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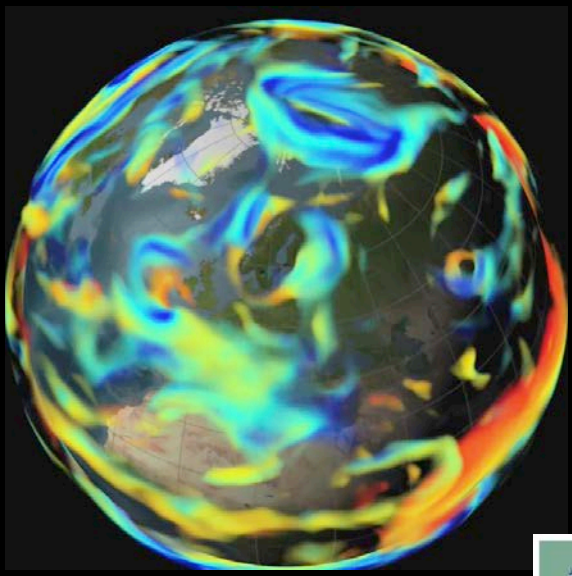
20-21 June 2013
School of Law, NUI Galway

Information and Communications Technology for Environmental Regulation:

Developing a Research Agenda

Workshop



GEOS-5 Model Run Showing Hurricane Katrina

Image by NASA Goddard Space Flight Center
http://www.flickr.com/photos/nasa_goddard/

NUI Galway
OÉ Gaillimh

Fáilte

Welcome to this exploratory interdisciplinary workshop on "Information and Communications Technology for Environmental Regulation: Developing a Research Agenda". Having researched in this area for a number of years, I have long felt that it would be useful to bring together a diverse group of researchers with a variety of different perspectives and experience in order to begin to map out in a comprehensive manner the possibilities, issues and challenges which are raised by the rapid development and deployment of digital technologies in environmental regulation.

Some initial funding from the Irish Research Council “New Foundations” programme provided the opportunity to do this. Six months and many email messages later, this event brings together a range of people from around the world for what should be a productive initial discussion across disciplinary boundaries, and the beginning of a network of researchers who can collaborate together on future projects in this area. Enjoy the workshop and your time in Galway, and I hope you make new friends and colleagues. Gach rath ar an obair.

I would like to thank those who have contributed to the development of the event: my colleague Professor Ronán Long, who first suggested this research area to me; my colleague Dr. Conor Hanly, who suggested convening a workshop; Professor Willie Golden of NUI Galway and Professor Jane Holder of University College London Faculty of Laws, for initial guidance; Dr. Martina Prendergast of the Ryan Institute, who provided much sensible advice; Dr. James Cunningham and Ms. Angela Sice of the Whitaker Institute who provided valuable practical support; our keynote speaker, Professor Bradley Karkkainen, for graciously agreeing to travel such a long distance to talk to us; those who agreed to chair sessions; the speakers; and, of course, those who provided funding and other support: the Irish Research Council, the Environmental Protection Agency, NUI Galway’s Ryan Institute for Environmental, Marine and Energy Research, the Whitaker Institute for Innovation and Societal Change, the NUI Galway School of Law, the Environment, Development and Sustainability cluster of the Whitaker Institute, and the Digital Enterprise Research Institute.

Rónán Kennedy
Workshop Convenor

School of Law
National University of Ireland Galway

Outline Schedule

Thursday 20 June 2013

	CA110	CA116
11.00	Welcome and Keynote	
12.00	*Using Information Effectively*	
14.00	*Access to Information*	
16.00	*Information Driving Innovation*	*ICT in the Regulatory Process*

Friday 21 June 2013

	CA110	CA116
9.00	*Putting Information to Work*	*Gathering Information*
11.00	*Putting Information to Work*	*Gathering Information*
11.45	*Privacy Issues*	*ICT and Environmental Management*
14.00	*Enforcement*	
16.00	Rapporteurs' Report	

Workshop Schedule

Thursday 20th June

11.00 **Welcoming Addresses** (Room CA110)

11.00 Professor Ciaran O'Neill, Dean of College of Business, Public Policy and Law

11.05 Rónán Kennedy, School of Law

11.15 **Keynote:** "You manage what you measure": Information, Incentives, and the Architecture of Environmental Regulation

Professor Bradley Karkkainen, Henry J. Fletcher Professor in Law, University of Minnesota School of Law

12.00 **Plenary Panel 1:** *Using Information Effectively* (Room CA110)

Chair: Professor Colin Brown, Ryan Institute, NUI Galway

Institutional Architecture and Information Flow (Professor Holly Doremus, University of California, Berkeley School of Law)

ICT and Sustainability: An Overview of Current Contributions and Future Research from the Information Systems Community (Professor Brian Donnellan, National University of Ireland Maynooth; Dr. Gabriel Costello, Galway-Mayo Institute of Technology)

ICT and Environmental Regulation: Critical Perspectives (Rónán Kennedy, National University of Ireland Galway)

13.00 **Lunch** (Friars Restaurant)

14.00 **Plenary Panel 2:** *Access to Information* (Room CA100)

Chair: Professor Brian Donnellan, National University of Ireland Maynooth

Environmental Information to Support Regulation and Governance (Professor Fiona Regan, Tim Sullivan, Edel O'Connor, Ciprian Briciu, Dian Zhang, Lisa Jones, Noel O'Connor, Alan Smeaton, Brendan Heery, Marine and Environmental Sensing Technology Hub, Dublin City University)

Constitutional Rights to Information: A Worldwide Survey (Professor James R May, Widener University School of Law)

Access to Environmental Information after the INSPIRE Directive: What has Changed? (Dr. Katleen Janssen, Katholieke Universiteit Leuven)

NGO-led Initiatives to Improve Public Participation and Access to Information in Environmental Matters (Andrew Jackson, An Taisce)

15.30 **Break** (Friars Restaurant)

16.00 **Parallel Panel 3.A**: *Information Driving Innovation* (Room CA110)

Chair: Professor Holly Doremus, University of California, Berkeley School of Law

Improving Policy Coherence and Accessibility through Semantic Web Technologies: Environmental Policies as Linked Open Data (Adegboyega Ojo, Digital Enterprise Research Institute; Lewis John McGibbney, Stanford University; and Dr Edward Curry, Digital Enterprise Research Institute)

Standarising Smart: Information Communication Technologies and the Environmental Promise of the Smart Grid (Professor Elizabeth Wilson, University of Minnesota; Professor Tarla Rai Peterson, Texas A&M University; and Professor Jennie Stephens, Clark University)

Identification of Dumping Behaviour at Bring Centres in Ireland and their Multi-Disciplinary Solutions (Aidan McDermott and John Dooley, National University of Ireland Maynooth)

The Public-Private Divide in Informational Regulation (Professor Sarah E Light, Wharton School of Business)

16.00 **Parallel Panel 3.B:** *ICT in the Regulatory Process* (Room CA116)

Chair: Professor James Cunningham, Whitaker Institute, National University of Ireland Galway

> "21st Century Regulatory Innovation": Can ICT Support Regulatory Reform? (Colin Armstrong, Northern Ireland Environment Agency)
>
> Historic Landfills: An Innovative ICT Solution (Breen Higgins, Environmental Protection Agency)
>
> Integrated EPA Licensing, Enforcement and Monitoring Application (Valerie Doyle and Owen Pullen, Environmental Protection Agency)
>
> Environmental Monitoring Data Sharing Using Web-based Operator Data Portals: Current Environment Agency Initiatives (David Purchase, Environment Agency for England)

17.30 **Close**

19.30 **Dinner** (House Hotel)

Friday 21st June

9.00 **Parallel Panel 4.A:** *Putting Information to Work* (Room CA110)

Chair: Dr. Edward Curry, DERI, National University of Ireland Galway

> Open Sustainability and Environmental Regulation (Jack Townsend, University of Southampton)
>
> Climate Change and Public Engagement: Conceptualising and Developing the Role(s) for ICT (Brenda McNally, Dublin City University)
>
> A Review of the MARGIS Modelling System and Its Use by the English Environment Agency in the Assessment of the Potential Impact of Discharge Consent in the Coastal Zone (Dr. Conor Delaney, MarCon Computations International Ltd)

Environmental Regulation with Corporate Governance: The Role of ICT (Fearghal McHugh, Whitaker Institute and Lero)

10.30 **Break** (Friars Restaurant)

11.00 **Parallel Panel 4.A:** *Putting Information to Work* (Room CA110)

Openly Accessible GIS Data and Local Government Planning Policy (Dr. Ronan Hennessy, Ryan Institute, National University of Ireland Galway)

Integrating Spatial Planning and Flood Risk Management: a Conceptual Framework of a Spatially Integrated Policy Infrastructure (Jing Ran and Professor Zorica Nedović-Budić, University College Dublin)

