



Environmental Protection Agency

STRIVE Programme

Fellowship & Scholarship Schemes

Seminar 2008

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Plenary Sessions

Ireland's Environment 2008

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The Environmental Protection Agency's *Ireland's Environment 2008* report (www.epa.ie) provides an overall assessment of Ireland's environment. It reviews the quality of all aspects of the natural environment, identifies environmental pressures, and provides an assessment of the impacts and potential responses.

Ireland's environment remains of generally good quality, though it is subject to potentially damaging pressures from a range of activities. As a result of continued economic development and changing consumer patterns these pressures have grown significantly over the past decade. There are a number of key environmental challenges facing Ireland in the coming years: limiting and adapting to climate change; reversing environmental degradation; mainstreaming environmental considerations; and complying with environmental legislation and agreements.

Developments in science, research and innovation can play an important role in rising to the environmental protection challenges. Quality research provides the foundation for credible decision-making, while technology and innovation provide solutions to environmental problems. In addition to ongoing research in the environmental sciences more research is required to understand better the socio-economic context of environment issues. The continued strong investment in environmental research is crucial, as today's environmental research will become tomorrow's environmental protection.

The natural environment is a critical national asset and its protection and enhancement benefit both economy and society, now and in the future. Within the context of sustainable development, it is important that the environmental conditions fundamental to the economic and social well being of future generations not be exhausted or degraded. It is vital that environmental considerations be placed at the heart of policy and decision-making across all economic sectors.

STRIVE Programme 2007-2013

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Environmental Protection Agency

The general objective of the Environmental Protection Agency (EPA) programme for Science, Technology, Research and Innovation for the Environment (STRIVE) is:

To protect and improve the natural environment by addressing key environmental management issues through the provision of world-class scientific knowledge generated through a vibrant, competitive programme of research supported and co-ordinated by the EPA.

The programme is based on the National Development Plan 2007-2013; the Government's Strategy for Science, Technology and Innovation; the EPA's most recent *State of Ireland's Environment* report; the EPA's *Strategy 2020 Vision*; a series of workshops, and the experience gained in the previous EPA programme 2000 - 2006. It also takes account of European and international developments.

The programme covers the period 2007 to 2013 and comprises:

- Seven thematic areas (Climate Change; Waste, Resource Management & Chemicals; Water Quality and the Aquatic

Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations);

- Three key measures (Sustainable Development, Cleaner Production and Environmental Technologies and A Healthy Environment); and
- Two support measures (Environmental Research Centre and Capacity & Capability Building).

The funding for the programme (c. €100m) is provided from the NDP 2007-2013; the Inter Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); co-funding with other state agencies and EPA core funding.

The EPA also provides key national support in respect of the EU's 7th Framework Programme for research, specifically the theme Environment, including Climate Change, as well as liaison and support in respect of other EU programmes and in the wider international context.

More information on the STRIVE Programme is available at: www.epa.ie/researchandeducation/research/.

Data Management: What the EPA require from your STRIVE funded project?

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One of the aims of the STRIVE programme is to "*disseminate the findings of individual research projects and the overall programme to the widest possible audience in a coherent and timely manner*". Data and information generated through research are recognised as a valuable, long-term resource with value within and beyond the lifetime of the project that generated it. The importance of this research data and knowledge cannot be underestimated. Some authors (Wouters and Schroder, 2003) remark that "*alongside human capital and instrumental capital goods, digital research data are developing into a third stream of scientific capital*". The volumes of research data being generated in the area of environmental monitoring and environmental science are increasing quickly. To mitigate future problems of data exchange, data quality, and general data usage it is important to adopt sound data management practices early in a project rather than at or close to the end. The Secure Archive For Environmental Research Data (SAFER-Data <http://erc.epa.ie/safer>) is the EPA's web-based data management system for data generated by research funded under STRIVE. This presentation will outline in detail the types of data and information researchers funded under the STRIVE programme must submit to EPA at the end of their project and shall include an overview of the key features of using SAFER-Data to submit and manage these data. The presentation will serve to provide advice on sound data management practices for environmental research data.

1Tackling Novel Contaminants in the Irish Aquatic Environment: Pharmaceuticals, cause for concern?

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The recent increase and urbanisation of the Irish population has resulted in municipal effluent overtaking agriculture as the main pollution source for both serious and moderate pollution in Ireland. As a result the consistency of municipal effluent has become more concentrated and more complex. For a long time municipal effluents from waste water treatment plants (WWTPs) have been known to contain toxic substances derived from domestic and industrial sources, including pesticides, organic chemicals and heavy metals. However, relatively recently, several new classes of biologically active pollutants have emerged, including commonly used pharmaceutical drugs that have been the focus of much environmental concern internationally. This presentation shall give some background to this new area of environmental research as well as outlining a new five year project to investigate the chronic effects of these novel pollutants in both the freshwater and marine environments using the zebra mussel (*Dreissena polymorpha*) and common mussel (*Mytilus edulis*) respectively. Results from a preliminary exposure of *Mytilus edulis* to the non-steroidal anti-inflammatory drug Diclofenac and the lipid regulator Gemfibrozil shall be presented and discussed in the context of answering the question, are pharmaceuticals in the environment a cause for concern?

Marie Curie funding opportunities for early career researchers in Ireland

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Irish Universities Association

The Marie Curie Actions programme in FP7 ('People' programme) provides funding for the mobility of researchers in Europe and beyond, both in terms of geographical mobility and mobility between public and private sectors. It offers fellowships to researchers at all career stages; supports transnational postgraduate research training programmes, and encourages the exchange of expertise and research culture between industry and academia through staff exchanges. Regional, national and international funding bodies can benefit from cofunding of their international fellowship programmes, and academic institutions that have ties to institutions outside Europe can get support for staff exchanges with those partners.

In short: the Marie Curie Actions offer opportunities for anybody involved in research, at any career stage, in any discipline, and from both the public and the private sector.

In this presentation I will give a short overview of the different schemes within the Marie Curie programme in FP7, and then provide some more details on those actions that could be of particular interest to individual early career researchers: the Marie Curie Intra-European and International Outgoing Fellowships, fellowships within Marie Curie host actions (Initial Training Networks, Industry-Academia Partnerships and Pathways), and opportunities within national or international programmes co-funded by the new Marie Curie COFUND scheme.

Fulbright Program: Overview & Opportunities

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Fulbright Commission

The Fulbright Program was established in 1946 under legislation sponsored by Senator J. William Fulbright of Arkansas. The *purpose* of the Program worldwide is to increase mutual respect and understanding between the people of the United States and the people of over 150 countries through educational and cultural exchanges. *Fulbright grants* include a monetary award, visa administration, health insurance and cultural and professional programs.

The primary function of the *Fulbright Commission* in Ireland is to administer the Fulbright Program which was established in Ireland in 1957 to provide scholarships to Irish citizens to lecture, research or study in the United States and for US citizens to lecture, research or study in Ireland. More than 1,600 Irish postgraduate students, academics and professionals have studied in top US colleges and research institutes and more than 600 US students and scholars have come to Ireland. According to one US Grantee to Ireland, his Fulbright grant was "*truly a once-in-a-lifetime experience and a priceless gift.*"

Fulbright Awards are for Irish students, scholars and professionals to undertake postgraduate study and research in the United States. Applications are encouraged in all disciplines including the visual and performing arts. The Fulbright – EPA Fulbright Award is for a post-graduate student in environmental studies / policy. The 2009 - 2010 competition closes 5th December 2008. Successful applicants must demonstrate in their application and at interview:

- Excellence in their academic / professional & personal qualifications,
- A clearly defined course of study or research,
- Admission to / affiliation with a recognised higher education institution in the US,
- Compliance with the Commission's citizenship criteria,
- Leadership potential, and
- The benefit of becoming a "Fulbrighter."

Abstracts of Oral Presentations¹

Environment & Health Session

Towards The Development of A Microbial Risk Assessment Model for Cryptosporidiosis

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Samples of faeces, slurry, soil and water were collected from a representative number of farms and surface waters within a river catchment in Co. Cavan during 2006. Microscopic analysis of these samples revealed no significant level of infection amongst the animals and a low level of environmental contamination. PCR analysis revealed higher levels of sub-clinical infection in calves and slurry in the catchment. Two new catchments more suitable for the project goals were identified and a similar sampling programme was carried out in these new sites. Calves on one farm in each catchment were diagnosed with clinical *Cryptosporidiosis*. These clinical cases involved the *C. parvum* species of *Cryptosporidium* which is infective to both animals and humans. This research uncovered more widespread contamination in each catchment other than the cases discovered during routine veterinary analysis. Analysis of water samples taken from each catchment revealed low oocyst numbers but higher concentrations were recorded during heavy rainfall. Dung heaps have been identified as major environmental sources of *Cryptosporidium* oocysts but contamination of surface waters is prevented by the natural filtering of soil and flora. The data obtained from faeces, slurry, soil, dung and water samples from the North and South Leinster catchments will be used to drive the risk assessment model.

Understanding the links between environment, health and well-being

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The focus of the fellowship was on a number of key topics including the interaction and exchange of information among the EPA, HSE and the IPH. This was advanced through a series of face-to-face meetings, telephone and email contact and discussions. During the two years of the fellowship, a number of position papers were produced, cooperation with the IPH in the area of HIA was advanced, links between the HSE and EPA GIS teams were developed and the future of environment and health research within the Irish context was explored. As a research component, an evaluative case study of the collaborative process used in the investigation of the presence and influence of lead in Silvermines was conducted.

The increasing emphasis on collaboration between agencies and sectors entails potential partners developing their capacity for working together across organisational and sectoral boundaries. Partnerships across government departments and their agencies are central to deal with complex problems but also to improved health and build healthy policies. Partnerships and collaborations must be seen as important change strategies.

¹ Copies of the presentations will be made available for download on www.epa.ie/news/events/research/past/

A Systematic Approach to Assessing Potential Environmental Impacts of Nanomaterials: Nanoparticle Synthesis, Characterisation and Impact Assessment

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Nanotechnology is expected to be the basis of the main technological innovations of the 21st century, including curing disease (nanomedicine), earlier diagnosis of disease (nanodiagnostics) and faster electronics (nanotechnology). An estimated 30,000 different nanomaterials are being developed worldwide, including semiconductor quantum dots, carbon nanotubes, and metal nanowires. Nanoparticles are materials with dimensions of less than 100 nanometres (nm). One nanometer is 10^{-9} m.

Responsible development of nanotechnology requires that in addition to optimising the applications of nanotechnology, a complete assessment of the potential risks to human health and to the environment associated with the production, use and disposal of nanomaterials is undertaken in parallel. Until more information is available regarding the safety of nanomaterials, it is necessary to protect workers involved in production and use of these materials, as well as ensuring that exposure of the world population and the ecosystem does not lead to harmful impacts later (such as occurred with asbestos).

The aim of this project has been to synthesise and completely characterise a series of "smart" copolymer nanoparticles which surface properties are varied systematically, allowing investigation of the impact of surface charge on observed responses in cells. A key issue is to ensure that the nanoparticles are properly dispersed in the relevant test media in order to control the dose of nanoparticles exposed to cells. Addition of a fluorescent label to the particles ensures that we track the uptake and sub-cellular localisation of the nanoparticles. Preliminary results from interaction studies with cells and simple ecotoxicological species are presented.

Nanotechnology: engaging the public on health, environmental and social issues

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Dublin City University

Nanotechnology has huge potential for Irish research and development. However there is a lack of awareness and little public discourse about these technologies. There is some concern, particularly about the unknown effects to health and the environment. In the EU and US, public consultation processes have begun to gauge opinion and facilitate public involvement in decision-making. This two-year EPA STRIVE research fellowship, drawing on ongoing multidisciplinary science and society work at DCU, will focus on issues of public perception and response to environment-health issues regarding nanotechnology. The research addresses two questions: 1) knowledge areas for nanotechnology in Ireland and 2) the potential mechanisms in which scientists, policy-makers and 'lay' members of the public can become engaged with the possibilities and risks associated with the technology.

The research project draws on current thinking within science communication and science and technology studies (STS) on approaches to local knowledge construction of, and public engagement with, emerging technologies. For the knowledge construction, the theoretical framework used includes the concepts of risk society, reflexive modernisation and communities of media practices. For public engagement, 'upstream' models of communication and public participation in nanotechnology discourse are investigated. For these two research objectives, nanotechnology is seen as a range of *discourses*, where local *discourse sites* have their own rules of engagement with the subject and framing strategies, and where there is potential for public involvement. These sites include public affairs media, university science, policy, education and local communities. Following contemporary science communication models, health and environmental issues associated with nanotechnology are expected to be closely linked to wider social, ethical and cultural concerns.

Biodiversity Session

A DNA-based method for identifying small mammal species of Britain and Ireland

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Small mammals are a significant component of biodiversity in the UK and Ireland, and recently there have been increasing calls for a coordinated small mammal monitoring scheme. Identifying and monitoring species is an essential requirement for effective conservation and management, and among the various techniques used for monitoring small mammals, non-invasive sampling methods are becoming ever more popular. Non-invasively collected samples such as hairs and faecal pellets can provide a source of DNA which can be analysed to identify species and/ or individuals, which may then be used to provide data on species' presence/ absence, estimates of abundance, and various aspects of population genetics. In this talk, we will describe a novel method for identifying small mammal species using real-time PCR as a tool for amplifying DNA from a variety of biological samples.

How does agricultural grassland management influence hymenopteran parasitoid communities?

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University College Dublin

The Order Hymenoptera contains the free-living sawflies, ants, bees and wasps, however, the vast majority of species in this large and diverse order are parasitoid wasps. These insects are often highly specialised and restricted in their feeding to certain groups of arthropods and plants. Hymenopteran parasitoids are also amongst the least well known of the insects due to their extraordinary diversity, small size and poorly understood taxonomy. Their abundance and diversity has been shown to be an accurate indicator of the diversity of other, potential host arthropods in agricultural grasslands. We are investigating their use as indicators of the effects of different management regimes in agricultural grasslands in south-eastern Ireland. In the course of this project, we compare hymenopteran parasitoid community structure in semi-natural grasslands with improved agricultural grasslands. As might be predicted, parasitoid communities are more taxon rich, and their host range more diverse, in semi-natural grasslands. We also carried out a survey of parasitoids in grasslands on 50 farms across south-eastern Ireland, with the aim of analyzing community structure in relation to grassland management. Parasitoid communities in these grasslands reflected management intensity, with an inverse relationship between nitrogen input level and their taxon-richness.

