks to the continued support from our sponsors EPA, TCD, Family of Maximillian Von Sternburg, CIWEM, CIWM, BEC Consultants and SSSI.

Sinead Macken, ESAI Administrator

#### PHOTOGRAPHY COMPETITION 2014

The theme of the Ninth Annual ESAI Photography competition was “**Urban Green Infrastructure**” and was opened to all amateur photographers on the 31st July 2014.

The winning photograph was Dublin, entitled “Urban copy of her photograph voucher, kindly sponsored by Institute at University College

The two runners up in the Unison” by Leon James Murphy, Michael Gavin, Dublin who both a one year membership to the picture quality, composition, and appropriateness of caption.



taken by Ms Catherine Bushe from Waterfall”. She received a framed together with a €200 One4all the Environmental Research Cork.

competition, “Planting and Graffiti in Dublin and “The Luas Green Line” by received a €50 One4all voucher and ESAI. Photographs were judged on



The winning photographs will be displayed in the Photo Competition Gallery section of the ESAI website at <http://www.esaiweb.org/gallery/photo-competition> and will be on display at the ESAI annual conference, Environ 2015, 25<sup>th</sup> Irish Environmental Researchers Colloquium, 8th-10th April 2015. Many thanks also for the assistance of the photography competition judge, Nutan. He has a long established reputation in photographic journalism. Check out [www.nutan.ie](http://www.nutan.ie) for examples of his work.

**ESAI INCOME AND EXPENDITURE ACCOUNT****For the year ended 31 December 2014**

<b>Opening balance as at January 1st 2014*</b>	<b>€</b>	<b>10442.51</b>
<u>Income</u>	€	€
Membership	6945.70	
Environ 2014 - Delegate Fee	24820.01	
- Sponsorship	7900.00	
Environ 2014 Prizes	1956.50	
Environ 2015 Sponsorship	500.00	
Nat Capital Workshop - Delegate Fee	4000.00	
<b>Total Income</b>	<b>46122.21</b>	
<u>Expenditure</u>		
Environ 2014 (inc prizes )	33033.14	
Nat Capital Workshop	4231.90	
Invasive Species Catering	392.40	
Stationary (Branded ESAI Pens)	655.37	
Website	1701.86	
Administration	8137.00	
Travel	688.44	
Bank Charges (inc. Merchant banking)	1233.60	
Ezine	840.00	
Insurance	837.50	
Photography Competition	201.25	
<b>Total Expenditure</b>	<b>51952.46</b>	
Excess Expenditure over income		-5830.25
Closing Balance as at 31st December 2014		4612.26

Balance per Bank @ 31/12/14

4612.26

\*The balance includes the Biodiversity Workshop 2000 surplus of €1982.56

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