Graphic Warning as a Regulatory Tool and Free Speech Interests in the U.S. (Professor Ellen Goodman, Rutgers University School of Law)

9.00 **Parallel Panel 4.B:** *Gathering Information* (Room CA116)

Chair: Professor Fiona Regan, Dublin City University

Development of an Online Systems Modelling Tool for Climate Adaptation (Anthony Patterson, Coastal and Marine Research Centre, University College Cork)

Satellite Remote Sensing for Environmental Monitoring and Regulation (Dr. Fiona Cawkwell and Ned Dwyer, University College Cork)

The Cause-and-Effect Problem in Regulated Environmental Monitoring (Dr. Rohan Sadler, Astron Environmental Services)

How the Law Supports Existing Models of Environmental Data Reuse (Laura German, University of Southampton)

10.30 **Break** (Friars Restaurant)

11.00 **Parallel Panel 4.B:** *Gathering Information* (Room CA116)

Examining the Potential of Crowdsourced Volunteered Geographic Information for Environmental Observation and Regulation (Dr. Peter Mooney, National University of Ireland Maynooth and Dr. Andrea Ballatore, University College Dublin)

Overcoming Barriers to Obtaining and Evaluating Energy Consumption Data (Professor Elizabeth Wilson and Professor Alexandra Klass, University of Minnesota)

An Argument for a GIS Contaminated Land Inventory for the Republic Of Ireland (Padraic Mulroy, Principal, Mulroy Environmental)

The Role of Non-Governmental Organisations (Dawit Dagnew Kebede, GIZ Energy Coordination Office and Addis Ababa University School of Commerce)

12.00 **Parallel Panel 5.A:** *Privacy Issues* (Room CA110)

Chair: Professor Ronán Long, National University of Ireland Galway

Cross-Fertilisation Between Fundamental Freedoms and a Clean Environment: The Legal Hook of Data Protection Legislation (Raphaël Gellert, Vrije Universitiet Brussel)

ICT and Perspectives of Privacy (Dr. Asher Vaturi, Max Stern Yezreel Valley College)

Environmental Protection and Data Protection Law: Clouding the Debate? (Professor Burkhard Schafer, SCRIPT Centre for IT and IP Law, University of Edinburgh)

12.00 **Parallel Panel 5.B**: *ICT and Environmental Management* (Room CA116)

Chair: Professor Dermot Diamond, Dublin City University

Regulation Enhancement with the Use of Information and Communications Technology for the Environmental Management and Monitoring of Waste Water Treatment Plants (Dr. Josephine Treacy, Ken Oakley, Niamh Devane, Annemarie Casey, Marie Henaghan, Kevin McDonnell, Limerick Institute of Technology)

Using Standard ICT and GIS to Facilitate Better Nutrient Management Planning on Irish F arms (Sarah Mechan, Stan Lalor, Oliver Shine & David Wall, Teagasc)

Changing Consumer Behaviour Through Information Provision (Joe Durkan, Sustainable Energy Authority of Ireland)

13.00 **Lunch** (Friars Restaurant)

14.00 **Panel 6:** *Enforcement* (Room CA110)

Chair: Professor Burkhard Schafer, University of Edinburgh

Distributed Sensor Networks: the Key to Democratising Environmental Regulation Enforcement (Professor Dermot Diamond, CLARITY Centre, Dublin City University)

Advancing the Right to Water and the 'Right to Know' through Telemetry Innovation in South Africa (Nathan J Cooper, University of Lincoln; and Dr. Andrew Swan, Leeds Metropolitan University)

Groundwater Monitoring: Reconciling Cost Effectiveness, Legal Requirements and Enforcement Realities (Andrew Allan and Professor Chris Spray, University of Dundee)

EU Regulation of Fishing Vessel Monitoring Systems: *Lex specialis ab initio* (Professor Ronán Long, National University of Ireland Galway School of Law)

15.30 **Break** (Friars Restaurant)

16.00 **Closing Plenary:** Rapporteurs' Report (Room CA110)

Chair: Dr. Martina Prendergast, Ryan Institute

Dr. Kieran Hickey, School of Geography and Archaeology, National University of Ireland Galway

Dr. Su-ming Khoo, School of Political Science & Sociology, National University of Ireland Galway

Keynote Speaker:

Professor Bradley C. Karkkainen
Henry J. Fletcher Professor in Law,
University of Minnesota School of Law

"You manage what you measure": Information, Incentives, and the Architecture of Environmental Regulation

Professor Bradley C. Karkkainen is a nationally recognized authority in the fields of environmental and natural resources law. After visiting at the University of Minnesota in the fall of 2003, Professor Karkkainen joined the University of Minnesota faculty in January 2004 at the rank of Professor. He held the Julius E. Davis Chair in Law in 2004.

Professor Karkkainen teaches courses in environmental law, international environmental law, natural resources law, water law, land use, property, administrative law, and regulatory theory. He is the author of numerous monographs, book chapters, and articles in leading legal and social science journals. His research centers on innovative strategies for environmental regulation and natural resources management, with an emphasis on mechanisms that promote continuous adaptive learning, flexibility, transparency, and policy integration.

Prior to joining the University of Minnesota faculty, Professor Karkkainen held a visiting appointment at the University of California-Berkeley (Boalt Hall) in 2002-03, and was Associate Professor at Columbia Law School in New York City from 1995 to 2003. He has also taught courses for European lawyers at Columbia Law School's Columbia-Amsterdam Program in the Netherlands, and for conservation biology graduate students at Columbia University's Center for Environmental Research and Conservation (CERC). Professor Karkkainen holds a B.A. in philosophy (1974) from the University of Michigan, and a J.D. (1994) from the Yale Law School, where he taught legal research and writing as a teaching assistant in 1993-94 and served as an editor of both the Yale Law Journal and the Yale Journal of International Law.

Panel 1: *Using Information Effectively*

Institutional Architecture and Information Flow

Professor Holly Doremus, UC Berkeley School of Law

New data tools and novel scientific methodologies can produce information and knowledge helpful for public resource managers and environmental regulators. That information will be put to good use, however, only to the extent that key agency personnel are able to recognize its value to their mission; translate, interpret or synthesize it; and apply it to the tasks they need to accomplish. That does not always happen, and even when it does it often seems to happen slowly and inefficiently. Institutional incentives have been recognized as a barrier to incorporating new tools and new knowledge into regulatory or management agency practices, but the problem is more complex than that. Institutional histories, cultures, and structures also play a role in inhibiting or facilitating the flow of information from production to policy use. This paper uses case studies of three long-established US federal resource management agencies (the US Forest Service, National Marine Fisheries Service, and US Fish and Wildlife Service) and a novel California agency (the Ocean Science Trust) to examine how institutional factors interact with the "information pipeline" at a variety of points. The goal is to identify key institutional factors that might be altered to increase the openness of agencies to new information and techniques without making them excessively prone to unproductive policy swings.

Holly Doremus is the James H. House and Hiram H. Hurd Professor of Environmental Regulation at the University of California, Berkeley; Director of the Berkeley Law Environmental Law Program; and Co-Faculty Director of the Center for Law, Energy, and the Environment. She is a Member Scholar of the Center for Progressive Reform and serves on the Board of Directors of Defenders of Wildlife. She received her B.S. in biology from Trinity College (Hartford, CT), Ph.D. in plant physiology from Cornell University, and J.D. from the University of California, Berkeley. After law school, she clerked for Judge Diarmuid O'Scannlain of the United States Court of Appeals for the Ninth Circuit and practiced law in Corvallis, Oregon. Doremus has written extensively about environmental and natural resources law; the primary focal points of her research work are biodiversity protection, the intersection between property rights and environmental regulation, and the interrelationship of environmental law and science.

Panel 1: *Using Information Effectively*

ICT and Sustainability: An Overview of Current Contributions and Future Research from the Information Systems community

Professor Brian Donnellan, National University of Ireland Maynooth; Dr. Gabriel Costello, Galway-Mayo Institute of Technology

This presentation will explore the current state of Environmental Sustainability from the perspective of the Information Systems research community. Information systems, which have become pervasive and hence have impact on most aspects of human activity, can help to reduce the negative impact of human activities on the environment in two main areas. On the one hand, information systems can play an important role in raising awareness of and controlling energy efficiency in a variety of areas, such as smart cities and smart buildings, traffic control, and utility management. Therefore, we can talk of designing information systems for sustainability. On the other hand, information systems themselves use computing resources and related facilities in data centres and offices and, therefore, have an impact on the environment. When these resources are handled with care, we may talk of sustainable information systems. Several authors have discussed the impact on the environment of all the phases in the ICT life cycle, from design to production of IT equipment, to usage, and finally to disposal.