A semi-quantitative assessment of Turlough vegetation types

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Turloughs are temporary lakes over karst limestone that fill and empty mainly in response to groundwater fluctuations. They are included as Priority Habitats on Annex I of the EU Habitats Directive (92/43/EEC), and are also protected as Groundwater Dependent Terrestrial Ecosystems under the EU Water Framework Directive (WFD) (2000/60/EC). Ireland is, therefore, under obligation to conserve and maintain these valuable habitats. Turloughs are subjected to regular inundation with calcium-rich groundwater, exerting a highly selective pressure on their biota, which has resulted in the unique flora and fauna of these ecotones. Regular zonation of vegetation is evident in turloughs, which is related to depth, frequency and timing of inundation.

During three field seasons, surveys were carried out in twenty-two turloughs recording plant species cover/abundance (using the DOMIN scale), along with information on mean vegetation height, amount of grazing and/or poaching and type of herbivores present. The relevé data were then analysed using ordination and hierarchical cluster analysis.

A range of species and vegetation types were found throughout the turloughs studied. These vegetation types will be described, and compared with the results of a qualitative study (Goodwillie, 1992).

Aquatic Coleoptera assemblages in the Irish agricultural landscape

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University College Dublin

The intensification of agricultural activities in Ireland has resulted in a long-term decline in water quality and in the clearance of non-farmed habitats, with detrimental effects on biodiversity. At present, Ireland does not have a systematic programme in place to monitor trends in species distribution associated with agricultural activities, despite this sector being the major contributor to changes in biodiversity.

The aim of this project is:

- 1) to provide extensive data on the biodiversity of ponds in the Irish agricultural landscape, using aquatic Coleoptera and plants as surrogates of biodiversity,
- 2) to improve our understanding of the distribution of Coleoptera and plant assemblages along gradients of pollution and other environmental variables, as well as management practices,
- 3) to identify the plant community types that support high Coleoptera diversity in farm ponds, and
- 4) to use the information obtained for the production of pond conservation guidelines.

During the first phase of this project, we assessed aquatic Coleoptera and plant assemblages for 25 ponds located in south-eastern Wexford. Coleoptera diversity was low at the local level (on average 15 species per pond). However, at the landscape level farm ponds supported a relatively large number of species (64), confirming the important contribution of ponds to biodiversity. Pond water quality was typically low and was characterised by high levels of nitrates and phosphates. A general decline in the number of ponds in the agricultural landscape due to waste disposal and housing development was also observed.

Land Use & Soils Session

Dissolved Carbon – The Missing Sink

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In regard to Articles 3.3 and 3.4 of the Kyoto Protocol it is important to accurately quantify the carbon sequestration capacity of managed ecosystems. Atmosphere-based estimates of terrestrial C sequestration are larger than inventory-based estimates possibly due to fluxes that are not considered in current C budgets. Our project has examined the hypothesis that the transfer of dissolved C from soils into the hydrosphere can explain this missing sink. To quantify leaching losses of biogenic C we determined the fluxes of dissolved organic C (DOC) and biogenic dissolved inorganic C (DIC) – analysed via $\delta^{13}\text{C}$ analysis – in the drainage water of the three major Irish land use types (arable, grassland, forest).

Our results show that DIC comprised ~85 % of the total DC. Across sites little difference in DOC concentrations at depth and over time was observed. DC losses decreased in the order grassland > arable land > forest with DC losses of 31.3, 20.9 and 8.5 $\text{gCm}^{-2}\text{yr}^{-1}$, respectively. The unexpectedly large grassland loss can be attributed to high DIC concentrations (64 mg l^{-1}). The average DC loss over sites was 20.4 $\text{gCm}^{-2}\text{yr}^{-1}$, which represents 20 % of the Net Biome Productivity (NBP). If the

two exceptionally wet summer months of 2007 are removed, however, this value drops to $12.7 \text{ gCm}^{-2}\text{yr}^{-1}$ (12.5 % of NBP) in agreement with the literature value ($11 \text{ gCm}^{-2}\text{yr}^{-1}$) predicted for major European land use types. Whilst DC fluxes are significantly correlated to soil water fluxes it is likely that DOC and DIC concentrations are regulated by a number of interacting factors.

Impacts of recent European Developments in regulating the management of contaminated land in Ireland – A Legal Perspective

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University College Cork

When compared with the regulatory control over other environmental media, such as water and air, it may be said that the regulation of the protection of soil in the EU is a neglected area. There is now however, an emerging focus in Brussels on the protection and remediation of soil, in the form of the relatively recently adopted Environmental Liability Directive and the proposal for a Soil Framework Directive.

This paper considers these developments and in particular the impact of their contaminated land provisions in regulating the management (including the identification, assessment and remediation) of contaminated land in Ireland. It concludes that these EC measures will have significant impact on how contaminated land will be regulated in Ireland. They may provide impetus to the process of establishing a more comprehensive and integrated regulation of contaminated land in Ireland. However, these EC developments have limitations. They may not be the cure-all for ensuring effective management of contaminated land in Ireland.

Using GIS and Geostatistics to Characterise Spatial Variation of Heavy Metal Pollution in Soils of a Sports Ground in Galway, Ireland

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The characterisation of the spatial variation of heavy metal pollution in urban soils is essential to achieve a better understanding of its sources and potential pollution risks. A total of 294 soil samples were collected at an interval of 10m on a grid system from a sports ground of Galway, Ireland. It was observed that the raw data showed wide diversity and asymmetric probability distribution features. A power transformation of the Box-Cox method was effective in pushing the data sets towards normality. Cluster analysis classified the variables into four distinct clusters with three well-known pollutants Cu, Pb and Zn clustered in one group. The three pollutants were subjected to geostatistical studies, including spatial structural analyses using variograms and theoretical modeling, following identification of spatial outliers using local Moran's I index. The probability kriging was applied to evaluate the potential risks of these heavy metals in soils of the study area. Maps with probabilities of these heavy metals exceeding their background values were produced using a GIS. It was shown that the areas with high risks were mainly located along the roadside and the middle-upper part of the study area, revealing the strong influence of local traffic pollution. Such results can be useful for management of parks in urban areas.

Active Microwave Remote Sensing of Soil Moisture

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The importance of land surface–atmosphere interactions, principally soil moisture, on hydrological, meteorological, and ecological processes has gained widespread recognition over the past decades. Its high spatial and temporal variability though, makes it difficult to monitor effectively and thus introduces inaccuracy into the modelling of these processes where it is implicated. There is a need, therefore, for an efficient and comprehensive approach to reliably estimating spatially distributed near surface soil moisture, wherein space borne microwave remote sensing offers a prime solution.

The purpose of this research is to address the potential of ENVISAT ASAR and ALOS PALSAR Synthetic Aperture Radar (SAR) in extracting information on surface soil moisture content over different land covers in southern Ireland using different sensor configurations. The applied technique is based on deriving the relative changes in soil moisture between different SAR acquisitions using a multi-temporal analysis. Simultaneous with each data acquisition, ground measurements of soil and vegetation parameters are being taken within the study sites. Experiments and their analysis are still on-going; however some preliminary results are presented.

Waste & Resource Management Session

Predicting sorption of pharmaceuticals and personal care products onto soil and digested sludge using artificial neural networks

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An investigation of the sorption behaviour of a large selection of over-the-counter, prescribed pharmaceuticals and illicit drugs to agricultural soils and freeze-dried digested sludges is presented. Batch sorption experiments were carried out to identify which compounds could potentially concentrate in soils as a result of biosolid enrichment. Solid-water distribution coefficients (K_d) were calculated based on slopes of sorption isotherms over a defined concentration range. Molecular descriptors such as $\log P$, pK_a , molar refractivity, aromatic ratio, hydrophilic factor and topological surface area were collected for all solutes and, along with generated K_d data, were incorporated as a training set within an artificial neural network to predict K_d for all solutes within both sample types. Bilogarithmic plots of predicted versus experimentally determined K_d are presented which show excellent correlation ($R^2 > 0.88$), highlighting that artificial neural networks could be used as an intelligent predictive tool to assess sorption of PPCPs in the environment. To evaluate the developed model, it was used to predict K_d for meclufenamic acid, mefenamic acid, ibuprofen and furosemide and subsequently compared to experimentally determined values in soil. Ratios of experimental/predicted K_d values were found to be 1.00, 1.00, 1.75 and 1.65, respectively.

Investigation of bacterial glutathione S-transferases in contaminated soil in the environment

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Toxic synthetic chemicals introduced into the environment, via industry or agriculture, can penetrate ecosystems and pose a threat to all living species. One family of enzymes that plays an important role in detoxification of a variety of compounds is glutathione S-transferases [GSTs], ubiquitous multifunctional proteins found in almost all species from bacteria to man. The study of bacterial GSTs, however, is still in its infancy. In our laboratory, a specific bacterial GST, BphK^{LB400} isolated from *Burkholderia* LB400, has been studied and was shown to be capable of dehalogenating a number of synthetic chlorinated organic compounds associated with varying levels of ecotoxicity, including chlorobenzoates (PCB metabolites) and commonly used pesticides (functioning as endocrine disruptors and associated with cancer). Laboratory scale phytoprotection studies suggest that this specific bacterial GST, BphK^{LB400}, is capable of dehalogenating toxic synthetic chlorinated organic compounds in soil protecting the plants from the effects of these chemicals.

In the current project, molecular biological and bioinformatics techniques are used to detect bacterial GST genes (known and novel) in environmental soil samples contaminated with chlorinated organic compounds. Bacterial GST sequences from contaminated soil DNA samples will be compared with known bacterial GST sequences with a view to identifying novel sequences that could be beneficial in detoxification of environmental pollutants. Bacterial GSTs could have potential in bioremediation of contaminated soil in the environment and could be used as bioindicators of environmental toxicity.

Environmental Risk Communication; Waste, Incineration and Dioxins

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The proposal to site a municipal solid (MSW) incinerator in the Dublin Bay area has met with strong opposition. Although similar controversies have been a feature of the Irish waste policy landscape over the past decade, this particular case is unique in that the local authority has undertaken an active communication programme for local residents.

Although regulators and waste industry experts usually contend that incineration poses no significant health or environmental risk, publics continue to harbour concerns and debates about incineration risks continue. The gap between technical risk assessments and 'lay' perceptions of incineration risks means that effective risk communication is crucial to incinerator siting decisions. Researchers claim that publics' perceptions of risk are governed not so much by risk probabilities, as by psychological factors such as whether risk is seen as voluntary, equally distributed and whether there is scientific uncertainty. Furthermore, efficacy in communicating risk is shaped by trust and transparency. Finally, the role of the media in communicating environmental risk has been emphasised by researchers.

This presentation describes the analysis of the health, environmental, social and economic risk messages in the discourse around the MSW incinerator planned for Dublin. The research consists of two-phases. The

first phase involves a content analysis of newspaper articles and materials produced by Dublin City Council's communication campaign. The second phase consists of in-depth interviews with stakeholders involved in the Poolbeg incinerator debate to elicit the motivations behind the risk messages identified in the first phase.

Development of a novel process for the removal of selected organic compounds from waste streams

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The focus of this study is to devise a novel method of treatment for a single selected organic chemical listed on the EPER database which is also present in industrial wastewater streams. Of the 25 organic chemicals on the database, phenol was selected due to its relatively high water solubility, potentially damaging environmental impact and significant release to industrial wastewater. The proposed process for removal of phenol consists of an initial adsorption step followed by a secondary catalytic oxidation step. The work to date has focused on the first step; adsorption of phenol onto zeolite-beta and the modification of zeolite beta to facilitate catalysis. Uptake of the phenol has been assessed as a function of contact time, pH, initial aqueous phenol concentration and silica to alumina ratio within the adsorbent material. It was found that phenol uptake takes place within the first 10 minutes of contact with a maximum uptake level of 17.42 mg g⁻¹ being achieved. Phenol removal was found to have a significantly negative relationship with increasing temperature and a positive relationship with increasing silica ratio but with no definable relationship to pH. The Freundlich model of adsorption provided the best correlation for phenol uptake on the zeolite-beta. The zeolite was also successfully modified with copper which was found to have a favourable relationship with adsorption and good aqueous stability within a pH range of 5 to 9. Further research work will assess the catalytic oxidation capabilities of the zeolite beta adsorbent in the second step of the process and the viability of the two-step system.

Air Quality & Climate Change Session

The EU ETS and early abatement: A quantitative analysis

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The pilot phase of the European Union Emissions Trading Scheme was a valuable learning experience for both industry and regulators. Almost half of European CO₂ emissions were monitored, reported and verified during 2005-2007. Interrogation of the Community Independent Transaction Log data reveals that likely over-allocation and possibly abatement occurred, but without much insight into the levels of each. Abatement is the difference between the hypothetical Business as Usual (BaU) emissions path, and the observed emissions level. This paper uses historical European industrial CO₂ emissions data to estimate a dynamic panel data model and estimate what BaU emissions would have been for the EU ETS sectors in the absence of the EU ETS. This quantitative analysis of the

2005-2007 trading period finds that over-allocation occurred, as concluded in previous studies. It also reveals that no abatement was undertaken, which is contradictory to the conclusions of Ellerman and Buchner (2008), the major study in this area.

Elucidating the Impact of Aerosols on Cloud Physics and the North Atlantic Regional Climate

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Aerosol-cloud interactions present scientists with some of the greatest uncertainties in predicting our future climate. These interactions, also known as the indirect aerosol effect describe how atmospheric aerosols, such as sea-salt or dust act as nuclei on which cloud droplets can form. How efficient different types of aerosols are at forming cloud droplets depends on a number of factors including their size and chemical composition. The number and size of cloud droplets is a key factor in determining the Earth's radiation balance and thus a key factor in climate change. It is necessary to include a treatment of these interactions in climate models and here an aerosol-cloud interaction parameterization has been implemented in the regional climate model REMOTE.

REMOTE (REgional Model with Tracer Extension) is under ongoing development at NUI, Galway and is currently one of the most advanced regional climate models available worldwide. The parameterization is based on the work of Nenes and Seinfeld (2003) and is a flexible and efficient method of representing aerosol-cloud interactions. Here, we present results of simulations for a model domain covering the North East Atlantic and most of Europe. Simulations were performed to investigate the effect different atmospheric aerosols have on cloud droplet number. Their effect on precipitation and cloud lifetime is also studied.

Coping with Uncertainties in Climate Modelling for Ireland

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In spite of the fact that it has long been recognised that different Global Climate Models produce significantly different regional climate responses even when forced with the same emissions scenario (Hulme and Carter, 1999), it was common practice until recently for many impact studies to employ only one climate change scenario, based on one emissions scenario, derived from a single GCM. This practice ultimately results in the suppression of crucial uncertainties and is considered as 'dangerous' due to any subsequent policy decisions which may only reflect a partial assessment of the risk involved (Hulme and Carter, 1999).

While a number of approaches have developed to address some of these shortcomings, such as adoption of a 'best guess' framework or taking the mean or median value from a range of scenarios, such top-down approaches are not particularly useful for use in vulnerability analysis due to an inability to attach probabilities. Without a clear statement on the uncertainties that have or have not been incorporated into the research, policy decision makers need to exercise extreme caution.

The use of probabilities is a well-established technique in both short- and medium- range weather forecasting where uncertainty in model output is represented by the dispersion of an ensemble and increasingly the use of probabilities in climate change impact assessments are becoming more

widely accepted. This presentation will outline a methodology to produce probabilistic climate scenarios for Ireland, taking into account a number of uncertainties.

Back-trajectory cluster analysis - a tool for the interpretation of atmospheric monitoring data

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In analysing atmospheric monitoring data, it is often necessary to group the data to make better sense of it. Data can be grouped according to season, wind direction, day of the week, tidal level, hours of sunshine on the day, origin of air mass etc.

One method is grouping according to back-trajectories, as an indicator of air mass origin. For large data sets (e.g. monitoring data over a few years) this can involve the clustering of thousands of back-trajectories, which requires an automated approach.

The method presented here is an implementation of the algorithm (in slightly modified form) suggested by Dorling et al., (1992) and described in Mattis (2002).

A short introduction to the concept of cluster analysis is given, followed by an outline of the algorithm implemented here, using Irish monitoring data as an example.

Socio-Economics Session

Spatial Analysis of Sustainable Development Indicators Using Geographically Weighted Regression

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This research project includes a spatial analysis of Sustainable Development Indicators for 71 settlements across three regions of Ireland. This analysis explores the database created at the Centre for Environmental Research (CER) University of Limerick within the Irish Environmental Protection Agency-funded project, Sustainability and Future Settlement Patterns in Ireland. It contains data on 175 environmental and socio-economic indicators for each of the 71 settlements in the Sligo, Midlands and Limerick regions of Ireland.

Population, population change, distance to gateway settlements, and a services index are analysed by geographically weighted regression for their effect on 44 other sustainable development indicators. Results are displayed visually in a Geographic Information System (GIS).

Previous research has used standard statistical techniques that analyze these data without regard to location. Correlation and linear regression have revealed relationships between some indicators, but it was assumed that these relationships are stationary throughout the study region.

Using a spatially explicit form of regression, this work reveals significant relationships that were previously undetected because they vary widely over the study area. This analysis also finds that some relationships previously suggested using standard regression are not stationary. The resulting maps illustrate how these relationships change over space.

By revealing how some processes that influence the sustainability of settlements vary from region to region, this work can contribute to more effective local, regional and national policies towards sustainable development.

On-Farm Innovative Diversification in Ireland; A Socio-Economic Appraisal

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The development of on-farm complimentary activities is a necessity for the long-term viability and survival of EU farm businesses. Central to this survival process is the generalisation and mobilisation of innovative ideas by farm households. Such innovation potentially offers tremendous micro-, meso- and macro-economic benefits to local rural economies and, concurrently, great potential to establish farming practices and production methods which reflect the increasing societal concern for conservation, landscape protection and quality food production. However, little rigorous examination has taken place of the nature and operation of linkages between farm households and rural institutions in the emergence and sustenance of on-farm diversification.

This research has an explicit focus upon sustainable rural development. In particular, it seeks to investigate the dynamics of farm household behaviours and their linkages with local and regional policy actors in the strategic field of on-farm innovative diversification and environmental sustainability. This scientific focus emphasises the paramount importance of the farmer-institution interface to the capabilities of rural policy actors to deliver successfully the key objectives of Chapter 4 [‘Development of the Rural Economy’] of the National Development Plan 2007-2013. Within the NDP the Rural Economy Sub-Programme places particular emphasis upon the promotion of the diversification of the rural economy with measures designed to assist “the diversification by farm families into non-farming activities...drawing on indigenous rural resources; the promotion of agri-tourism...and conservation of areas of high natural and cultural value” (NDP 2007; 81). This project seeks to examine how innovative on-farm diversification is a dynamic and territorial embedded process within this conceptual framework.

Applying a novel Environmental Emissions Index to quantify industrial environmental performance

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The Irish EPA has been issuing Integrated Pollution Prevention Control (IPPC) licences, or their early equivalents, since 1993. Annual Environmental Reports (AERs), submitted to the EPA by licensed installations, contain data on mass annual emissions for a range of substances. Given Ireland’s comparatively long history of IPPC licensing, these data may provide useful insight into the environmental performance of IPPC regulated industry.

All AER emissions data from the pharmaceutical and electricity-generating sectors have been collated to generate emissions time-series dating back to 1996 and 2001, respectively, for installations from each sector. In order to quantify and compare overall environmental performance trends, we devised a novel Environmental Emissions Index (EEI), based on

methodologies used in life-cycle assessment (LCA). Twenty emissions routinely reported in AERs were characterised according to their contribution to six impact categories: Acidification Potential; Aquatic Toxicity Potential; Eutrophication Potential; Global Warming Potential; Human Toxicity Potential; Tropospheric Ozone Formation Potential. The resulting six Environmental Indicators (EIs) were then normalised against Irish and EU15 total emissions, and each EI weighted using distance-to-policy-target weighting factors, before being summed into the EEI. EEI trends indicate reductions of 40% and 30% in the environmental impacts attributable to emissions reported from the pharmaceutical and electricity-generating sectors, respectively, between 2001 and 2006. However, it is difficult to identify the degree of decoupling in the pharmaceutical sector, owing to variable product output. Economic output data may be used to normalise environmental performance at the sectoral level. Data gaps and uncertainty must be considered when interpreting reported emissions.

A best practice approach to socially sustainable wind farm development applicable to Ireland

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Effective governance plays a crucial role in promoting sustainable development and will be a key consideration if Ireland is to achieve the ambitious targets for wind energy penetration over the next 12 years. Taking this into account, this project focuses on the social sustainability of wind energy development. Much work has been undertaken on the environmental and economic sustainability of wind energy, whereas studies on the social sustainability of wind energy have been largely limited to public acceptance and institutions, the role of different wind energy entrepreneurs, visual intrusion and job creation. By incorporating core principles of sustainable development, collaborative planning, participation and good governance, this project takes a more holistic view of social sustainability and formulates operational factors for investigating the social sustainability of wind farm development. Key factors of consideration for this assessment include, for example, differences in local governance, planning systems, wind farm development mechanisms, government support and policy detail, environmental awareness, and the style and level of local involvement in wind farm development. A qualitative multiple case study and multi-perspective evaluation approach, based primarily on semi-structured interviews, is used to assess the social sustainability of wind energy in Ireland, Denmark and The Netherlands. Drawing extensively on Danish and Dutch wind energy development and governance support mechanisms, the project aims to formulate a best practice approach to socially sustainable wind farm development applicable to Ireland.

Water Quality Session

Macroalgal biomonitoring - applying phenolic compounds as biomarkers for metal uptake characteristics in Irish coastal environments

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When assessing potential metal contamination of coastal and transitional waters, seaweeds are commonly used as biomonitors due to their ability to bind the bioavailable fraction of heavy metals. Besides polysaccharides such as alginates and fucoidan, phenols are the major cellular compounds responsible for this metal-binding capacity. However, phenol contents of brown seaweeds, and consequently the metal-binding ability of these seaweeds, are known to fluctuate. Also exudation of these compounds has been reported, caused by environmental factors such as salinity or nutrient levels. In this study we report on the metal contamination and phenol content of *Ascophyllum nodosum* and *Fucus vesiculosus* collected from a number of sites around Ireland with different environmental conditions. Culture experiments under controlled environmental conditions were also conducted to quantify the interactive effects of environmental parameters and metal contamination on the metal binding ability of *A. nodosum* and *F. vesiculosus*: their physiological responses, phenol content, composition and exudation, as well as their metal content were assessed under a range of different salinity regimes and copper concentrations. The research outcomes of this project will allow a better understanding of the environmental impact on phenol content and exudation and subsequent metal-binding properties *in situ*, and this, in turn, will facilitate an improved application and reliability of brown macroalgae in biomonitoring studies.

Towards the development of a combined Norovirus and sediment transport model for coastal waters

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Sewage effluent in coastal waters used for oyster culture and water-contact recreation poses a risk to human health. The primary pathogen in outbreaks of gastroenteritis following consumption of raw oysters is the *Norovirus* or “winter vomiting bug”. The virus has a long survival time in coastal water from 7 days (summer T90) to 30 days (winter T90). The goals of the research are: (a) to quantify the risk of *Norovirus* infection through coastal waters, (b) to evaluate possible containment of treated sewage effluent, rather than dilution, and (c) to make a prototype early alert system. The primary methodology of the research, contributing to all three objectives, is physically-based high-resolution modelling of the release, transport and decay of *Norovirus* in coastal waters. Cork Harbour and Clew Bay provide case studies for the research.

Viruses are electrically charged colloidal particles which may adsorb to suspended sediment in the water column. Adsorbed viruses may be taken out of the water column when sedimentation occurs and, subsequently, be added to it with resuspension of the bed sediment. These processes may therefore influence the behaviour and transport of viruses in coastal waters. The current phase of the research is concerned with including these processes in the Cork Harbour and Clew Bay *Norovirus* models.

Towards an Early Warning Service for Water Treatment Plants

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Supporting the Concept of Early Warning Analysis (SCEWA) is a 5-year research project focusing on the development of methods and tools which are aimed at supporting the analysis, design, and development of early warning systems in engineering facilities and in critical infrastructures whose undisturbed operation is important for maintaining and improving the quality of our everyday life.

The goal in SCEWA is to develop an early warning service aiming at receiving from and transmitting to stakeholders (i.e. EPA, HSE, local authorities and water utilities personnel) information and signals on imminent events and critical conditions that might cause problems and failures to water treatment plants, as well as warnings of imminent failures in a timely, effective and reliable manner.

A brief description of the categories of events and conditions leading water treatment utilities to failures and operational problems will be given, together with high level descriptions of the of the early warning service operation and architecture. Emphasis will be given also on the implementation of computer science and knowledge engineering methods and technologies as well as at the safety science tools which will be used extensively for the development of the knowledge base of the early warning service.

Water quality and phytoplankton biodiversity in an Irish marine reserve

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Eutrophication – the enrichment of coastal waters by nutrients, and subsequent excessive growth of phytoplankton – has emerged as one of the leading causes of water quality deterioration over the last 50 years. Water samples are being collected monthly to study the relationship between nutrient levels and phytoplankton biodiversity in Lough Hyne Marine Nature Reserve, southwest Ireland. Preliminary multivariate analysis of phytoplankton assemblages shows a clear distinction between samples from Lough Hyne and the adjacent coastal areas. Lough samples tend to have overall lower abundances of diatom species, and higher abundances of microflagellates, tintinids and dinoflagellates, the latter being a group known to cause harmful algal blooms and production of toxins leading to fish kills and shellfish poisoning. Both lough and coastal assemblages tend to separate in the same way over time, suggesting that they respond in similar ways to changing environmental conditions. Initial water chemistry results show nitrogen levels in both lough and coastal waters 7 times higher than previously reported, while phosphorus and silicon levels remain consistent with 1992 levels. Links between these nutrient levels and phytoplankton assemblages are being investigated. The high N:P ratios in the area suggests a departure from the usual nitrogen limitation in marine systems to a phosphorus limited one, while the high N:Si ratios may alter phytoplankton communities toward those dominated by potentially harmful or toxin producing dinoflagellate species.

Environmental Technologies Session

Advanced Systems for Biological Assessment of Toxicity of Industrial Chemicals and Environmental Samples

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The project is to develop and validate new analytical systems for the assessment of industrial chemicals defined under REACH, for their biological risk and hazard to the environment. The approach is based on the analysis of toxicological impact of chemicals and environmental samples on organisms ranging from eukaryotes (Jurkat T-cells), prokaryotes (*E.Coli*), small invertebrates (*Daphnia magna*, *C.Elegans*), and vertebrates (Zebrafish embryos), by monitoring changes in organism oxygen consumption by optical oxygen sensing. Attention is focused on the development of a new portable system for respirometric analyses. Test organisms are exposed to toxicants and then allowed to respire in a sealed compartment in the presence of soluble oxygen probe added to the sample or alternately in closed system with solid-state phosphorescent oxygen probe. Phosphorescent oxygen-sensitive probes and detection on a fluorescent plate reader or phase-fluorimetric detector are used. The resultant depletion of the dissolved oxygen causes an increase in sample fluorescence over time, thus reflecting the organism respiration rate and its alterations. The neuro-toxicity of pesticides as paraoxon and carbofuran was also tested. The assay is based on coupled cholinesterase / choline oxidase system with acetylcholine and dissolved oxygen as substrates, and measurement of enzymatic oxygen consumption.

Emerging organic-inorganic hybrid membranes for dewatering ethanol by pervaporation

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Pervaporation (*Permeation + evaporation*) is a membrane separation process. Its most common application is for dewatering solvents and breaking solvent water azeotropes. It is an energetically less costly method compared to distillation. In the case of ethanol dewatering, a feed solution is passed across one side of a hydrophilic membrane in which a vacuum exists on the other. There are two types of membranes currently commercially available: polymeric and zeolitic (crystalline microporous sieves molecular sieves). Both classes of membranes have advantages and disadvantages for PV. Polymers have good film forming properties, are cheap and easy to process but are unstable at high temperatures. Ceramic membranes have better thermal, mechanical and chemical stability but are brittle and difficult to process. Thus, researchers are investigating hybrid membranes which offer both advantages. The simplest method is to disperse inorganic particulates (filler) to the polymeric casting solution with an interaction at the micron scale. Increased functionality can be obtained by introducing the inorganic component at the molecular scale by addition of liquid inorganic precursors to the polymeric solution and subsequent hydrolysis at room temperature (sol-gel method).