Whilst great emphasis has been placed on the production and assessment of energy-efficient hardware, consideration of energy efficiency in the context of information systems and their design has only recently emerged as an issue. The following areas of research in ICT and the impact on the environment will be addressed:

Information systems as consumers of power: In this domain the impact on the environment of IT infrastructure, such as office equipment, data centres, and service centres, is considered. Research in this field is labelled in various ways, such as Green IT, Green IS, and Sustainable Computing.

Information systems to support awareness and control of energy efficiency, for example, in buildings, cities, water, and electricity grids. In this case the research is mainly in the specific application area, but IS research can contribute towards understanding and developing the Green Domain, defining the relevant concepts and the relations between them, managing monitoring data, providing services and service infrastructure, and focusing on Quality of Service (QoS). This research area is labelled Green IS or IS for Green.

Brian Donnellan holds the Chair of Information Systems Innovation at the National University of Ireland Maynooth (www.nuim.ie) and is Co-Director of the Innovation Value Institute (www.ivi.ie). Prior to joining NUI Maynooth, Prof. Donnellan was a faculty member in the National University of Ireland, Galway. He has spent 20 years working in the ICT industry where he was responsible for the provision of IS to support Product Development.

Gabriel J. Costello is a Lecturer in Engineering at the Galway-Mayo Institute of Technology. Prior to this he worked for twenty years in the telecommunications industry where he held engineering, supply chain and product line management positions. In 2010 he completed a PhD in Management Information Systems at the J.E. Cairnes School of Business & Economics, National University of Ireland, Galway in the area of information systems innovation.

Panel 1: *Using Information Effectively*

ICT and Environmental Regulation: Critical Perspectives

Rónán Kennedy, National University of Ireland Galway

The use of ICT for environmental regulation is not simply a matter of the increased use of computer databases or putting pollution data on the World Wide Web. ICT can play a significant role in improving the application, efficiency and effectiveness of government regulation, but the deployment of information technology often has unintended effects. A better understanding of the regulatory process and the social and economic consequences of disclosing information and making processes more interactive is necessary in order to design appropriate systems.

The information used in environmental regulation comes principally from the physical sciences. It is not always the case that legislators, policy-makers and the general public are sufficiently scientifically literate to understand the basis of a regulatory scheme. The scientific models used in legislation may not be accurate or may lag behind the state of the art. They are an attempt to understand a system rather than the system itself. The creation, evaluation and choice of models can have important social, political and legal consequences. In addition, the data collected in order to apply these models may not itself be accurate. It may not be verifiable or consistent.

Any regulatory system based on the analysis of information, particularly information expressed in numerical form, can be manipulated so as to avoid thresholds or other triggers for regulatory intervention. There is a common assumption that ICT is autonomous and determines particular technical outcomes, rather than being socially constructed and developed. As it becomes an increasingly significant component in the regulatory process, it can significantly slow down internal institutional, organisational and procedural change while further disempowering those external actors who were already excluded from the process by educational or financial disadvantage.

The legal decision-making process is not a simple or linear system, easily amenable to modelling through computerised logic and expert systems. If the consequences of the implementation of an ICT system in a government context is not properly understood and the system is not well-designed at the outset, this is likely to degenerate into a destructive feedback cycle. When in place, ICT may have unanticipated and undesired effects which are difficult to undo, becoming part of the infrastructure in a way that is very difficult and expensive to remove, unlike paper-based systems.

We do not know enough about what ICT does to government processes, particularly regulatory systems. The focus of studies in e-government to date has been on the interface between the individual and the state. These tend to view the citizen as a consumer, which is not always appropriate. They generally view government action as a single-step decision-making event rather than an ongoing engagement (or game) involving diverse public, commercial and non-governmental entities. There has been little examination of the internal workings of the system and particularly not of processes that are information-intensive feedback loops. Further research is needed here.

After working as a systems analyst, Rónán Kennedy was Executive Legal Officer to the Chief Justice of Ireland, Mr. Justice Ronan Keane, from 2000 to 2004. He was called to the Bar of Ireland in 2003 and graduated from New York University with an LL.M. in General Studies in 2005. He has been a member of the Law School at NUI Galway since 2006. His research focuses on the relationship between information and communications technology and environmental regulation. He is Programme Director for the LL.M. in Law, Technology and Governance.

Panel 2: *Access to Information*
Environmental Information to Support Regulation and Governance

Professor Fiona Regan, Tim Sullivan, Edel O'Connor, Ciprian Briciu, Dian Zhang, Lisa Jones, Noel O'Connor, Alan Smeaton, Brendan Heery, Marine & Environmental Sensing Technology Hub, Dublin City University

Real-time continuous monitoring can provide valuable information to assist in water quality management and environmental regulation. New supporting technologies such as multimodal sensor networks can assist regulators in making informed decisions that can improve our water quality and the health of our citizens.

This paper shows how successful demonstration projects in Dublin Port and Malahide in 2011 and 2012 using state of the art technology can be implemented for cost effective continuous monitoring. The sites vary in their physico chemical characteristics as well as their activity. The Port is known to be a dynamic, rapidly changing estuarine environment affected by tidal movement, ship traffic and Liffey river inflow, whereas Malahide is a less complex environment. Data is collected every 15 min using a YSI multi-parameter sonde connected to a telemetry system. The measured parameters are: temperature (oC), conductivity (mScm-1), turbidity (NTU), optical dissolved oxygen (ODO) (mgL-1) and pH. Collected data is processed and analyzed and the temporal fluctuations in water quality parameters will be outlined. Trends arising from tidal movements, climate conditions, ship traffic and fouling of the sensors will shown, as well as the impact of the intense activity in the port, on the water quality. During these studies, wireless sensor technologies have proved to be a reliable and cost effective tool, able to withstand harsh environmental conditions and to give a better understanding of the temporal resolution of the data into a complex and dynamic environments.

The value of this environmental data is in providing a decision support system for the stakeholder or user. In Ireland currently the EU environmental legislation (e.g. Water Framework Directive and Marine Strategy Framework Directive) identifies the monitoring requirements for a particular area depending on the level of risk. This monitoring approach does not place a requirement to carry out continuous measurement and therefore pollution events are often not identified at the time of occurrence. We believe that ICT has a significant role to play in improving how we manage our water resources for better compliance and improved quality of life.

Fiona Regan, Associate Professor in Environmental Sensing since 2009, established the Marine and Environmental Sensing Technology Hub (MESTECH), DCU in 2010. She studied Environmental Science and Technology at the Institute of Technology in Sligo and graduated in 1991. After completing her Ph.D. in analytical chemistry in 1994, and postdoctoral research in optical sensing in 1996 at DCU, she took up a position at Limerick Institute of Technology as lecturer in Environmental and Analytical Science. In 2002 Fiona returned to the School of Chemical Sciences, DCU, as a lecturer in analytical chemistry, in 2008 she became senior lecturer and in 2009 became the Beaufort PI in Marine and Environmental Sensing. Her research is in the area of separations and sensors, materials for sensing and anti-biofouling applications on aquatic deployed systems, including novel sensors and sensor networks and decision support systems. Fiona is Director of MESTECH and coordinates the Marine ICT SmartBay research under PRTLI V and the International SmartOcean Graduate Enterprise Initiative (ISGEI).

Panel 2: *Access to Information*

The Role of Constitutionally Instantiated Rights to Information, Participation and Justice

Professor James R May, Widener University School of Law

Environmental constitutionalism is an emerging global phenomenon. The constitutions of about three-quarters of nations worldwide address environmental matters in some fashion, some by committing to environmental stewardship, others by recognizing a basic right to a quality environment, and still others by ensuring a right to information, participation, and justice in environmental matters. Dozens of nations and many subnational governments have recently adopted constitutional guarantees to environmental rights. Indeed, most people on earth now live under constitutions that protect environmental rights in some way.

Procedural rights can help to keep environmental regulation vital. Environmental regulation is more likely to take root when stakeholders have the right to receive free and timely information for, participate in deliberations about, and appeal to government agencies granting permission to, for example, dam a wild river, emit mercury laden air pollutants near an elementary school, clearcut a forest that provides habitat for endangered megafauna, or inexorably alter scenic landscape.

Procedural rights classically consist of three 'pillars,' allowing for rights to information, participation and access to justice. These pillars work in tandem to help ensure better decisionmaking in environmental matters. First, informational rights include access to timely and reliable information from governmental agencies charged with overseeing activities that affect the environment. Second, participatory rights are those that enable stakeholders to shape governmental decisions in environmental matters, including permission to submit comments, ask questions, and attend public meetings. Third, adjudicatory rights are those that allow stakeholders to seek civil mediation and enforce court orders in the face of recalcitrant or improvident government action in environmental matters. Collectively, such process rights can raise awareness, provide opportunities to participate, foster empowerment, strengthen local communities, facilitate government accountability, increase public acceptance of decisions, and contribute to the legitimacy of governmental action. Procedural rights can also promote discourse and democratization through concomitant rights to assemble, speak and participate in governance.