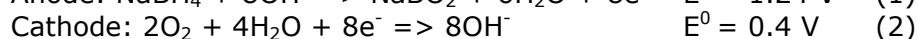
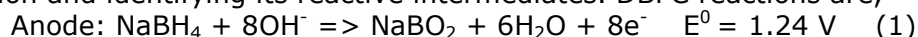
Experiments on prepared membranes are carried out on a Sulzer bench scale pervaporator which houses 6-inch diameter flat sheet membranes. Preparation and characterisation of pristine and mixed matrix polymeric

membranes are described as well as flux and selectivity measurements which are compared to commercial Sulzer membranes.

Direct Borohydride Fuel Cell - Zero Emission Energy Technology **Nagle, Lorraine (lorraine.nagle@tyndall.ie)**

Tyndall National Institute

The Direct Borohydride fuel cell (DBFC) is currently under investigation in an effort to develop sustainable power sources. Establishing this technology hinges on understanding the mechanism of borohydride oxidation and identifying its reactive intermediates. DBFC reactions are,



Borohydride is a promising fuel given its high theoretical specific energy and high specific capacity. However, careful selection of the anode catalyst is crucial in minimising competing hydrolysis resulting in non-faradaic hydrogen evolution that decreases fuel utilisation and lowers cell performance



Owing to the mechanistic similarities of borohydride oxidation and hydrolysis, good catalysts for oxidation are usually good for hydrolysis. However, gold is an effective catalyst for oxidation but non-catalytic for hydrolysis. We seek to exploit the high specific surface area of nanoporous gold in developing a DBFC anode catalyst. Herein silver was selectively dissolved from electrodeposited $\text{Ag}_x\text{Au}_{(1-x)}$ films causing the remaining gold atoms to coalesce and evolve into a porous material. This useful yet sparsely investigated form of gold has an intrinsically high step density. The onset potential for oxidation of 0.02 M NaBH_4 in 2 M NaOH at nanoporous gold at -1.05 V vs SCE was 0.20 V lower than at bulk gold. A limiting current density of 30 mA cm^{-2} at bulk gold while 60 mA cm^{-2} was recorded at NPG.

Biodegradable solvents for the pharmaceutical industry: toxicity, ecotoxicity and stereochemistry

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The search for greener, more environmentally friendly alternatives to Volatile Organic Compounds (VOC) has become an important issue in recent years. Ionic Liquids have been studied as possible replacements for these VOC's. Ionic Liquids have rapidly become an area of interest, not only to those in the academic world, but also to environmentalists and industrial disciplines alike. Ionic Liquids are non-volatile in nature; hence they have been classed as 'Green solvents'. The "green" nature of these new solvents has been questioned and as a result various toxicity, ecotoxicity and biodegradation studies have been carried out. Most ionic liquids are water soluble, and therefore may enter the environment via wastewater effluents. A number of achiral and chiral Ionic Liquids have been designed and synthesized in our laboratory. The synthesis of the achiral ILs involved a two-step process using readily available starting materials, followed by anion exchange. An extra step was employed for the preparation of the chiral ILs.

Toxicity and biodegradation studies have been carried out on the Ionic Liquids, to investigate their potential as Green Solvents. In the toxicity

screening, the ILs were tested against seven strains of bacteria. These were a range of gram negative and gram positive bacteria; *Pseudomonas aeruginosa*, *Salmonella*, *klebsiella*, *Bacillus subtilus*, *Staphylococcus aureus*, *Enterococcus*, and *Micrococcus*. An activated sludge assay was also employed to investigate the biodegradability of the ionic liquids. HPLC-MS analysis was also used to determine the possible metabolites or degradation products formed during biodegradation. The results obtained from these tests proved to be very promising and were in accordance with results previously reported.

Abstracts of Poster Presentations

Air Quality, Atmospheric Deposition and Noise

1. Secondary Organic Aerosol Formation from the Photooxidation of Naphthalene

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous air pollutants that are released into the atmosphere as a by-product of combustion processes. They can be chemically transformed in the lower troposphere via reaction with the hydroxyl radical to produce a range of oxidised organic compounds and other pollutants such as ozone and secondary organic aerosol (SOA). Epidemiological studies have established that exposure to this type of air pollution is associated with damaging effects on the respiratory and cardiovascular systems, and can lead to asthma, oxidative stress, health deterioration and even death.

In this project, a comprehensive programme of laboratory studies is being performed on the atmospheric degradation of a series of PAHs. Work to date has focussed on determining the yields of SOA formed from the gas-phase reaction of naphthalene with the hydroxyl radical. A series of experiments has been performed in a large atmospheric simulation chamber equipped with a gas chromatograph and analyzers for monitoring nitrogen oxides (NO_x) and ozone. SOA formation was measured using a scanning mobility particle sizer. The effect of NO_x concentration on SOA formation was evaluated by varying the initial naphthalene and NO_x concentrations. The results clearly show that a higher hydrocarbon to NO_x ratio produces a higher yield of SOA. The SOA mass yields were also found to increase as the relative humidity was raised from 0 to 50%. This work is the first study of the formation of SOA from naphthalene and the results will be compared to those obtained from other aromatic compounds.

2. Comparison between the levels of soot burnt using 1%Pt/10%BaO/Al₂O₃ materials and Rare Earth Oxides

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Diesel engine exhausts invariably contain large concentrations of NO_x and carbonaceous particulate matter (PM). Both are recognised pollutants. On the other hand diesel engines combust fewer hydrocarbons and thus their exhausts contain far less CO₂ than gasoline equivalents (with consequent benefits in terms of fuel economy and greenhouse gas emissions). Particulates are trapped and oxidised using O₂/NO mixtures on catalysed or un-catalysed soot filters. A primary step in the operation of a NO_x trap is the oxidation of NO to NO₂ and the subsequent formation of bulk nitrates through reaction with a NO_x adsorbent component (NAC). This suggests that the combination of these systems may be possible. Such a combination of NSR systems with PM combustion catalysts in the after-treatment system of a diesel engine exhaust would be a major advancement in the development of 4WC after-treatment systems. Understanding the mechanisms that affect catalytic activity in porous ceramic diesel particulate filters (DPF) at the temperature range 200 to 400°C is important for the successful modelling of the initiation and evolution of catalytic regeneration by use of fuel additives. This refers not

only to the dry carbon particulate, but also to the volatile hydrocarbons adsorbed on it. In this paper, a detailed analysis of the levels of soot combusted using air and NO/O₂ using thermo gravimetric analysis coupled with mass spectrometry (TGA-MS). Isothermal and non-isothermal soot combustion experiments were performed using 1%Pt/10%BaO/Al₂O₃ and direct comparisons between the levels of soot combusted using rare earth oxides were performed.

Based on the TGA data, the kinetic parameters of the soot oxidation reaction will be calculated in the future.

Climate Change

3. Using Data Blocking and Parallelism to improve Hydrological Simulation Efficiency

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Micro hydrological Simulation based on distributed model like DEM (Digital Elevation Model) requires massive computation on solving relevant hydrological equations in each iteration of time step. Straightforward sequential handling using isolated processor cannot make ends meet as DEM of studying area becomes more and more detailed in resolution. With block data decomposition and multi-threaded programming techniques, modern multi-core processors can be fully utilized to implement the parallelism so as to maximize the simulation speed and decrease processing time dramatically. This poster demonstrates a simple implementation of data blocking used in the micro hydrological model GEOTop based on DEM. Experiments show this method is feasible and effective.

4. Seasonal variation of DOC concentration and annual loss of DOC from an Atlantic blanket bog in South-western Ireland

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This study examines the seasonal variation and annual loss of dissolved organic carbon (DOC) for the calendar year 2007 from a stream draining an Atlantic blanket bog in Southwest Ireland. At 30-minute intervals, the DOC concentration was measured using an in-stream spectroanalyser and the stream height was recorded with a pressure transducer. The concentration of DOC ranged from 2.7 to 11.5 mg L⁻¹ with higher values during the summer and lower values during the winter. A simple linear regression model of DOC concentration versus air temperature of the previous day was found suggesting that temperature more than discharge was controlling the DOC concentration in the stream. The annual export of DOC for 2007 was 14.1 (± 1.5) g C m⁻². The flux of DOC calculated with the 30-minute sampling was compared with that calculated with lower sampling frequencies. We found that sampling frequency of weekly or monthly were adequate to calculate the annual flux of DOC in our study site in 2007.

5. The impact of climate change on biodiversity – adding “biology” to bioclimatic envelope models

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The European Commission’s Green paper “Adapting to Climate Change in Europe-Options for EU Action” highlights the need for early action in implementing climate change adaptation strategies. It argues that such strategies, if acted on now, will bring about clear economic benefits and minimise threats to ecosystems. Recent observations confirm that the global mean temperature has increased by 0.8 °C compared with pre-industrial times for land and oceans. Projections suggest further temperature increases in Europe between 1.0–5.5 °C by the end of the 21st century.

The COCOADAPT project (Co-ordination, Communication and Adaptation for Climate Change in Ireland: an Integrated Approach) is a multidisciplinary integrated assessment of the drivers and impacts of climate change on a variety of sectors in Ireland, towards the development of adaptations strategies at local, regional, national level.

The principal aim of this component of the COCOADAPT project is to examine the impact of climate change on protected species and habitats in Ireland. Various bioclimatic envelope models will be evaluated as to their potential to predict future species distribution changes under a variety of climate change scenarios. The lack of “biology” has been identified as a significant limitation to this modelling approach, with few models to date dealing with other factors that determine species distribution such as habitat fragmentation, the ability of a species to disperse, and the interactions between species. This project will attempt to incorporate analyses on these migration processes, helping to fine tune current models.

The outcomes of this project will provide decision support tools and guidelines in support of conservation strategies for managing biodiversity under changing climate.

Impacts on Biodiversity

6. Will biocontrol nematodes have an impact on service-providing insects on Irish clearfell sites?

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Efforts are being made to control the large pine weevil (*Hylobius abietis*) by applying entomopathogenic nematodes to tree stumps on clearfell coniferous sites. Concerns with this biological control method that are being addressed in this study include possible secondary effects on service-providing insects and the persistence and establishment of the applied nematode species. Preliminary results indicate that entomopathogenic nematodes persist on treated clearfell sites for one but not two years after application. They have not spread from treated sites in significant numbers one year after application. While field and laboratory experiments show that the nematodes are capable of infecting larvae and adults of the abundant wood decomposing longhorn beetle *Rhagium bifasciatum*, destructive sampling of decomposing logs from treated

clearfell sites indicates that the risk to these insects from applied nematodes is very low due to the targeted nature of the application.

7. Effectiveness of bumblebee pollinators of the invasive alien plant *Impatiens glandulifera* (Balsaminaceae) in Ireland

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Although many alien invasive plants are visited by native generalist insects, they can be pollen limited due to a lack of effective pollinators. In much of its invaded range, the alien *Impatiens glandulifera* is predominantly visited by bumblebees. Whilst bumblebees are known to be effective pollinators of *I. glandulifera*, it remains unclear whether their effectiveness is influenced by bumblebee foraging behaviour, bumblebee and/or flower morphology or the pollination mechanism of the alien. We investigated the effectiveness of native generalist bumblebee (*Bombus pascuorum*) pollinators of *I. glandulifera* by firstly estimating pollen deposition on stigmas and pollen removal from androecia and secondly by seed production after a single bumblebee visit. In addition, morphological characteristics of floral and bumblebee body parts were measured and multiple linear regression analyses were performed to determine which parts influence pollen deposition and removal. We found that despite depositing low pollen quantities on *I. glandulifera* stigmas, *B. pascuorum* is highly effective at pollinating the alien. This could be due to bumblebees transporting and removing large quantities of pollen, inducing maximum seed set after a single visit, high visitation frequency and lastly, the morphological match between bumblebees and flowers. The impact of bumblebees on *I. glandulifera* pollination and the implications of the pollination mechanism of the alien for its successful spread are discussed.

8. Preliminary results from a paleolimnological study of Lough Furnace (Co. Mayo)

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Using a tapper corer two sediment cores were collected from Lough Furnace, a brackish coastal lake in the Burrishoole catchment, County Mayo. Lithological analysis including wet density, dry weight and Loss On Ignition (LOI₅₅₀) have been conducted. The sediment is anoxic, dark in colour and its consistence is flocculent, with high organic matter content; in both cores LOI₅₅₀ values range between 20-30%. Diatoms are optimally preserved. The species identified are characterised by a wide salinity tolerance spectrum; freshwater diatoms coming from Lough Feagh upstream and brackish and marine species were found. In June 2008 a data logger was installed by the Marine Institute, for a period of two years. It permanently records 12m depth water column features including: temperature, salinity, specific conductivity, dissolved oxygen, pH, chlorophyll and nephelometry. Preliminary three-month data show a constant stratification due to the high salinity level that strongly limits the mixing through the water column causing oxygen absence below 3m depth.

9. The genetic relationships, phylogeny and conspecificity of Irish *Eriocaulon aquaticum* populations with those from Scotland and North America

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Eriocaulon aquaticum belongs to a group of plants whose distribution spans the Atlantic, termed the "Amphi-Atlantic Plants". Little research has been carried out on this group and even less is known about the differentiation between the American and European populations of *E. aquaticum*. While abundant on the North American continent *E. aquaticum* is found in Europe only in Western Ireland and a few locations in the Scottish Hebrides. This study tries to determine the taxonomic status of the European *E. aquaticum* populations and their phylogenetic relationships with the American populations.

Extensive sampling covering the whole distribution area has been undertaken. Morphological and anatomical characters will be studied as well as cytological and molecular properties of the sampled specimens employing flow-cytometry, sequencing of nuclear and chloroplast markers and AFLP genotyping. Should the European *E. aquaticum* gain separate taxonomic status as a result of this study, measures have to be devised in order to protect this plant and its habitat in Ireland.

10 Meiofauna of Irish East Coast Transitional Waters: Initial Environmental Parameters

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Previous ecological studies of Irish estuarine systems have mainly focussed on macrofaunal communities and neglected the meiofauna, a group of invertebrates defined by their size (63 to 1000µm) with potential applications in environmental quality assessment. We aim to develop a typology of east coast Irish transitional waters, characterising meiofaunal community composition, diversity and indicator species response to measured environmental parameters. Four type II (Boyne, Castletown, Rogerstown and Slaney estuaries) and two type VI transitional waters (Broadmeadow and North Bull Island lagoons) were sampled to test for differences between salinity zones and transitional water type. The power of analysis along the salinity gradient was maximised by sampling from twelve sites in each estuary, distributed as evenly as possible between the *a priori* chosen salinity zones, from low (>0 to 5‰), mid (5 to 25‰) and high (>25‰). Interstitial salinity ranged from 0 to 41.7‰ at 0-2cm sediment depth and from 0.2 to 36.3‰ at 18-20cm depth. Chlorophyll concentrations were determined to a sediment depth of 2cm to provide an estimate of the algal biomass, which ranged from 2.0 to 32.4µg/cm² and correlated inversely with salinity ($p < 0.05$). Taxonomic identification of the meiofauna in relation to abiotic parameters (organic nitrogen and carbon, metal contaminants, particle size) will be used to elucidate the determinants of meiofauna community structure in these sites and the impact of increased productivity with decreasing salinity. We anticipate that the typology developed from this study will provide the basis for a novel method by which to evaluate the health of Irish transitional water bodies.

11. Spatial variability in diet, condition and growth of juvenile plaice (*Pleuronectes platessa*) at sandy beach nursery grounds on the south west coast of Ireland

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Suitable habitat is crucial for settlement of juvenile flatfish and characterization of habitat quality is important for the management of nursery areas. Food availability is one important determinant of habitat quality that can affect the condition and growth, and thus survival, of flatfish.

Temporal variation in diet and trophic niche overlap between different flatfish species has been widely studied. Levels of intraspecific variation in diet at small spatial scales are relatively unknown, with most studies focusing only on large-scale variability. This study investigates how diet, growth and condition of juvenile plaice vary over small spatial scales (m's – km's). Juvenile plaice were collected from three beaches and from three replicate hauls on each beach using a beach seine. Length, weight and morphological characteristics were measured and Fulton's condition factor was calculated. Gut content analyses of 63 juvenile plaice from size class 70-90mm were carried out. Stomach fullness, total number of taxa and total number of individuals in the stomach were measured. Otolith microstructure analysis was used to assess growth rates.

Significant variability in the measured parameters was observed between beaches and between hauls within each beach. The results highlight the importance of considering small scale variation when attempting to link broad scale habitat types to feeding, growth and condition of juvenile flatfish.

12. SIMBIOSYS: Sectoral impacts on biodiversity and ecosystem services

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Biodiversity and associated ecosystem services are fundamental to humanity but are threatened by human activity in a range of sectors. The project SIMBIOSYS (*Sectoral Impacts on Biodiversity and Ecosystem Services*; www.simbiosys.ie) will quantify impacts of cultivation of bioenergy crops, road landscaping and aquaculture in Ireland on genetic, species and landscape biodiversity and the ecosystem services they provide, including pollination, biological pest control, carbon sequestration and resistance to alien species invasion.

In addition, SIMBIOSYS will test methods for mitigating impacts, carry out in-depth strategic reviews in order to inform national policy decisions, and make recommendations for future strategic research and management.

The SIMBIOSYS project, which began in April 2008, is funded by the Irish Environmental Protection Agency STRIVE programme. The project, which will run for 54 months, will involve multi-disciplinary research across three Irish research institutions working in close collaboration: Trinity College Dublin (TCD), University College Cork (UCC), and University College Dublin (UCD).

13. Biodiversity of plants and molluscs in woodland and grassland habitats in a limestone landscape – Effects of Grazing and Fragmentation

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Grazing animals are known to have significant impacts on biodiversity. It is often unclear however, whether these impacts are positive or negative. Fenced exclosures have been used in Killarney to confirm that oakwood biodiversity may be threatened by either high grazing levels or the absence of grazing. It is difficult to make general statements based on isolated studies due to the amount of variability possible – not least in relation to number and species of grazer. It is agreed, however, that there is a lack of experimental data on the effects of grazing on Irish woodlands/scrub on base-rich soils, and on species-rich grassland.

The Burren is famous as one of the most botanically interesting and biodiverse areas in Ireland. Although the Burren covers only 1% of the surface area of Ireland, it contains more than 75% of its plant species. And it is in the Burren that many of Ireland's rarest and most fascinating mixtures of plants can be found. With regard to the molluscan fauna, about 70 of the 100 Irish land snail species occur within the study region.

This project aims to investigate experimentally the impact of grazing on biodiversity in woodland, grassland and scrub in the Burren area. This will be done through a network of permanent plots and fenced exclosures. These have been erected at 12 sites and the study will monitor responses among the communities of vascular plants and molluscs. Additional work will investigate the dynamics of some rare/specialised woodland plants within the landscape in order to elucidate the effects of fragmentation.

Soils and Land-Use

14. Beneficial Reuse Technologies for Dredged Material in Ireland

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Ireland generates approximately 1.2 million wet tonnes of dredge material annually from maintenance projects and capital dredging amounts vary to over 2 million wet tonnes/year. A study of dredging in Ireland by Harrington et al. (2004) identified the limited practice of beneficially reusing dredge material, primarily for the fine-grained fraction.

This paper presents current work investigating the potential implementation of proposed new dredge material recovery and reuse technologies in Ireland. Maintenance and capital dredge material volumes generated in Ireland over the next decade are estimated and quantified. A survey of dredging projects in Ireland has been completed and survey results are presented including physical characteristics of the dredge material, dredging equipment utilised and the method of dredge material disposal or reuse.

Three dredging sites (Bantry Harbour, Fenit Harbour and Waterford Port) where either maintenance dredging is undertaken or capital dredging is planned were chosen and for each an appropriate potential beneficial reuse of dredge material is proposed. Bantry Harbour's beneficial reuse proposes land improvement post treatment as the material is

contaminated; Fenit Harbour's proposes coastal protection using geotubes while the proposal for Waterford Port involves a manufactured topsoil production facility combining dredged material and household organic waste. At each site, a sediment sampling and testing programme has been undertaken and technical, environmental and economic analyses for the proposed beneficial end uses are ongoing. The critical parameters required to ensure the successful application of each of the selected beneficial reuses is being established.

15. Sustainable food systems: An evaluation of the potato supply chain in Ireland using life cycle assessment

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In this International Year of the Potato (UNFAO, 2008), the "humble potato" is being touted as a "super crop", with the potential to "feed the world" (New Scientist, 2008). However there are significant hurdles to be overcome if this food system is to become sustainable and fulfil its potential. This research focuses on the potato sector in Ireland using a Life Cycle approach (i.e. considering the entire cradle-to-grave 'life-cycle' of a product), combined with an ecological assessment of the soil and macrofauna in order to examine its extended environmental effects. Working in-depth with potato farmers and distributors this research seeks to identify measures to increase the environmental performance, and potentially reshape the current system towards a more sustainable future.

Socio-Economic Considerations

16. An objective measure of value of biodiversity for sustainable management and planning

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For sustainable development to succeed an objective measure of value of biodiversity must be incorporated into decision-making. Conventional economic approaches fail to reflect the importance of biodiversity in supporting sustainability. Lack of clarity on definition of biodiversity and how it can be measured give rise to further problems. Therefore, in the scope of this research, an objective measure of value of biodiversity will be constructed by (1) operationalising the concept of biodiversity within a larger framework of concepts; (2) finding patterns between measures of biodiversity; (3) proposing a new fundamental meaning of biodiversity. A thorough meta-search of the literature on biodiversity measures will be conducted. A relational database of biodiversity measures and relationships among them will be compiled and statistically analysed. A link with economic value of biodiversity will be established. This research will make a useful contribution into the literature of biodiversity by increasing understanding of what biodiversity is. The constructed scientific measure of biodiversity value will serve as an alternative to economic value of biodiversity.

Environment & Health

17. A risk assessment methodology for evaluating exposure and human health risks from nanoparticles through environmental pathways

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The recent commercial interest in nanomaterials has resulted in the potential release of large quantities of these nanomaterials into waste treatment systems and the environment. Their scale and subsequent reactivity may result in unique environmental transport properties and enhanced bioavailability, and so exposure and human health hazard research is required. An exposure scoping-model is presented here in which nano-functionalised product/process characteristics are considered on a quantitative basis to determine release to different environmental compartments. Material characteristics are considered in a qualitative basis to describe a range of nanomaterial behaviours and mechanisms in the environment. These release and behaviour factors are then combined and converted to a relative qualitative scale to compare human exposure scenarios that may arise.

The area of nanomaterial human health risk assessment is currently unclear on the best exposure metric by which to measure and ultimately regulate nanomaterials. Surface area has often been suggested as the principal influence on potential nanomaterial reactivity and a surface area based metric, possibly in tandem with number concentration and mass measurements, may be more relevant in determining true reactive potential. The reactive scoping model presented here takes nanomaterial characteristics (primary particle size, aggregate size, surface area, density) and converts potential nanomaterial exposure scenarios to mass, number concentration and surface area bases. This complement of exposure metrics are then compared to current nanotoxicological studies and standard regulatory limits (EPA, OSHA, NIOSH, etc.) converted to mass, number concentration and surface area bases to allow an initial estimate of human health risk posed by commercially available and nano-processes and products in development.

18. Investigation of *Cryptosporidium parvum* and other human-virulent pathogens during secondary sewage treatment processes in County Sligo

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Contamination of public water supplies by human sewage has been implicated in many cryptosporidiosis outbreaks. The aims of the study were to: (1) investigate the pathogen load, i.e. *Cryptosporidium parvum*, *C. hominis* (oocysts), *Giardia lamblia* (cysts), human-virulent microsporidia (spores), i.e. *Enterocytozoon bieneusi*, *Encephalitozoon hellem*, *E. cuniculi*, and *E. intestinalis*; (2) assess microbial indicators; (3) evaluate the treatment efficiency in four Sligo Sewage Treatment Plants (A-D).

Samples from four stages of the STPs (influent, secondary, effluent and sludge cake) were collected and centrifuged. Aliquots of the resulting pellets were stained with immunofluorescent antibodies (oocysts and cysts) and the 18S rRNA was hybridised with species-specific

fluorochrome-labelled probes (oocysts, cysts and spores). *E. coli*, *Enterococci* and *Clostridium perfringens* were cultured on selective agar.

Protozoan pathogens loads were highest at Plant A, followed by Plants B, C and D. Plant D sludge had the highest (residual) viable (oo)cysts. Plant D was positive for all microsporidian species in raw sewage and contained the highest load. *E. hellem* and *E. intestinalis* were 100% detected in all plants; however, *E. bienersi* was present in the highest quantity. 2~3-log of *E. coli* and *Cl. perfringens* were reduced by treatment processes. *Enterococci* were 100% removed in all effluents but was detected in resulting sludge cakes of Plants A and D.

This on-going research study shows the presence of pathogens during sewage treatment and in corresponding end-products, i.e. sewage sludge and final effluent, posing risks to public health via environmental contamination of soils and receiving waters utilised for drinking water and recreational purposes.

19. Identity, Sources, and Health Effects of Oxygenated Organic Compounds in Atmospheric Particles

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Particulate Matter (PM) is ubiquitous in the troposphere and has effects on visibility, climate, and human health. PM is composed of inorganic salts, mineral dusts, organic compounds, and elemental carbon. Up to 70% of the mass of PM_{2.5} consists of organic compounds such as alkanes, polycyclic aromatic hydrocarbons and a range of oxygenated species, including aldehydes and carboxylic acids. The oxygenated organic compounds are particularly important because they can form part of the secondary organic aerosol (SOA) formed from the oxidation of gas-phase organics in the atmosphere. However, these compounds can be difficult to analyse directly by techniques such as gas chromatography-mass spectroscopy (GC-MS) due to their polar nature and derivatisation techniques are often used prior to analysis.

This project involves the determination of oxygenated organic compounds in atmospheric particles and investigations of the associated health effects. In the first year of this project a sampling campaign was performed at Tivoli Docks in Cork, where PM_{2.5} was collected and analysed using GC-MS. Chemical derivatisation using N-Methyl-N-(trimethylsilyl)trifluoroacetamide (MSTFA) was employed to identify carboxylic acids and sugars such as levoglucosan; a marker for wood burning. Also, an acetylation derivatisation technique is being tested for quantification of quinones which are of toxicological interest due to their ability to produce oxidative stress in cells. Future work includes in-vitro toxicological tests to confirm the toxicity of quinones.

20. Development of a biosorption column utilising seaweed based biosorbents for the removal of metals from industrial waste streams

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The use of seaweeds as biosorbents has its advantages over conventional chemical and biological treatment of industrial effluents due to their

widespread distribution and their ability to accumulate heavy metals in both living and non-living form.

Three different species of non-living seaweeds (*Fucus vesiculosus*, *Polysiphonia lanosa* and *Ulva lactuca*) and a seaweed waste product derived from *Ascophyllum nodosum* (referred to as WAP) were studied for the biosorption of single and combined heavy metals (Ni^{2+} , Zn^{2+} , Al^{3+} and Sb^{3+}) in a 10 mg/l aqueous solution. Removal efficiencies of 96%, 93% and 68% were achieved for Zn^{2+} , Ni^{2+} and Al^{3+} respectively using WAP. An antagonistic effect was observed when Sb^{3+} was mixed with the other metals resulting in a significant reduction in uptake of the above metals by WAP. However, 91% of Sb^{3+} alone and in combined metal solutions was removed by non-living biomass of *P. lanosa*. WAP immobilized in agar was used to investigate the sorption of Zn^{2+} , Ni^{2+} , Al^{3+} and Sb^{3+} using a laboratory scale fixed-bed sorption column fed with a metal solution containing single and combined heavy metals at a concentration of 10 mg/l. Both short and long term studies were investigated. Sorption isotherm studies as well as an investigation of the antagonistic effect of Sb^{3+} on the sorption of the other metals were also carried out. On-going research includes the testing of a scaled-up model of a fixed-bed sorption column to treat industrial pollutants.