This presentation explores the reasons for and extent to which countries have instituted express constitutional protections of process rights in environmental matters, and the extent to which courts have vindicated such rights. Professor May concludes that procedural environmental constitutionalism can fill gaps left by extant international, regional and domestic laws in promoting procedural rights. It also concludes that procedural environmental rights are important in their own right, and perhaps even more useful than substantive environmental regulation because courts might be more inclined to use them to vindicate environmental interests while pushing the actual decision-making to the political sphere; all the courts have to do is adjudicate the terms of the conversation without taking the heat for promoting development over the environment or vice versa.

James R. May is a Professor of Law, co-director of the Environmental Law Center, and Adjunct Professor of Graduate Engineering, at Widener University. He has been an academic, a clinic director, a founder and director of two environmental advocacy organizations, a founder and director of a program on marine policy, a federal litigator, and an environmental attorney. He has litigated 200+ public interest environmental claims at levels up to the U.S. Supreme Court. He is the author of two books, *Principles of Constitutional Environmental Law*, and *Environmental Constitutionalism: Implications for Present and Future Generations* (with Erin Daly, forthcoming), and more than 70 articles and book chapters relating to environmental and constitutional law.

May is a Fellow of the American College of Environmental Lawyers, and a Member of Faculty to the National Judicial College. May has served as a Council Member to the governing board of ABA Section on Environment, Energy and Resources, a founder and inaugural Chair of ABA SEER's Task Force on Constitutional Law, and is a member of the Committee on Environmental Law to the IUCN.

Panel 2: *Access to Information*

Access to Environmental Information after the INSPIRE Directive: What has Changed?

Dr. Katleen Janssen, KU Leuven

With the INSPIRE directive, the European Union intended to create a European-wide infrastructure for the exchange of geographic or spatial data between public authorities for their policy purposes relating to the environment. This directive requires the Member States to create a network of services through which the public can discover, view or download spatial data. These services enable the citizen to get access to a large amount of environmental data. In addition, the extensive technical requirements imposed by the INSPIRE directive and its implementing rules should ensure that the data and services provided are of a high quality. However, the INSPIRE directive also includes provisions on the possible charges and conditions for access to the network of services. Hence, the question can be asked what the actual impact of the INSPIRE directive is on public access to environmental information.

The impact of the INSPIRE directive should be seen against a broader background. Some Member States have taken the opportunity to align their policy on spatial and environmental data to their open data policy, in this way also imposing open licences and easy access to environmental data. Moreover, the European institutions are currently revising the directive on the re-use of public sector information, also in the direction of an increase in open data.

This paper will give an overview of the relevant aspects of the INSPIRE directive for access to environmental information and try to assess its impact on access environmental information in the field.

Katleen Janssen is a postdoctoral researcher at the Interdisciplinary Centre for Law and ICT of the Faculty of Law of the KU Leuven. She specialises in legal aspects of open data, public sector information, geographic data, spatial data infrastructures, intellectual property rights and privacy. In 2009, Katleen obtained her Phd with a thesis about the legal framework for the availability of public sector spatial data, mainly dealing with the relationship between INSPIRE, PSI and access to environmental information. She is the coordinator of the LAPSI 2.0 Thematic Network on Legal Aspects of Public Sector Information (www.lapsi-project.eu). She was the co-chair of the INSPIRE Drafting Team on Data and Service sharing and currently co-chairs the Legal and Socio-Economic Committee of the Global Spatial Data Infrastructure Association.

Panel 2: *Access to Information*
NGO-led ICT Initiatives to Improve Environmental Democracy

Andrew Jackson, An Taisce

This presentation discusses two new NGO-led initiatives to improve public participation and access to information in environmental matters.

Andrew Jackson holds a B.A. in law from Oxford University, an LL.M. from Cambridge University, and an M.Sc. in biodiversity and conservation from Trinity College Dublin. From 2001 to 2007 he worked as a lawyer in London, first for Slaughter and May, an international law firm, and latterly for the UK government's Department for Environment (Defra), where he advised principally on nature conservation matters. He lectures on topics relating to environmental policy at Trinity College Dublin (TCD) and University College Dublin, and recently submitted his doctoral thesis to TCD on the history of EU nature conservation law and policy. From 2007 he worked with the environmental NGO Friends of the Irish Environment, and from February 2013 he has worked full time with An Taisce as their Natural Environment Officer. He is a member of The Access Initiative, a global network of NGOs dedicated to environmental democracy goals.

Panel 3.A: *Information Driving Innovation*

Improving Policy Coherence and Accessibility through Semantic Web Technologies: Environmental Policies as Linked Open Data

Adegboyega Ojo, DERI; Lewis John McGibbney, Stanford University; and Dr Edward Curry, DERI

The complexity, volume and diversity of government policies and regulations raises significant burden on both the complying parties and government itself. On the one hand, businesses, civil organizations and other societal entities are required to simultaneously comply with and interpret different and possibly conflicting or inconsistent regulations. On the other hand, government as a whole must ensure policy and regulatory coherence across its various policy domains. While the recent wave of open government initiatives have led to significantly more public access to these documents, features allowing cross-referencing related documents and linking to less formal documents or comments on other media more understandable and accessible to the public are not common if at all available today. As a solution to this challenge, we propose an Open Government-wide Policy and Regulation Information Space consisting of documents that are "semantically" annotated and cross-linked to other documents in the information space as well as to external resources such as interpretations, comments and blogs on the social web.

Our approach is three-fold. First, we identify the requirements for the infrastructure. Second, we elaborate a Reference Architecture identifying the various elements needed within the infrastructure. Third, we show how such infrastructure may be realised as a linked data portal where policies and regulations are published as linked open data. Finally, we present a case study involving environmental policy and regulations; discuss the potential impact of such infrastructure on coherency and accessibility of policies and regulations and concludes with challenges associated with provisioning a linked open policy and regulatory information infrastructure.

Dr. Edward Curry is a Research Scientist and leads the Green and Sustainable IT research group (dgsit.deri.ie) at the Digital Enterprise Research Institute (www.deri.ie). His research projects include studies of sustainable IT, energy intelligence, semantic information management, and collaborative data management. Edward has worked extensively with industry and government advising on the adoption patterns, practicalities, and benefits of new technologies.

Edward has published over 60 scientific articles in journal, books, and international conferences. He has given invited talks at Berkeley, Stanford, and MIT. In 2010 he was a guest speaker at the MIT Sloan CIO Symposium to an audience of 600+ CIOs and senior IT executives. He currently participates in a project for the European Commission to define a research strategy for the Big Data economy within Europe. He has a Ph.D. from the National University of Ireland Galway and serves as an Adjunct Lecturer within the University.

Panel 3.A: *Information Driving Innovation*

Standarising Smart: Information Communication Technologies and the Environmental Promise of the Smart Grid

Prof. Elizabeth Wilson, University of Minnesota; Prof. Tarla Rai Peterson, Texas A&M University; Prof. Jennie Stephens, Clark University

Globally, electricity and heat production are responsible for over 41 percent of carbon dioxide emissions, with natural gas and coal use growing 9 and 5 percent respectively between 2009 and 2010 (EIA 2012). Electricity production also adversely affects local air quality and cooling thermal power plants uses massive amounts of water. Reducing emissions and controlling water use from the electricity sector will require a fundamental transformation in both electricity production and electricity use. Increasing the penetration of renewable electricity sources and massively scaling up demand side management are two technological approaches which are well known but difficult to integrate into the existing electricity system. A suite of Information Communication Technologies (ICTs), collectively known as Smart Grid (SG), could enable integration of these approaches into the electricity system. Motivated by the desire for a more efficient, resilient, and secure electricity system, SG proponents argue that better use of system resources will facilitate increased penetration of variable renewable resources, demand response, distributed generation and more energy efficiency and carbon and pollutant management. The additional ICT sensors and controls at every level of the system—from generation, transmission, distribution and use—enable smartening the electricity system through two-way and networked communication between elements of the system architecture and the energy system manager, but also raise cybersecurity and privacy concerns. Creating SGs in the U.S. is also an issue of multi-level governance.

These concerns highlight challenges of linking the relatively nimble ICT industries with the change-resistant and more heavily regulated electric utilities. Developing a SG requires integrating the business models of ICT Smart Grid vendors which create the components, software and integration expertise and public and private electric utilities to which SG represents a rupture of current business practice. Evolving ICT standards for SG and its components are being created at the international and national levels. In the U.S., these standardization efforts interact with multi-state Regional Transmission Organizations (RTO) which operate electricity markets, and multiple state-level institutions. These interactions are especially evident in (1) laws such as Renewable Portfolio Standards, (2) energy and environmental agencies, and (3) Public Utility Commissions which approve electric system rate cases in traditionally regulated states.