21. Development of a pathogen transport model in an Irish catchment using ArcSWAT

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Catchment-scale evaluation of factors influencing pathogen concentrations in water can represent an effective means of providing clean drinking water and protecting source water. SWAT (Soil and Water Assessment Tool) represents a dynamic modelling system that can be applied to any water catchment and is used to quantify the impact of land management practices on a continuous time basis. The objective of this study was to develop a risk model, using SWAT and ArcGIS (ArcSWAT), capable of simulating criteria affecting water quality and predicting pathogen loads in Irish catchments. The study area is based on the river Fergus catchment, located in the west of Ireland. Observed data (meteorological, hydrometric and bacterial) over a 4-year period (2003 – 2006) was used for model calibration and validation. Using data gathered on agricultural practice, demographic information and hydrological parameters, the model was run to predict concentrations of *Escherichia coli* and faecal coliforms. Hydrometric validation results display a good correlation between observed and predicted data, and indicate satisfactory simulation of hydrologic processes within the catchment. To date, pathogen predictions have proved variable between observed and simulated figures. However, these results can be used to highlight high risk periods and regions, enable risk reduction strategies to be selected/tested and help ensure safe drinking water by predicting potential human exposure to pathogens. The developed model provides a tool capable of protecting water sources and human health from waterborne pathogens.

22. Homolytic Aromatic Substitutions of Benzimidazol-2-yl Radicals by Photochemical Methodology

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The following presentation describes light-initiated homolytic aromatic substitutions of benzimidazol-2-yl radicals. These cyclisations are more efficient in terms of yield than literature Bu₃SnH/AIBN mediated reactions. Our methodology avoids the use of toxic and hazardous radical initiators (and associated waste disposal problems), and gives less incidence of competitive radical reduction than the Bu₃SnH-mediated reaction.

Previous work by our group has focused on the generation of imidazol-2-yl radicals using UV-light and their subsequent cyclisation onto aromatics. We now expand the credentials of this methodology by applying these annulations towards the synthesis of new [1,2-a] alicyclic ring fused benzimidazolequinone anti-tumour agents containing additional fused aryl rings. Benzimidazolequinones containing [1,2-a] fused alicyclic rings have been shown to have cytotoxicity in the nanomolar (10⁻⁹ M) range with increased potency towards hypoxic (deoxygenated) regions of solid tumours. Selectivity towards the latter is determined by the ease of single electron reduction by enzymes such as cytochrome P-450 reductase. The increased conjugation of the diazoles presented may further facilitate reductive activation, thus increasing selectivity towards hypoxia.

Water Quality and the Aquatic Environment

23. A Study of Irish Groundwater Fauna

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Groundwater habitats harbor a diversified fauna of crustaceans. Between 2008 and 2011 the very first large scale study of Ireland's groundwater biota will be conducted under the EPA-STRIVE program (2007-W-MS-1-S1) at University of Ulster. Following up on a pilot-study 2006, we aim to provide a definitive baseline data on the biogeography of Irish subterranean crustacean fauna and on its response to selected environmental parameters. Furthermore we aim to gather evidence on whether the Irish endemic amphipod *Niphargus kochianus irlandicus* did survive the last ice-age in Ireland or whether it arrived here by post-glacial migration.

The sampling effort of the current project is focused on aquatic subterranean sites which are representative of key geological formations and aquifer types in Ireland. In addition to the crustacean fauna basic environmental parameters of water chemistry and sediment composition are also recorded. These parameters will be combined with other available geological and hydrological data to reveal distribution patterns in subterranean fauna.

The results are expected to reveal characteristic features of aquatic subterranean biodiversity in Ireland, including information on temporal and spatial pattern in selected individual aquifers. Moreover we also hope to gain a first insight into the history of Ireland's groundwater fauna.

24. An Investigation into the Mechanisms of Bioaccumulation of Chromium by seaweed

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Heavy metals in industrial effluents are of particular concern because of their ability to bioaccumulate in the food chain, making it possible for toxic levels to reach higher animals and plants. Chromium is widely used in processes such as leather tanning, electroplating, pigmentation and in corrosion inhibitors. Trivalent and hexavalent are the most common species used in industry, hexavalent being the most toxic.

The accumulation of Cr by six species of seaweeds, common to the south-east of Ireland, was investigated in order to identify seaweeds with a high capacity for bioaccumulation and investigate mechanisms of bioaccumulation. Potentiometric and conductimetric titrations allowed the number and type of acidic groups on the seaweed surface to be calculated, facilitating the identification of the most promising seaweeds for further study. FTIR spectroscopy of protonated and metal bound forms was used to identify the key functional groups present on the seaweed surface and their relative importance in metal binding. Preliminary studies using scanning force microscopy were carried out with significant surface morphology changes on metal binding identified.

25. Legal Issues Relating to the Gathering of Environmental Data in the Case of Water Quality

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26. Inactivation of problematic organisms including *Cryptosporidium* in Irish Water with Pulsed UV Light

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The protozoan parasite *Cryptosporidium* has emerged as one of the most frequent causes of waterborne infectious disease. The environmentally robust oocysts are very persistent in water and are extremely resistant to the disinfectants commonly used in drinking water treatment processes such as chlorination. These characteristics, together with the low numbers of oocysts required for infection make this organism one of the most critical pathogens for the production of safe drinking water. Ultraviolet (UV) disinfection has become a viable option for water and wastewater disinfection. Before 1990 most UV treatment installations consisted of monochromatic low pressure UV that produced minimal or no disinfection by-products (DBP's), but did not effectively inactivate protozoans such as *Cryptosporidium*. This study focuses on the sterilisation of *Cryptosporidium parvum* and includes waterborne and food related microbial pathogens *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa* and the yeast *Saccharomyces cerevisiae* using a novel pulsed UV approach. Pulsed light is a non-thermal method of sterilisation that is produced by storing electrical energy in a capacitor and releasing it in extremely short high intensity pulses of duration of 1 μ s. Treatment of *C. parvum* oocysts with chlorine (4 ppm, 10 ppm, 20 ppm and 2000 ppm) had no effect of viability as determined by vital staining. However, following exposure to pulsed UV light at 700 volts (9.8 J) complete inactivation of

the parasite was achieved and no infection was seen *in vitro*. Significant levels of inactivation occurred following exposure to a range of UV pulses, with each increase in energy input an increase in the rate of inactivation occurred. It was found that the yeast *S. cerevisiae* was the least UV sensitive organism, while *B. cereus* and *P. aeruginosa* showed similar levels of susceptibility to UV inactivation. Continuous wave UV studies also gave significant levels of microbial inactivation however, compared to continuous wave UV, PUV is a quicker and more energy efficient disinfection method as it requires less energy input for maximal microbial inactivation and disinfection can be achieved in a matter of seconds.

27. Limno- and palaeo-ecological responses to lake water dissolved organic carbon (DOC)

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In Ireland it has been estimated that peats soils cover 16.8% of the land area. Surface waters draining peat catchments often have a characteristic brown colour due to the presence of humic substances and dissolved organic carbon (DOC) compounds. During the last 15-20 years increasing DOC in surface waters have been documented for several areas in Northern Europe and North America. This increase will potentially have an effect on run off chemistry, aquatic ecology and problems during drinking water purification. This project aims to investigate the present ecological response in bacterio- and phytoplankton communities in the water column and the recent palaeoecology. Two lakes will be examined, Lough Feeagh, Co. Mayo and Lough Guitane, Co. Kerry. Furthermore, the project aims to evaluate the potential roles of land use change, declines in acid deposition, climate change and help inform predictions of future state.

28. Development of novel photocatalytic adsorbents for organics removal from water and wastewater

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The purpose of this work is to develop new integrated photocatalytic adsorbents (IPAs) for the removal and photodegradation of priority organic pollutants in water and wastewater. These are to be based on the adsorption potential of activated carbons in combination with the photocatalytic properties of titanium dioxide (TiO₂). By combining the properties of these two materials together it is possible to significantly enhance the photocatalytic degradation of hazardous organics in water. Thus it is possible to create activated carbon filters that adsorb but also degrade hazardous organics in the presence of UV light. Analytical methods, including Solid Phase Extraction (SPE) followed by liquid chromatography-mass spectrometry (LC-MS) methods developed at DCU will be employed. Additional testing will be carried out to determine the microstructure and the associated physical properties of the IPAs.

29. Autecology of Irish groundwater fauna: Salinity tolerance of *Niphargus kochianus irlandicus*

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Groundwater fauna are an important but under-studied group of animals. As part of a new EPA-funded STRIVE study on the distribution, structure and functioning of subterranean fauna in Ireland, the current research examined the effects of salinity on the key groundwater species *Niphargus kochianus irlandicus*. Increases in salinity commonly arise due to saltwater intrusion in coastal limestone aquifers used for potable water abstraction. The effects of salinity on animals were studied using laboratory bioassays ranging from 0 p.s.u. (control) to 4 p.s.u. (slightly brackish) over a 2-week period. Specimens of *N. kochianus irlandicus* used in the bioassays were retrieved from a groundwater spring source in Corrandulla, Co. Galway. Data from the bioassays indicated that *N. kochianus irlandicus* was highly tolerant of mildly saline water (>90% survival at 3 p.s.u.). Decreased survival (62%) and non-lethal detrimental effects such as impaired movement, as measured using motion analysis software, occurred at 4 p.s.u. Present findings emphasise the vulnerability of highly endemic populations of groundwater fauna to habitat degradation and contamination arising from anthropogenic activities.

30. Factors affecting methods of analysis for priority pollutants

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Dublin City University

The Water Framework Directive (WFD) is a EU Directive, which commits all EU Member States to ensure all water bodies, inclusive of marine waters up to a kilometre from shore, are of good status by 2015. Since 2003, national regulations implementing the Directive have been put in place. There are currently 41 pollutants that are listed as priority pollutants and there are many more hazardous substances. We will present the work done to date on method development for determination of priority pollutants using Solid Phase Extraction, HPLC and GC, focussing in this case on pesticides.

The usual aim of chromatography is the separation of compounds within an acceptable time limit. When the mixture of compounds has greater than 15 – 20 analytes, the separation using HPLC becomes more difficult and a gradient method is usually required. While using GC or HPLC different variables are used to optimise the separation of the compounds. Some conditions to be optimised include flow-rate, temperature programme, volume of injection and split ratio (GC) wavelength, gradient/isocratic flow, and mobile phase (the latter three dealing mainly with HPLC).

A factor that has an impact on the extraction and analysis of the relevant analytes, is Log Kow values. Solvents must be adapted to encompass all of the compounds, taking into account their physical chemical characteristics. Log Kow became one of the major issues looked at while doing SPE method development for the pesticide group.

Waste & Resource Management & Chemicals

31. Spent mushroom compost (SMC) management and options for use

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Dundalk Institute of Technology

Despite the fact that an estimated 300,000 tonnes is produced annually in Ireland, legislations and best management practice guidelines are not regulated or imposed and, if not controlled appropriately, SMC can cause considerable environmental pollution. This research is focusing on various aspects of spent mushroom compost management, including the development of a 'Best Management Practice' manual for mushroom growers in order to promote effective disposal strategies and to impart ownership of SMC management on the relevant mushroom growers, farmers and authorities. These plans take into account the volume of SMC produced in various areas, the proximity of mushroom farms to other agricultural outlets, local weather patterns, and variability in soil type and nutrient content. Additionally, various outlet options for SMC are being considered, including the establishment of in-house constructed wetlands using SMC as a substrate for the treatment of acid mine drainage from mine shafts in the Avoca mining region.

32. Biomass to biofuel: Generation of cellulose-based biomass degrading strains of brewery yeasts

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As the world enters the post-fossil fuels era, there is now the need for environmentally sustainable energy sources. One such potential energy source is the use of biofuels derived from biomass or known more specifically as lignocellulose. Cellulose, the main component of lignocellulose, is made up of thousands of repeating units of the disaccharide cellobiose. Consequently, cellulose represents a major reservoir of sugar that could be potentially converted to alcohol and used as a fuel source. The most characterised microorganism known to ferment simple sugars to ethanol is the yeast *Saccharomyces cerevisiae*, however *S. cerevisiae* does not possess the enzymes needed to degrade cellulose. These enzymes are known as cellulases. There are three major types of cellulases: endoglucanases (EG), cellobiohydrolases (CBH) and β -glucosidases (BGL). The filamentous fungus *Trichoderma reesei* is known to have five EG genes, at least two CBH genes and two BGL genes.

The overall aim of this project is to introduce and express a cellulolytic gene from each of the three major classes of cellulases from *T. reesei* into a number of stress-tolerant *S. pastorianus* strains, that are known for their high fermentative capacity. Using RNA extracted from *T. reesei*, cDNA clones of the *eg1* and *cbh2* have been generated and transformed into a lab strain of *S. cerevisiae*, S150 via a series of galactose-inducible expression vectors known as pGREG vectors. Studies indicate that the EG1 is being expressed and secreted by the transformed yeast. Experiments are on going to synthesize *bgl1* from cDNA. An assay to determine if CBH2 is being produce is also being developed.

Environmental Technologies

33. Smart Heating System for Green Homes

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Cork Institute of Technology

The residential sector consumes approximately 20% of Ireland's total energy consumption. In a typical home, space heating accounts for approximately 50% of the energy used. While new developments are 'greener' through the construction materials and heating control technology (zoned heating) utilised, older residences remain inefficient. The purpose of the study was to investigate if the heating system in an older residence could be easily retrofitted using wireless sensors and significant savings achieved through intelligent heating control. The poster describes how a Wireless Sensor Network (WSN) was researched, designed, developed, and deployed to a suitable residential house, which is divided into two heating zones. The modelling section outlines how the data acquired via the WSN was used to develop a model (using MATLAB's System Identification toolbox) that characterises the heating properties of the house which will soon be used for control purposes. The individual zone models and disturbance model validations are presented. The results portray the accuracy of the simulated versus measured responses for the heating dynamics of the system. However it is seen that the cooling dynamics are not accurately tracked and further work needs to be carried out in this area. These results are used to answer some research questions posed prior to work commencement.

34. The development of chemically engineered nano-porous adsorbents for phosphate removal from waste water streams

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University College Cork

Phosphorus is an important element that is widely used in agriculture as a fertilizer and in industry as a detergent. However, phosphorus poses many problems when it is released into the aquatic environment resulting in eutrophication which causes a depletion of oxygen. This is a major problem in the aquatic environment which can lead to fish kills and the degradation of habitat with loss of plant and animal species. The EPA has identified eutrophication as the greatest threat to Irish waters as a result of excess phosphorus input. Ordered mesoporous silica has proven to be a good adsorbent, due to their high specific surface area, controlled pore diameters and controlled morphology, e.g. spheres, rods and disks. Generally unmodified mesoporous silicas show little or no phosphate adsorption capacities. However, mesoporous silicas doped with metals have been shown to be promising candidates for phosphate adsorption. In this study Iron and Titanium doped mesoporous silica (SiO_2) was successfully used to remove phosphates from water. Mesoporous SiO_2 doped with Ti, Fe show fast adsorption kinetics while also displaying high adsorption capacities of up to 100%. This method has many advantages, as it is a highly efficient, robust material, which is also non-toxic and environmentally friendly.

35. Exploitation of Sugar Kinases in Green Chemistry

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Queen's University Belfast

In a perfect world chemical processes would be environmentally friendly and there would be no industrial waste. Resources would be cheap and no hazardous chemicals would be used. This project works toward that goal by focusing on the design of two enzymes for biotechnical use.

The interests of this study are the human enzymes galactokinase and N-acetylgalactoseamine kinase. While it is known that galactokinase is the second enzyme of the Leloir pathway and a lack or decrease of this enzyme's activity leads to the disease galactosaemia, the work on N-acetylgalactoseamine kinase is still in its infancy.

The aims are to make the human enzymes galactokinase and N-acetylgalactoseamine kinase more promiscuous by site-specific mutagenesis, and also to investigate if the phosphorylation process would be feasible in industrial processes.

36. adh2 from Halobacterium sp NRC-1: cloning and over-expression in Haloferax volcanii

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University College Dublin

One of the major achievements in the development of green chemistry is finding cleaner and cheaper catalysts which will minimise waste and reaction times. The main goal of our group is to implement the use of enzymes as biocatalysts. To overcome some of the enzymes drawbacks such as stability in organic solvents and versatility, we have focussed our effort on Halophilic archaea organisms which as source of enzymes with unique biophysical characteristics. Halophilic proteins are more resistant to organic solvents with respect to their mesophilic counterpart.

Alcohol dehydrogenase (ADH) from Halobacterium sp NRC-1 is the class of enzymes investigate in this project. The over-expression of halophilic proteins is generally achieved by using E. coli. The expression system is well known and optimised to deliver high levels of protein. Two enzymes were over-expressed using a pET system, aryl alcohol dehydrogenase (aad) and alcohol dehydrogenase 4 (adh4), from Halobacterium sp. NRC-1. However, this method was inadequate to over-express a third ADH, alcohol dehydrogenase 2 (adh2). To express adh2 we used an halophilic shuttle vector, pRV-1, develop by A. Large et al. The vector was introduced into Haloferax volcanii DS70, the over-expression of the gene is under a tryptophan promoter. Here we present our most recent results.

37. A functional Metagenomics approach to the identification of cyanide/nitrile metabolizing enzymes

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Waterford Institute of Technology

Metal cyanide complexes are of environmental concern because they release cyanide upon dissociation, an extremely toxic substance. Metal remediation by physicochemical techniques is expensive and requires tremendous labour but also uses a large amount of fuel or energy. Microbial degradation is a spontaneous process and in course of time the

natural micro-flora is stimulated to degrade the cyanides in the toxic conditions.

The samples have been enriched in minimal media containing glucose and cyanides and incubated both aerobically and anaerobically under varied conditions and pure isolates have been isolated. Currently the isolates are being screened for 16S rDNA sequencing for their individual selection. The degradation activity has been plotted with respect to the growth and the OD of the cultures.

The Metagenomic approach is advantageous over other molecular techniques, as it would involve the incorporation of small DNA fragment in a suitable vector and expression to get the desired clones. Total soil DNA has been extracted and subjected to restriction digestion. This would be followed by the construction of metagenomic library which would be made from the soil DNA which by digestion would be cloned into λ ZAP II vector and the recovery of phagemids for functional selection. The gene libraries will be screened using plaque hybridization with a range of probes to genes known to be involved in nitrile/cyanide metabolism. This will allow the identification of the protein coding capacity of the cloned regions and identification of potential novel nitrile/cyanide metabolizing enzymes.

38. Investigation of polyhydroxyalkanoates (PHAs) synthesis by an activated sludge from a dairy processing plant

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Polyhydroxyalkanoates (PHA) are biodegradable polymers of 3-hydroxyalkanoate that accumulate intracellularly in various microorganisms when an essential nutrient such as nitrogen or phosphorous is limited in the presence of an excess carbon source. The production of these 'bioplastics' has received significant, global research interest as they offer a potential replacement polymer for environmentally recalcitrant petrochemical plastics. Attempts at commercial microbial production of PHA have focused on pure culture approaches, but high fermentation and downstream processing costs have resulted in poor market competitiveness to date. One potential, low cost alternative is the use of mixed culture systems, such as activated sludge, which do not require bioreactor construction or maintenance of sterile conditions, combined with nutrient rich industrial waste waters as a source of cheap carbon substrates. The current project seeks to investigate the potential for PHA accumulation by an activated sludge microbial consortium utilising a high COD and inorganic nutrient waste water stream from an Irish dairy processing facility. Work to date has focused on the optimisation of a sequencing batch reactor (SBR) system to promote PHA accumulation using aerobic and anaerobic cycling conditions. Molecular analyses are also ongoing in an effort to characterise the underlying microbial ecology of this biotechnological application.

39. Survey Research Methodologies for the Development of a Quality Management System for Urban Wastewater Treatment Plants in Ireland

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Limerick Institute of Technology

This poster will discuss the survey research methodologies used for the development of a quality management system for urban wastewater treatment plants in Ireland.

This research is in response to legislative requirements such as the Water Framework Directive and the European Pollutant Release and Transfer Register. In order to achieve compliance with this new legislation a more stringent approach to monitoring and reporting is required. This project aims to help manage and control liquid waste generation in Ireland by reducing the effects of pollution and emissions through legislation, monitoring, analysis, compliance, reporting and education.

The survey research will investigate sources of liquid waste, pressures on Wastewater Treatment Plants and stakeholder attitudes and opinions. It will also investigate current monitoring and compliance as well as areas of possible improvement in wastewater treatment plants. The survey research will be carried out through oral interviews and written questionnaires in the participating catchment areas. The catchment areas are Charleville, Dublin and Limerick. The three sample groups include the Public, Industry and Wastewater treatment plant personnel.

The results of the surveys will be used in the design phase of the development of a water quality management system for Urban Wastewater treatment plants in Ireland.

It is hoped that this data management system will lead to improvements in waste management planning and data reporting.

40. The study of *Steinernema feltiae* and the effects heavy metals have on its insecticidal ability

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Institute of Technology Carlow

Nematodes are useful bioindicator organisms for environmental monitoring. The overall aim of this project is to study the effects of long-term lead, cadmium and zinc exposure on entomopathogenic nematode populations in the Silvermines area, and to evaluate the entomopathogenic nematode (EPN) *Steinernema feltiae* as a bioindicator organism. This will be achieved by developing laboratory bioassays and genomic analyses of *S. feltiae*.

Mining sites that have not been remediated have caused serious environmental pollution. The village of Silvermines, Co. Tipperary, Ireland, has a long association with mining, principally producing lead and zinc. The last mine, Magcobar, closed in 1993. The discovery of a giant vug lined with various crystals in the zinc-lead mine of Mogul in 1978 has led to elevated cadmium, lead and zinc concentrations in soils in the vicinity. This resulted in the deaths of livestock from lead poisoning in 1999. Currently, there is no specific legislation in Ireland dealing with the remediation of abandoned mine sites.

This presentation will highlight the results of bioassays in which *S. feltiae* infective juveniles are exposed in soils to heavy metals and allowed to infect the host insects, *Galleria mellonella*. The heavy metals consisted of cadmium, lead and zinc at varying concentrations. The pathogenicity of *S.*

feltiae is expressed through the mortality of the test host insect after infection. The insecticidal ability of *S. feltiae* was determined, and nematode progeny numbers were assessed. These parameters were used to determine the effects of heavy metals on *S. feltiae* in soils as part of the on-going investigation of nematode species as useful indicators for the assessment of heavy metal pollution in the environment.

41. Recombinant DNA approaches to enhance the degradation of the toxic pollutant styrene in the bioreactor isolate *Pseudomonas putida* CA-3

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Pseudomonas putida CA-3 is a bioreactor isolate capable of degrading the toxic pollutant styrene. In addition, under appropriate growth conditions, this strain also has the ability to redirect styrene catabolism to the production of poly-hydroxyalkanoates, a potential source of biodegradable plastics. Here we seek to enhance the ability of *P. putida* CA-3 to degrade styrene by applying recombinant DNA approaches to increase the flux of styrene through the pathway and eliminate potential bottlenecks. The *styABCDE* operon encodes the genes necessary for the conversion of styrene to phenylacetic acid and analysis of the promoter region has identified the presence of three separate transcriptional regulator binding sites which, under different growth conditions, are involved in the transcriptional activation or repression of the *sty* operon. One site located downstream from the transcription start site of the *sty* operon is the target of negative regulatory influences, including catabolite repression. Site-directed mutagenesis has been used to disrupt this inhibitory binding site and the effect of these base pair changes on the transcription of the catabolic genes and on overall styrene degradation is currently being examined under mixed substrate growth conditions. In addition we have previously demonstrated the role of a *styE* gene encoded active transport protein in styrene uptake and increased transcriptional activation of the *sty* operon. We are currently investigating the effects of random mini-Tn5 transposon based chromosomal introduction of a *pstyA-styE* construct on pathway activity in the presence of styrene. Finally, the effects of increased *styABCD* gene copy numbers will also be examined.

42. Scanned Probe Methods for the Characterisation of Organic Photovoltaic Materials

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We report on recent progress in the development of organic photovoltaic devices based on a polymer blend of MEH-PPV and PCBM. The long-term aims of this work are to develop efficient biodegradable polymer photovoltaic cells that also have the benefit of having flexible substrates. To meet these requirements we have examined the potential for developing flexible transparent anodes based on nanonet technologies. Methods currently under development in our laboratory for the fabrication and characterisation of these types of devices will be discussed. Of primary importance to our work is the ability to locally characterise the device performance at the nanoscale and to develop generalised performance models for our devices. Scanned probe methods are

employed within our laboratory to characterise the device at different stages of manufacture. We will outline the potential of these methods for the elucidation of device characteristics.

43. Investigation of the use of enzymes to reduce the environmental impact of cleaning-in-place (CIP) in dairy processing

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Effective cleaning of process equipment coming in direct contact with a product is essential for efficient plant operation and for the production of safe, quality dairy products. Such cleaning is generally achieved using alkaline detergents and acid and is an energy and water demanding process. Enzymes have been exploited for cleaning in various other sectors, most notably the laundry and automatic dishwasher detergents sectors, and benefits include reduced usage of chemicals, energy and water and reduced generation of waste. With the exception of ultrafiltration membranes, little attention has been given to the widespread application of enzymes for CIP in dairy processing, which could potentially reduce the environmental impact of cleaning. In the present study, 8 commercial proteases were assessed in terms of their suitability for this purpose. pH and temperature profiles were generated for each enzyme using a gel produced by thermal denaturation of whey protein isolate as substrate. Optimum activity was generally observed at pH 10-11 and at 60-70°C. Cleaning studies were performed at 40, 50 and 60°C, in which the enzymes were individually incubated at optimum pH for 1 hour with stainless steel panels experimentally fouled with milk. For 7 of the enzymes tested, visibly clean surfaces were observed after cleaning. When these panels were subsequently cleaned with 1% NaOH to remove any residual fouling, less than 1% of the original COD and protein associated with the fouled panels before cleaning was detected in the cleaning solution. These results indicate that some of the proteases tested may be of potential use for CIP in dairy processing. More detailed investigation of their cleaning efficiency is ongoing.

44. Detection and quantification of phosphorothioate oligonucleotide degradation by selective physicochemical means

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Several antisense drugs (chemically modified RNA and DNA which down regulate the expression of specific disease related genes) have or will shortly gain approval for medical use. Phosphorothioate oligonucleotides, in which one of the non-bridging oxygens of the internucleotide phosphodiester linkage is replaced by sulphur (Agrawal and Iyer, 1995), are one of the earliest and still most extensively used (Ito *et al.* 2003) and commercially available backbone modifications of antisense oligonucleotides (Golden *et al.* 2002; De Mesmaeker *et al.* 1995). Phosphorothioate oligonucleotides display increased chemical stability, (Crooke, 2001), and also by design display increased stability to nucleases. Their unique manufacturing routes and bioactivity raises unique, unaddressed environmental issues. This project seeks to establish

the environmental impacts associated with the production lifecycle of an antisense drug and to develop technical methodologies to evaluate and treat specific manufacturing waste streams rendering them free of active antisense product.

Work to date has focused upon developing and adapting appropriate analytical methodologies to detect and quantify antisense molecules and their degradation products. Physical (temperature), chemical (acidic pHs, I_2 and $AgNO_3$) and enzymatic methods of degrading phosphorothioate oligonucleotides have been identified and are currently being investigated both qualitatively and quantitatively using Polyacrylamide Gel Electrophoresis (PAGE) and Ion-Pair Reversed-Phase chromatography (IP-RP LC). The influence of heat (25-100°C) on oligonucleotide stability was assessed over for periods of up to 8 hours and no significant degradation resulted, suggesting that these oligonucleotides are heat stable over this temperature range. However, when the oligonucleotides were subjected to high temperatures of 121°C for 15 minutes (autoclaving conditions), a significant decrease in peak area of 41.9% was observed by HPLC analysis. Treatment of oligonucleotides with either silver nitrate ($AgNO_3$) or iodine solution (I_2) presents the most promising results to date. $AgNO_3$ (50mM) and I_2 (0.1M) efficiently and effectively degrade the oligonucleotide at room temperature within 30 seconds of treatment. Phosphorothioate oligonucleotide degradation will be assessed in terms of, the efficacy of oligonucleotide degradation, the influence of chemical concentration, the environmental implications of each treatment method, duration of treatment, cost effectiveness and energy efficiency.