We present a review of state and industry documents, along with discourse drawn from a series of focus groups conducted with influential actors involved with SG development in three U.S. regions. We use this comparative analysis of RTO (New England, the Midwest, and Texas), state (Illinois, Massachusetts, Minnesota, Texas, and Vermont), and utility discourses to explore the role played by standards in managing the evolving relationship between ICTs and traditional electricity sector actors such as utilities, Our analysis suggests that, at least in the U. S., the environmental promise of a smart electricity system will require new standards that enable energy system actors to balance needs and expectations for system security with the rapid pace of innovation in the ICT industry.

EIA (2012). CO2 EMISSIONS FROM FUEL COMBUSTION Highlights (2012 Edition). IEA. Paris, OECD.

Tarla Rai Peterson holds the Boone and Crocket Chair of Wildlife and Conservation Policy in the College of Agriculture and Life Sciences at Texas A&M University, and is Guest Professor of Environmental Communication at the Swedish University of Agricultural Sciences and Adjunct Professor of Communication at University of Utah. She studies intersections between communication, environmental policy, and democracy. Her research questions center on understanding how communication enables/constrains governance, and how this shapes relations between humans and the larger biophysical community. Her goal with this research is to facilitate development of public policy that contributes to sustainability. She also maintains an active Theory to Practice Program, including design and evaluation of best practices for facilitating public participation in science and technology issues related to energy and environmental policy.

Panel 3.A: *Information Driving Innovation*

Identification of Dumping Behaviour at Bring Centres in Ireland and their Multi-Disciplinary Solutions

Aidan McDermott and John Dooley, National University of Ireland Maynooth

Environmental legislation in Ireland is clearly following the recommendation for 'The polluter pays principle'. However there is still a large effort and great expense required to clean up the waste left at bring centres. During the course of an EPA project to deploy camera equipment at various bring centres a number of observations were noted and some trends emerged. The trends identified fell into three broad categories, namely: Design/Planning, Technology and Human Behaviour.

Firstly in terms of design and planning of bring centres it is clear that they have evolved in an ad-hoc manner over time. This is evident from different layouts, bin types, signage, locations, surroundings, and the types of materials that are recycled at each site. Consequently these variations have resulted in users having different dumping behaviours across bring centres and providers of bring centres having difficulty in effective maintenance and monitoring.

At present the majority of bring centres employ little or no technology to improve the user's experience or to improve the effective management of the centres. Where technology has been used it has typically been in the form of CCTV monitoring. This has proven effective in aiding enforcement activities at these sites but due to cost constraints it is not ubiquitous. A number of additional technologies to prevent dumping and enforce environmental law have been identified over the duration of the current project based on experiments and research on international best practice. Some of these technologies have a 'preventative' application where the objective is to avoid the dumping behaviour rather than 'reactive' application where the objective is the prosecution of the offenders.

Finally, observation of users at bring centres has uncovered a number of insights into human behaviour. It has been noted for example that there is a large difference in the gender balance in users of bring centres, there are different classifications of dumpers and definite catalysts which promote dumping behaviour.

Having identified catalysts for dumping at bring centres a number of solutions are proposed in the areas of design/planning, technology and human behaviour at bring centres. In conjunction with project partners across multi-disciplinary fields these solutions can be further developed, validated and successfully implemented at a national level.

Aidan graduated from UCD in 1991 with a B.Eng. (Mechanical). He completed an M.Sc. in Management of Innovation and Technology from DIT in 2008. Following 19 years working across medical and ICT multinational organisations (Tyco Medical and Hewlett Packard), he has significant experience in new product introduction. Since 2010 he has been based in NUI Maynooth (NUIM) and involved in developing novel camera technology for environmental enforcement. He is currently working on an EPA STRIVE postdoctoral research project in NUIM which is focusing on investigating novel technologies and new procedures for environmental enforcement. During this project all local authorities in Ireland were surveyed to identify their main environmental enforcement issues, solutions were subsequently identified and/or developed. Field trials to evaluate the effectiveness of the solutions were completed across a number of local authorities. The insights gained through this work include understanding main challenges facing local authorities, novel and emerging technology coupled with best practices to address these challenges.

Panel 3.A: *Information Driving Innovation*

The Public-Private Divide in Informational Regulation

Professor Sarah Light, Wharton School of Business

In the environmental context, scholarly literature on informational regulation has largely addressed the impact of disclosure rules on private firms. One often-cited informational regulation success story, the Toxics Release Inventory program (TRI), requires certain facilities to report annually their use and releases of listed chemicals. According to the Environmental Protection Agency (EPA), as a result of TRI, releases and disposal of listed chemicals have decreased dramatically. Bradley Karkkainen and others have argued that self-monitoring by firms and external monitoring by corporate peers, regulators, the public, and investors influence corporate actors to reduce pollution in response to TRI and other informational regulation.

Federal government agencies are a significant source of pollution in their own right, and are likewise subject to disclosure rules designed to reduce pollution. Although TRI was extended to apply to government agencies by Executive Order in 1993, none of the extensive literature discussing TRI addresses its impact on government agencies. Important questions thus remain unanswered as to whether agencies respond to informational regulation like private firms, or whether their incentive structures and responses are different. While a vast political science literature discusses agency motivation from a theoretical perspective, and legal scholarship addresses different forms of institutional control over agencies, this Article will take an empirical approach to ask how agencies have responded to disclosure rules, focusing in particular on the TRI program. Based on the empirical data, the Article will recommend whether informational regulation must take into account the regulatory target's public or private status.

Sarah E. Light will join the faculty of the Wharton School of Business at the University of Pennsylvania in July, 2013, as an Assistant Professor of Legal Studies and Business Ethics. Previously, Light served as a Visiting Assistant Professor of Law at Brooklyn Law School, and a Lecturer at the Columbia University Earth Institute. Prior to joining the Academy, Light served for ten years as an Assistant U.S. Attorney for the Southern District of New York and as Chief of that Office's Environmental Protection Unit for four years. She has extensive experience litigating and negotiating complex cases and disputes under the Superfund statute, the Resource Conservation and Recovery Act, the National Environmental Policy Act, among others.

Panel 3.B: *ICT in the Regulatory Process*
"21st Century Regulatory Innovation": Can ICT Support Regulatory Reform?

Colin Armstrong, Northern Ireland Environment Agency

The Northern Ireland Environment Agency (NIEA) is embarking on a programme of regulatory reform that will overhaul Northern Ireland's environmental regulatory systems. The aim is to design a 21st century system in which responsible businesses face less red tape and irresponsible businesses are more quickly and powerfully held to account. NIEA regulates water, air, waste, biodiversity and built heritage, and activities that have potential to impact detrimentally on the environment are managed through an array of environmental permits. Currently there are more than 50 different permit types and most of these are managed by separate teams within the organisation with their own rules, guidance, forms and ICT systems.

NIEA would like to be able issue a single, fully integrated permit covering all environmental issues that relate to the activities being undertaken at a site or by a business that operates across multiple sites. This integration will improve regulatory decision making and allow NIEA deliver a more efficient, outcome focused approach that will both protect the environment and contribute to the development of a prosperous economy.

Access to information is fundamental to the regulatory process and NIEA uses a diverse range of ICT solutions. Examples include: databases for each regulatory regime, risk assessment models, geographical information systems, online application forms for permits, mobile mapping devices, remote monitoring systems with data loggers and telemetry, and data capture devices such as digital pens. Each system delivers improvements to how information is managed but many were developed in isolation to address a specific objective and this has resulted in a fragmented mosaic of data holdings. Using the existing systems to deliver integrated permitting will present significant challenges.

To support the delivery of the regulatory reform programme, NIEA is looking for opportunities to better utilise ICT and The Department of Environment Digital Strategy 2013-2016 will be a catalyst for change. NIEA recognises that while effective ICT systems are crucial in providing the right information to the right people at the right time, they are only part of the solution. Effective data management, to maximise business intelligence, goes hand in hand with the technology.

Investment will be needed to develop integrated information systems and to cover the resources required to run them. However on balance, it is hoped there will be savings by improving the efficiency of data management and by improving the cost-efficiency of existing investments. Overall, benefits will be improved environmental management because of better quality information and less administrative burden for businesses. NIEA will be working with the Department's new Technology and Innovation Unit, ICT providers, stakeholders and staff to utilise 21st Century ICT in the delivery of 21st Century Regulatory Innovation.

Colin Armstrong worked for 8 years as a Freshwater Ecologist and in the past year moved into the NIEA Better Regulation team. He is now involved in an extensive regulatory reform programme and focusing on the development of innovative approaches to environmental permitting.

Panel 3.B: *ICT in the Regulatory Process*
Historic Landfills: An Innovative ICT Solution

Breen Higgins, Environmental Protection Agency

The Waste Directive (1975) required each Member State to authorise landfilling activities within their respective jurisdictions. The EC deemed that Ireland inappropriately transposed the requirements of the Directive and instituted proceedings in the European Court of Justice under Case C-494/01; the court found in favour of the Commission against Ireland. Those landfills that had previously gone unregulated must now be authorised. Exacting timeframes have been imposed for this authorisation process with no additional resource allocation to the EPA.

The solution employed by the Agency to deal with this challenge was to utilise existing ICT knowledge within the organisation to build an electronic platform for the use of on-line application forms (utilising internal geo-spatial data), capture of critical data once related to each individual landfill site for multiple future use (impact analysis on the environment and enforcement), use of geo-spatial data provided by the EPA to risk rank of individual landfill sites based on EPA risk assessment rules built in, use of competent person registered with Professional Organisations to complete the assessment formally done by the Regulator, use of a drop down list of remedial options defined in EPA guidance and based on the degree of risk posed to the receiving environment, surfacewater, groundwater or air, use of electronic communications to manage the licence application process, i.e., acknowledgements, requests for further information, notification of key milestones, etc., and creation of electronic permits based on the information provided through the on-line application forms, and management of workflows required to process the applications to conclusion.

This approach has delivered a number of benefits to the Agency and to the other stakeholders in the process. These benefits include, but are not limited to, many of the priorities identified under the Programme for Public Sector Reform:

Customer Service Delivery - receipt of application forms in a timely manner in line with an aggressive timeframe agreed with the European Commission,

Enhanced Customer Service - reduced burden on the Local Authority applicant as a result of the provision of significant information and geo-spatial data through the on-line form,

Working in new ways – reduced administrative and inspectorate burden as a result of electronic communications and a reduced emphasis on submission of lengthy technical reports,

Reducing costs to drive better value for money – project is projected to result in savings of the order of €900,000 or 12 full time equivalent licensing inspectors over the life time of the project.

The historic landfill project has been identified as a template for future developments both internal and external to the EPA and is viewed as an effective and efficient use of contemporary ICT in the field of environmental regulation.

Breen Higgins is a licensing inspector within the Environmental Licensing Programme of the Environmental Protection Agency's (EPA) Office of Climate Licensing and Resource Use. For the past three years he has been seconded to work within a cross office ICT project aimed at re-engineering the way in which the EPA executes its role as regulator of public and private organisations. He holds a B.Sc. in Environmental Science, a P. Grad in Environmental Engineering and a M.A. in Public Management and has worked with the Irish EPA since 2004.

His main technical areas of interest are water protection and management and waste management and he has delivered on a number of programmes and projects in these and other areas during his tenure at the EPA. Prior to joining the EPA he worked in both the private and public sector in the areas of water protection and waste Management.

Panel 3.B: *ICT in the Regulatory Process*

Integrated EPA Licensing, Enforcement and Monitoring Application

Valerie Doyle and Owen Pullen, Environmental Protection Agency

"A clean, healthy and well protected environment supporting a sustainable society and economy" In the context of public sector reform and increasingly complex legislation, the EPA has recognised the need to prioritise the deployment of its limited resources to activities which have the greatest impact in reducing impacts and risks to the environment. To help the EPA better understand and manage these activities, the EPA has developed LEMA – the Licencing, Enforcement and Monitoring Application – to transform the way it deals with the licensing and enforcement of environmental emissions in Ireland.

The LEMA development project has spanned multiple business units, and has been the catalyst for the EPA to: simplify and standardise business processes across departments; automate administrative effort; revise and improve interactions with external organisations; prioritise those licencing and enforcement actions which provide the most significant environmental outcomes; standardise and centralise data from multiple sources; provide the EPA with a single "view of the truth" in a single location.

The platform has users that range from members of the public, small private operators, through local authorities and on to large multinational organisations. Innovative tools have been developed to allow different communities to interact with the EPA effectively and consistently. Organisations can apply for new licences, and manage their interaction with the EPA throughout the licencing process through a self–service online portal. Members of the public can view all details of the licence application and the licencing process online at the Agency's website (www.epa.ie). Once licensed, the EPA and licensee can communicate electronically through the same portal, allowing the rapid and accurate sharing of environmental and regulatory information. Organisations can communicate with the LEMA system to report environmental incidents immediately. Members of the public can report environmental issues directly in to the LEMA system using an on – line form on the Agency's website. The EPA is made aware of incidents and issues immediately they are reported, and these reports are automatically routed to the correct team for investigation.

Now that it has established a single platform and standard data model, the EPA can understand the significance of multiple indicators of compliance status in those sectors which it regulates, and can take timely and appropriate action to mitigate risks and issues. The EPA can then monitor the effectiveness of those mitigating activities in order to refine and improve for the future. The EPA has developed a very innovative solution to streamline Licencing and Enforcement of core activities, and has been active in managing and communicating this change through its many and varied stakeholders. The project underpins the Agency's core activities: Regulation, Knowledge, Advocacy.

Following 20 years working in the food industry, Valerie Doyle commenced working in the Environmental Protection Agency's division for licensing and enforcement in 2002. Valerie was responsible for producing the 'Focus on Environmental Enforcement in Ireland 2006 – 2008'. Valerie has driven the change agenda for Enforcement as the business lead on the LEMA project and took over as LEMA project director in January 2013.

An experienced Project Manager with a portfolio of successful change initiatives, Owen Pullen joined the LEMA team as Project Manager in 2011, since when he has helped to shape, and has been responsible for the delivery of, the LEMA project. Owen has a background in large – scale change management, from strategy definition to delivering initiatives across a wide range of domains. Owen's expertise in project delivery is complemented by significant experience of shaping and driving business strategy and developing the IT roadmap to enable it.

Panel 3.B: *ICT in the Regulatory Process*

Environmental Monitoring Data Sharing using Web-based Operator Data Portals: Current Environment Agency Initiatives

David Purchase, Environment Agency for England

The Environment Agency (EA) is working in partnership with a number of operators to improve the way environmental monitoring data required by our permits are made available to us by using web-based operator data portals. These are log-in websites that give access to defined layers of data and information held by the operator in their environmental data management system. They are owned and maintained by the operators, and accessed by EA officers under the terms of formal voluntary agreements.

There are many benefits from having such a portal, including: easy access to on-line high quality data, the development of more effective working relationships between regulator and operator, the ability to anticipate and resolve issues, and an effective means to improve the environmental performance of their sites.

Following the success of a national trial within the waste sector, we are extending the opportunity to use such portals to other operators within the waste sector and across other sectors. This initiative is a key part of our organisational programme to improve our use of regulatory data and to reduce the burden on our customers of providing their data to us.

The paper will explain our development of operator data portal agreements and how they fit into the larger national picture, particularly the current UK government Better Regulation programme and Smarter Environmental Regulation Review (SERR). It will examine lessons learned and ideas for future development.

Dave has over 30 years experience in regulation, risk assessment and environmental protection, at operational, managerial and advisory level. He has worked in both the nuclear and non-nuclear waste management sectors. He has been with the Environment Agency since 1996, working on modernising and improving regulation. Since 2010 he has been managing a project to reduce the data burdens of environmental monitoring data on industry and ourselves, whilst improving the effectiveness of that data. Web-based data portals are at the centre of this work.

He also likes playing acoustic guitar and singing.

Panel 4.A: *Putting Information to Work*
Open Sustainability and Environmental Regulation

Jack Townsend, University of Southampton

With the rapid growth of the Internet, an ever increasing quantity and variety of knowledge is available for reuse. An open knowledge movement has emerged to increase the availability and reuse of open data and other legally and technically accessible information such as open source software and open access to the scientific literature. These open resources can provide excellent opportunities for advancing environmental sustainability. Firstly, they are a political resource that can bring transparency to the environmental impact of institutions. Governments open data initiatives are increasing the quantity and quality of environmental information on both public and private sector bodies and their assets. This presents new opportunities for environmental regulators as well as the third sector to use this radical transparency to hold organisations to account fairly. There is great interest in the potential of ICT-enabled transparency to reduce corruption, particularly in the developing world. This is particularly pertinent for the environment, with many biodiversity hotspots located in emerging economies with poor governance. Politically, open knowledge may also provide a basis for informing public understanding and developing trust in environmental science, that is a required to support environmental legislation. The second major opportunity for open knowledge to advance sustainability is allowing more efficient use of resources with the aim of decoupling total energy use from economic growth. This can occur simply through sharing information with users (e.g. public transport information) or through the algorithmic optimisation of data (e.g. supply chain planning). Giving individuals greater access to their personal resource use data, such as energy bills, can increase efficiency of use. The third and final opportunity for open knowledge to advance sustainability is providing a basis for increased innovation required for both the technical and political transition to more sustainable society. For example, the Climate Colab allows virtual global communities to develop creative-commons licensed policy ideas, which could feed into the legislative process. Whilst there is evidence that overall, the opening up of knowledge can provide economic and social benefits, it is less clear that there will be net environmental benefits without effort and possible regulation to tackle significant complexities including the rebound effect and respecting sensitive information such as personal privacy. Beyond these practical connections, there are parallels and contrasts between how we govern the natural commons, and how we govern these proliferating "creative commons" of shared information.