45. Synthesis of Carbon Nanocages and Application for the Removal of Lead from Aqueous Solution

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University College Cork

Lead contamination in drinking water has recently been highlighted due to problems arising in the Galway region. Prolonged exposure to lead ingestion can result in accumulation in the lymph and circulatory systems which can cause kidney damage, high blood pressure as well as stunted mental and physical development has been reported in children. In this study carbon nanocages (CNCs) were tested as a possible adsorbent of lead (Pb^{2+}) ions in solution. High surface area CNCs (over 1200 m^2/g) were synthesised using a supercritical fluid (SCF) technique whereby p-Xylene is decomposed at high temperature over a transition metal catalyst to graphitise carbon into cage like structures. Oxidation of the surface to introduce adsorption sites was accomplished by nitric acid treatment. Testing as a lead ion adsorbent was undertaken by batch adsorption technique under a range of different parameters including agitation time, pH and adsorbent loading. A comparative study with commercial activated carbon, which is widely used as a heavy metal ion adsorbent, was carried out. The CNC materials showed adsorption capacities of over 90 % which was significantly more than activated carbon.

46. Mesoporous Silica Spheres as Indoor Air Pollution Scavengers

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Indoor air pollution has been identified as a serious health risk. Changes in people's lifestyles and building design have led to an increase in the amount of exposure to indoor pollutants. Volatile Organic Compounds (VOC's) represent the vast majority of indoor air pollutants. Many VOCs are either toxic or carcinogenic under prolonged exposure, or pose indirect threat to public health by deteriorating air quality through photochemistry to form other secondary pollutants such as ozone and organic nitrates. In this research we have investigated the use of mesoporous silica spheres for the adsorption of VOC's from polluted air. The effectiveness of these mesoporous silica spheres in the removal of aromatic and carbonyl based VOCs is compared to the industrial standard XAD-4 resin. The silica material showed trapping efficiencies of 100 % for various carbonyl and aromatic VOCs and was significantly more efficient than XAD-4.

47. RFID Signalling to Stimulate Reuse of Personal Computers

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Over the last half century, personal computers have become an irreplaceable part of life for many people. As a result of this fact, the number of computers in use is continuously increasing. One unfortunate side-effect of dependence on technology is that the manufacture of computers puts an increasing burden on the environment. The disposal of computers is equally damaging, with people choosing to replace their computers after 4-6 years, and a very small market for second hand computers.

One of the barriers to second hand computer use is a lack of consumer faith in the product. The functionality of a second hand computer is to a great extent determined by the conditions under which it has been used, and in the absence of a way of reliably communicating these conditions, people are unwilling to buy used systems.

Most current computers have on-board sensors for the purpose of monitoring failure conditions. These sensors are mostly used only for preventing catastrophic failure in the system by reducing power at times of high stress. However, continuous recording of the outputs of these sensors provides a picture of the conditions under which computer systems are used.

Using Radio Frequency Identification (RFID) technology, it is possible to extract life cycle data recorded using these sensors. This information can then be used to develop a usage profile for a system, and from this decide on a fair price. Using a system of this type, it should be possible to encourage a second hand market for PCs.

48. Antifouling coatings for the environmental monitoring technologies

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Dublin City University

Biofilms are communities of bacteria that colonize surfaces in an aqueous environment. The development of a biofilm is usually initiated when a layer of organic molecules adhere to the surface. This is commonly known as a conditioning layer and is considered a precursor for the initial attachment of planktonic cells on a surface. Attachment of microorganisms occurs within minutes of immersion into an aqueous environment and following this they produce extracellular polymeric substances (EPS), otherwise known as biofilm. Biofilm formation is ultimately a defence mechanism for the microbiological community. Existence of biofilms persists in all environments, as bacteria bound in an EPS matrix display a noticeable decrease in susceptibility to antimicrobial agents and harsh environmental conditions. For marine and riverine sensors, biofouling decreases the operating lifetime and increases the cost of maintenance of a submerged device. A potential solution to prevent biofilm formation is the development of novel antifouling materials that can be applied to a sensor housing or windows to combat these deleterious effects. The modification of polymers is a well-documented method for conferring antifouling ability to polymer surfaces. These coatings are fabricated by incorporating nanoparticles and other agents into polymers. Nanoparticles are known to exhibit antibacterial capabilities, and these materials offer an effective solution to biofouling. With a reduction in bacterial adhesion, a subsequent reduction in anti-fouling will be achievable – thereby allowing longer lifetimes with sensors in the field.

48. Investigation into the effects of chemically modified nanoparticles on protein fibrillation

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University College Dublin

Proteins can exist in an isolated, monomeric state or associated with each other in a globular, fibrillar state. As the protein passes from the monomeric state to the fibrillar state, it passes through a clustered, oligomeric state. It has been seen that these clustered proteins can be toxic in many cases, such as Amyloid β ($A\beta$) clusters in relation to Alzheimer's disease and β 2-microglobulin ($\beta 2m$) clusters in Dialysis-Related Amyloidosis.

It has also been observed that engineered copolymer (NIPAM: BAM) nanoparticles can have a significant effect on the rate and extent to which protein fibrillation occurs when these particles are in solution with the protein. These nanoparticles have been shown to significantly affect the lag-phase of protein nucleation. We plan to expand the range of nanoparticles used in these fibrillation experiments involving $A\beta$ and $\beta 2m$ to include surface-modified nanoparticles, working on the elucidation of the role of the nanoparticle surface and surface modification on fibrillation. The fibrillation is followed by fluorescence intensity and transmission electron microscopy to determine the kinetics and mechanisms of the protein-nanoparticle interactions. Initially, the particles used are polystyrene – carboxylated, amine-modified and unmodified. These are characterised before use by dynamic light scattering, nanosight and zeta potential measurements to allow correlation between nanoparticle size, charge and the effect seen on the nucleation lag-phase.

50. Environmental Improvement Strategies for Micro to Small Enterprises from Cleaner Production and Industrial Ecology perspectives

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It is estimated that the cumulative environmental impact of Small to Medium Sized Enterprises (SMEs) could contribute up to 70% of industrial pollution. SMEs serve as an engine of economic growth. Within Ireland micro to small SMEs provide employment to approximately 777,000 people (2006). However, micro to small SMEs face a number of barriers to improved environmental performance: a perception of having little individual impact on the environment; limited knowledge of cleaner technologies and methodologies, and cost factors.

This study worked with 15 micro to small SMEs, across 6 industry sectors, based in the Munster Region. The aim of this research was to identify patterns for Sustainable Production and Consumption within participants by assessing the potential for Cleaner Production and Industrial Ecology opportunities. To this effect Initial Environmental Reviews of each company are completed and a broad range of Cleaner Production and Industrial Ecology opportunities were identified that were common to both business parks.

This work illustrates that there are many low cost Cleaner Production opportunities to be exploited by micro to small SMEs. Furthermore, co-located SMEs can develop enhanced environment performance and exploit business and economic benefits through implementation of IE strategies. A central conclusion is, in light of the existing base of co-located businesses within development agencies' business parks, a regionally based, national body should be established to promote and coordinate Industrial Ecology development within Ireland. SMEs supports tools, desktop and Internet based, are developed and piloted in this study to assist micro to small SMEs integrate Cleaner Production systematically into company management.

More Information

For more information on the EPA Doctoral & Masters Scholarships Schemes and Research Fellowships Schemes and more details on the EPA-funded projects, please visit our website at:

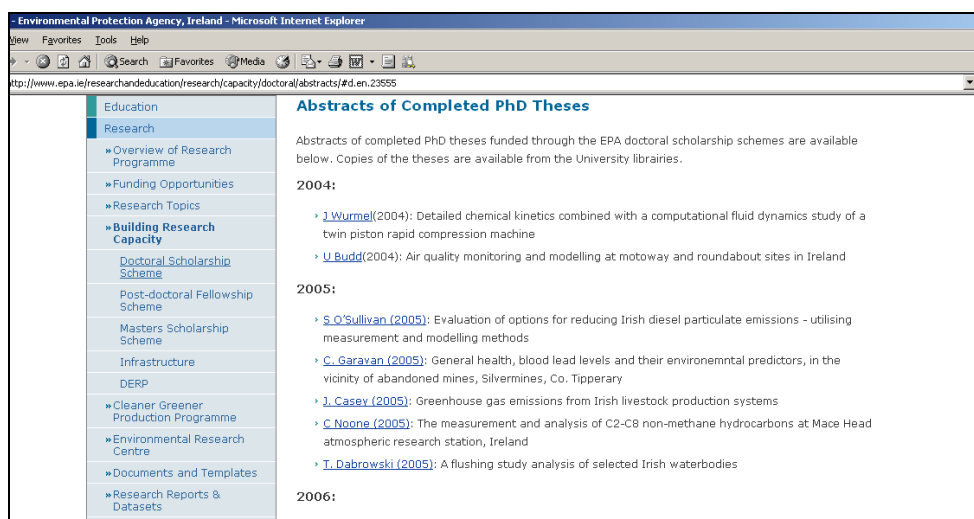
<http://www.epa.ie/researchandeducation/research/capacity/>



The screenshot shows a Microsoft Internet Explorer browser window displaying the EPA website. The address bar shows the URL: <http://www.epa.ie/researchandeducation/research/capacity/>. The page features the EPA logo and a navigation menu with options like 'Home', 'Contact us', 'Site Map', 'EPA Maps', and 'View Cart'. A search bar is also present. The main content area is titled 'Building Research Capacity' and includes a sidebar with a 'Research' menu. The text on the page describes the EPA's support for young researchers through various schemes, including the ERTDI Programme, and mentions the Fulbright-EPA award.

To view the abstracts of completed PhD theses, please consult our website at:

www.epa.ie/researchandeducation/research/capacity/doctoral/abstracts/



The screenshot shows a Microsoft Internet Explorer browser window displaying the EPA website. The address bar shows the URL: <http://www.epa.ie/researchandeducation/research/capacity/doctoral/abstracts/#d.en.23555>. The page features the EPA logo and a navigation menu. The main content area is titled 'Abstracts of Completed PhD Theses' and includes a sidebar with a 'Research' menu. The text on the page states that abstracts of completed PhD theses funded through the EPA doctoral scholarship schemes are available below. It lists several theses from 2004, 2005, and 2006, each with a brief description and a link to the abstract.

For more details, please contact: research@epa.ie

List of Attendees²

Title	First Name	Surname	Organisation
Ms	Mary	Garvey	Athlone Institute of Technology
Ms	Cheryl	Carmody	Cork Institute of Technology
Dr	Joseph	Harrington	Cork Institute of Technology
Mr	Colm	Sheehan	Cork Institute of Technology
Dr	Leon	Barron	Dublin City University
Ms	Deborah	Coleman	Dublin City University
Mr	Thomas	Hayes	Dublin City University
Ms	Lisa	Jones	Dublin City University
Mr	David	Keane	Dublin City University
Dr	Padraig	Murphy	Dublin City University
Ms	Rachel	NicArdghail	Dublin City University
Ms	Emma	Weir	Dublin City University
Dr	Siobhan	Jordan	Dundalk Institute of Technology
Ms	Helen	Bruen	Environmental Protection Agency
Dr	Brian	Donlon	Environmental Protection Agency
Dr	Micheal	Lehane	Environmental Protection Agency
Dr	Stephan	Leinert	Environmental Protection Agency
Dr	Micheal	O Cinneide	Environmental Protection Agency
Ms	Lisa	Sheils	Environmental Protection Agency
Dr	Larry	Stapleton	Environmental Protection Agency
Ms	Katie	Tedd	Environmental Protection Agency
Dr	Alice	Wemaere	Environmental Protection Agency
Mr	Kevin	Woods	Environmental Protection Agency
Dr	Colleen	Dube	Fullbright
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² as per registration on 10/11/2008

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Dr	Martina	McGuinness	Institute of Technology, Carlow
Ms	Hui-Wen	Cheng	Institute of Technology, Sligo
Dr	Dagmar	Meyer	Irish Universities Association
Ms	Niamh	Devane	Limerick Institute of Technology
Ms	Carol	Meagher	Limerick Institute of Technology
Dr	Josephine	Treacy	Limerick Institute of Technology
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Dr	David	Bourke	National University of Ireland, Galway
Dr	Solene	Connan	National University of Ireland, Galway
Mr	Ligang	Dao	National University of Ireland, Galway
Dr	Robert	Flanagan	National University of Ireland, Galway
Mr	Yaxin	He	National University of Ireland, Galway
Dr	Tara	Higgins	National University of Ireland, Galway
Mr	Eoin	Moriarty	National University of Ireland, Galway
Ms	Brid	Walsh	National University of Ireland, Galway
Dr	Chaosheng	Zhang	National University of Ireland, Galway
Dr	Rowan	Fealy	National University of Ireland, Maynooth
Mr	Christopher	Harvey	National University of Ireland, Maynooth
Dr	Peter	Mooney	National University of Ireland, Maynooth
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Ms	Olga	Lyashevskaya	Queen's University Belfast
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Ms	Joanne	Rourke	Trinity College Dublin
Ms	Nova	Sharkey	Trinity College Dublin
Dr	Jane	Stout	Trinity College Dublin
Dr	David	Styles	Trinity College Dublin
Mr	Maximilian	von Sternburg	Trinity College Dublin
Dr	Lorraine	Nagle	Tyndall National Institute
Mr	Brian	Barrett	University College Cork
Mr	Kevin	Barry	University College Cork
Ms	Jennifer	Bell	University College Cork
Mr	David	Burke	University College Cork
Dr	Fiona	Cawkwell	University College Cork
Ms	Alice	D'Arcy	University College Cork
Mr	Paul	Delaney	University College Cork
Prof	Alan	Dobson	University College Cork
Dr	Ioannis	Dokas	University College Cork
Dr	Mark	Emmerson	University College Cork
Dr	Mark	Jessopp	University College Cork
Dr	Donal	Keane	University College Cork
Ms	Deidre	Kenny	University College Cork
Ms	Ann-Kristin	Koehler	University College Cork
Ms	Mary	McCullagh	University College Cork
Mr	Colm	McManamon	University College Cork
Prof	Michael	Morris	University College Cork
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Mr	Rory	Coffey	University College Dublin
Ms	Sheila	Covery	University College Dublin
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Mr	Stephen	McCormack	University College Dublin
Mr	Stephen	McDonald	University College Dublin
Mr	Terrance	McFadden	University College Dublin
Mr	Stephen	Morrin	University College Dublin
Mr	Niall	O'Brien	University College Dublin
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Ms	Karin	Eriksson	University of Ulster
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Mr	Sharbhanu	Ghosh Dastidar	Waterford Institute of Technology
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