Jack Townsend is researching the role of open knowledge and the Web in tackling climate change and advancing sustainability. This question has taken him from the energy sector - where he founded and led the global web and data innovation team for the trading arm of BP - to the Web and Internet Science group at the University of Southampton, UK, which has pioneered Web technologies, linked data and open data. Jack is a coordinator of the Open Sustainability group of the Open Knowledge Foundation, and was an organiser of the Sustainability Stream of the Open Knowledge Festival in Helsinki. He is also an organizer of Cleanweb UK, a web for sustainability community with monthly events in London, part of the global Cleanweb network. Last year he created Globe-Town.org, a winner of the World Bank #Apps4Climate competition, which conveys the risks, responsibilities and opportunities of climate change using open data. Find him at @JackTownsend_<http://twitter.com/@JackTownsend_>

Panel 4.A: *Putting Information to Work*

Climate Change and Public Engagement: Conceptualising and Developing the Role(s) for ICT

Brenda McNally, Dublin City University

This paper examines the use of communication technology in environmental governance and adaptation to environmental change. According to the NESC (2012) ICTs will be part of the technologies of governing around climate change policy, however this paper draws attention to the role of ICTs in public engagement and is therefore interested in ICTs and dissemination i.e. the socio-cultural aspects of environmental regulation. In particular, the paper highlights the social dimensions of adaptive environmental governance by exploring how ICTs can enhance the capacity of individuals and local communities to participate in transition to low carbon future. It argues that ICTs can play a crucial role in enacting public participation in climate adaptation by drawing on ideas about 'informational governance' and developing communication tools aimed at eResilience and eAdaptation (Ospina & Heeks, 2010).

While science and policy are central to meeting EU2020 commitments (and beyond) this paper highlights that public communication is also vital to achieving this goal. Thus the aim of this paper is to review developments and trends in climate change communication and public engagement in order to develop suggestions for understanding the role of ICTs as a tool for public participation. However, while ICTs offer a modality and the means to reach public(s) the question remains what type of information and choices should be offered? This is a significant concern as an increasing number of climate change organisations i.e. those involved in monitoring, mitigation and adaptation are now concerned with engaging publics in tackling climate change. This raises an additional question – how should they build ICTs into their strategic thinking?

To this end, the paper draws on the understanding of information as an influential (re)source with transformative powers and employs a framework for understanding processes of transition developed by Geels and Kemp (2007) to map out the communication context at the meso level. While at the micro level, it draws on theories of social practice over the dominant behaviour change model (Hargreaves, 2011). This approach to understanding the communication challenge is in line with the move within environmental governance to approaches that involve 'regulation through the social sphere' rather than 'command and control' approaches i.e. to informational governance rather than regulatory-based governance (Mol, 2009).

Brenda McNally commenced her Ph.D. studies at DCU in 2011 following an M.Sc. Dissertation on Climate Change Communication and NGOs in Ireland (2010). Her doctoral research examines the factors that constrain (potential) citizen engagement in communication strategies and media representation about climate adaptation in Ireland. The research sheds light on how state and non-state actors conceptualise and enact public participation in on-line communication initiatives, policy-formation and print media coverage. The purpose of the research is to extend knowledge about mediated participation particularly in the context of transitions associated with environmental change and technoscientific progress. In doing so, the project aims to contribute a communications perspective on the need for a socio-technical template for transition to a low carbon future.

Brenda is interested in communication strategies and media practices associated with environmental risks and sustainability. Her research focuses on the socio-cultural and socio-political dimensions of communication about environmental, sustainability and risk issues.

Panel 4.A: *Putting Information to Work*

A Review of the MARGIS Modelling System and Its Use by the English Environment Agency in the Assessment of the Potential Impact of Discharge Consent in the Coastal Zone

Dr. Conor Delaney, MarCon Computations International Ltd

Numerical water quality models are a key tool in management of environmental quality in estuarine ecosystems. The use of water quality models can require technical skills that may not be available to the managers of such ecosystems. To facilitate the day-to-day use of water quality models in estuarine management a water quality model was embedded into a GIS application called MarGIS. MarGIS combines state-of-the-art GIS functionality with a powerful numerical hydrodynamic and solute transport model, DIVAST, and a database management system (DBMS). MarGIS enables users to interact with and visualise the complex processes occurring in transitional waters and determine appropriate management strategies for the water body.

The system is currently used by the English Environment Agency in the assessment of discharge consents as part of the Review of Consents under the Habitats Directive (Council Directive 92/43/EEC), which aims to protect Natura 2000 designated sites. MarGIS has been used to produce evidence to defend decisions to replace existing discharge consents with more stringent ones. An example of such a planning decision against a major utility company is discussed here.

Currently Conor is managing the Marine work package of the ENVIROFI project (www.enviofi.eu). This is a Framework 7 research project to investigate the potential of Cloud Computing technologies when used with EU environmental data standards (i.e. INSPIRE).

Conor has over 15 years' experience of software development and database design focused primarily in area of environmental management and research. However he also worked as software developer in others fields such as financial services and management software development. He is experienced in many different IT technologies including numerous database systems. Conor is also experienced in GIS (Geographical Information Systems) developed and remote sensing. He has developed many environmental management systems based on GIS technology. He experienced with using both aerial and satellite remote sensing. Dr. Delaney holds an honours degree, (B.A. (mod)), in Mathematical Science, a master's degree, (M.Sc.) in Environmental Science and a Ph.D. in Atmospheric Physics. He is a member of the Royal Meteorological Society and the European Geophysical Union.

Panel 4.A: *Putting Information to Work*
Environmental Regulation with Corporate Governance: the Role of ICT

Fearghal McHugh, Whitaker Institute and LERO

ICT systems can report and support better decision making on regulation and environmental controls across the enterprise, and provide indicators where these processes exceed imposed control limits. Corporate governance can affect the design of systems and decisions across the enterprise in terms of control and reporting, they are also limited by the practice of comply or explain; relying on the good will of the company to establish how their environmental performance is reported as demonstrated by PUMA (PUMA, 2011), and how much explanation is actually required when compliance is weak in terms of environmental standards.

Mr McHugh is a lecturer in corporate governance and information management principles at the National University of Ireland Galway and Galway-Mayo Institute of Technology. His research interest is decision support systems.

Panel 4.A: *Putting Information to Work*
Openly Accessible GIS Data and Local Government Planning Policy

Dr. Ronan Hennessy, Ryan Institute, National University of Ireland Galway

GIS (Geographical Information Systems) is a globally adopted information and communication technology (ICT) used for the investigation and visualisation of environmental and socio-economic information. Throughout the past decade in Ireland there has been a vast increase in open access to GIS datasets from state organisations (e.g. Geological Survey of Ireland, National Parks and Wildlife Service; Environmental Protection Agency) via Internet data delivery systems. In consideration of data acquisition and resource administration, this open access regime has greatly served to support the environmental obligations encountered by both government organisations and environmental consultants in the completion of environmental assessments and surveys. Two case studies are herein presented, which discuss the role of openly accessible GIS resources and online services (WMS) in the completion of reports that serve to inform local government planning regulations and policy. The first case study introduces the role of GIS in the completion of a Strategic Environmental Assessment (SEA) and Appropriate Assessment (Directive 2001/42/EC) for a County Development Plan Review. The second case study introduces a lesser-known county planning related programme; the Irish Geological Heritage Programme (IGHP). The IGHP was established to document sites of geological heritage in Ireland and to ensure conservation in future local government planning decisions. The development of INSPIRE Directive (2007/2/EC) compliant GIS databases and informative maps and visualisations was central to the two case studies, examples of which will be presented.

Ronan Hennessy is the Senior Technician in Geographical Information Systems (GIS) at NUI Galway's Ryan Institute for Environmental, Marine and Energy research. Ronan also teaches at NUI Galway's Department of Earth and Ocean Science, where he was awarded a Ph.D. in 2009. Ronan has conducted research in the fields of GIS, geoscience, public health and environmental management and public policy. In 2011, Ronan was invited to present his research on Google Earth at Google Headquarters in California, and has presented his research throughout Ireland, the UK, USA, and Scandinavia. Within the field of GIS, Ronan has been involved in county development planning projects, county and national heritage initiatives, and international environmental education programmes. Ronan worked as Geopark Geologist with the Burren & Cliffs of Moher Global Geopark from 2009 to 2011, where he helped to secure the designation of the Burren as a UNESCO Global Geopark. As well as publishing many science-press articles and academic papers, Ronan has co-published two books: *Stone, Water: A Geology Trip through the Burren*, and *Galway's Living Landscapes: Part 1 Eskers*.

Panel 3.A: *Information Driving Innovation*

Integrating Spatial Planning and Flood Risk Management: a Conceptual Framework of a Spatially Integrated Policy Infrastructure

Jing Ran and Professor Zorica Nedović-Budić, University College Dublin

Flooding is a widely occurring natural hazard that causes noticeable damage to property, people and the environment. In the context of climate change, the integration of spatial planning (SP) and flood risk management (FRM) has gained further prominence as an approach to dealing with risks of flooding. The absence of appropriate information base and technological capacity are among the factors impeding this integration. Limited research has been conducted to develop the framework for the integration of SP and FRM and investigate the role of information and technologies in the integration process. This paper reviews a variety of literatures and identifies three core dimensions of integration: territorial, policy and institutional dimension. Territorial integration focuses on consistency cross boundaries or alignment between different spatial scales. Policy integration is the management of crosscutting issues that transcend the boundaries of established policy fields. Institutional integration indicates co-operation and coordination between different parties. To expand the capacity of integration facilitating, a Spatially Integrated Policy Infrastructure (SIPI) is conceptualized. The SIPI encompasses three elements: a) data and information, b) decision support and analysis tools, and access tools and protocols. This SIPI framework responds to the three integration dimensions and will guide the development of the Spatially Integrated Policy Infrastructure (SIPI) for supporting the considerations and interactions coming from both spatial planning and floor risk management perspectives and stakeholders.

Jing is a PhD candidate in the School of Geography, Planning and Environmental Policy since September 2011 and is supervised by Professor Zorica Nedovic-Budic. Her research topic is “Geospatial technology and infrastructure for evidence-based planning and policy in flood-prone areas”. Jing is graduated from University College London in UK with a merit M.Sc. degree in Geographic Information Science in 2011. Before that, she got her B.Sc. degree in GIS from Beijing Normal University in 2010.

Panel 4.A: *Putting Information to Work*

Graphic Warning as a Regulatory Tool and Free Speech Interests in the U.S.

Professor Ellen Goodman, Rutgers University School of Law

Around the world, environmental activists have pursued mandatory labeling regimes to achieve a range of regulatory goals, such as the reduction of hormones in milk and mercury in landfills, reduced lifecycle carbon release, and the consumer's right to know about genetically modified organisms. Those who study "regulation by disclosure" posit that communication with consumers is most persuasive and informative when it's simple, graphic, and at the point of purchase. Significant research on nutritional labeling and energy efficiency has borne out this hypothesis. When it comes to pushing consumers towards pro-social consumption or warning them off harmful consumption, powerful images and graphics will convey the desired message most effectively.

When the U.S. government tried to implement these insights, as well as the global consensus on tobacco warning labels, it ran into an obstacle that will shape all mandatory labeling regimes in the U.S.: the free speech interests of the regulated entity. In 2010, the U.S. Congress ordered the Food and Drug Administration to follow dozens of other countries in adopting graphic warning labels to replace the textual warnings that have long been required on cigarette packages. In 2012, a U.S. appeals court ruled that these warnings violated the First Amendment of the U.S. Constitution. Indeed, the ruling cast doubt on a wide range of labeling approaches that use graphic and emotionally charged images to communicate risk. It was widely assumed that the government would challenge the decision at the Supreme Court, as it typically does in these cases. But the government declined to do so, apparently worried that it risked a sweeping adverse ruling that would cripple its ability to mandate all manner of disclosures on products.

The jurisprudence around mandatory product disclosures is in disarray with no consensus on the proper balance to be struck between the regulatory goals and the free speech interests implicated. My paper criticizes the approach taken with respect to the tobacco warnings to the extent that it turned on the emotional power and ambiguity of graphic communication. The First Amendment and free speech values do not privilege textual or purely cognitive channels of speech. Instead, I propose an analytical frame that puts listener autonomy interests at the center. We should be wary of compulsory messages, regardless of form, when they commandeer private resources for the government's ideological purposes. However, the fact that the government has a normative agenda (e.g., to reduce smoking, obesity, carbon emissions) – rather than merely an informational one (e.g., to promote informed consent) -- does not render the government message ideological. Even highly emotional and graphic disclosures, which have indeterminate meaning, do not necessarily compromise listener autonomy. Indeed, to the extent that these kinds of communications transmit information more effectively, they enhance listener autonomy.

Professor Ellen P. Goodman, Rutgers University School of Law, is a leading American expert on media policy. She co-directs and co-founded the Rutgers Institute for Information Policy and Law and teaches media law, intellectual property law, advertising law, and property law. She recently served as Distinguished Visiting Scholar with the Federal Communications Commission and was responsible for the nonprofit media section of the landmark Information Needs of Communities Report. Professor Goodman has published extensively on public media models, spectrum policy, and advertising law. Her writing is available at ssrn.com. She has had visiting appointments at the University of Pennsylvania's Annenberg School of Communications, as well as Penn's Wharton School of Business and Law School, and Bar Ilan University. Prior to joining the Rutgers faculty, Professor Goodman was a partner at Covington & Burling LLP, where she practiced in the information technology area. A graduate of Harvard College and Harvard Law School, Professor Goodman was a law clerk for Judge Norma Shapiro on the federal court for the Eastern District of Pennsylvania. She lives near Philadelphia with her husband and three children.

Panel 4.B: *Gathering Information*

Development of an Online Systems Modelling Tool for Climate Adaptation

Anthony Patterson, University College Cork

Scientific evidence indicate that the earth's climate is changing and that without taking appropriate and early action, climate change will have detrimental impacts for many areas of the planet, including Ireland. However, knowledge about future climate, particularly the local impacts of global climate trends is incomplete. Nonetheless, it is clear that adaptation actions will be required to reduce the negative impacts and take advantage of any opportunities climate change might present. In response, the National Climate Change Adaptation Framework, published by the Government of Ireland in December 2012, provides a strategic policy focus to ensure adaptation measures are taken across different sectors and levels of governance to reduce Ireland's vulnerability to the negative impacts of climate change.

For several years and in order to enable spatial planners develop measures to adapt to climate change in coastal areas, researchers at the Coastal & Marine Research Centre at University College Cork have been employing fuzzy cognitive mapping techniques (FCM) to facilitate planning for adaptation. FCM is a semi-quantitative method, which provides a means of mapping complex systems and their inherent dynamics where system uncertainty is high and empirical data is deficient or costly to collect. More recently and in order to support this work, a prototype web-based software system called iasess:coast has been developed.

Two major factors motivated the employment of a strongly ICT focused solution to coastal adaptation. Firstly, the workload involved in employing cognitive modelling techniques in a workshop setting was proving a barrier to more widespread deployment of the toolkit. Secondly, the deployment of elements of the toolkit potentially opens up a vast new user base, allowing inputs from a much wider stakeholder group.

Initial prototyping has focused on building a web-based solution, as this was felt to maximise the potential audience. The key challenges include building a system which can scale to the internet, while still being useful to and comprehensible by a small group of practitioners; balancing stakeholder expressiveness with a need to constrain inputs so that a representative group model is achievable; and incorporating useful feedback into the system so that it becomes a tool not just for capturing causal relations but for exploring the consequences of those relations.

The software is already being incorporated into Ireland's Climate Information Platform, a key part of the EPA's Climate Change Research Programme and the government's National Climate Change Adaptation Framework. There it is being used to explore the boundary between qualitative and quantitative modelling in order to transform complex climate data based on physical models into actionable information aimed at local policy makers.

Anthony Patterson is a researcher at the Coastal & Marine Research Centre specialising in the development of software in support of environmental data analysis and visualisation. He has designed the systems architecture for the recently completed NETMAR FP7 project. He has also developed the prototype Climate Information Platform for Ireland under EPA sponsorship.

Prior to entering research, Anthony worked for fifteen years as a software designer and developer.

Panel 4.B: *Gathering Information*
Satellite Remote Sensing for Environmental Monitoring and Regulation

Dr. Fiona Cawkwell, Department of Geography, University College Cork

Since the first Earth Observing satellite sensors were launched in the 1970s, the potential for environmental mapping and monitoring offered by remote sensing has been recognised. However, until recently limitations posed by spatial, spectral and temporal resolution, as well as a paucity of long time series datasets with which to evaluate change, have restricted the use of such tools for regulatory purposes. In recent years technological developments, including the launch of several sub-metre imagers, a growth in the number of all-weather microwave sensors, constellations of sensors offering multiple views per day, and an increase in computing and visualisation power have enabled Earth Observation to become a more widely accepted regulatory tool. The role of satellite data in supporting national and international environmental targets has been demonstrated through a variety of projects at University College Cork.

As an Annex 1 signatory to the UN Framework Convention on Climate Change, Ireland is obliged to report an annual inventory of greenhouse gas emissions and removals in 'land use, land use change and forestry'. Satellite imagery provides much higher resolution national information on the spatial variability of these features than current, predominantly statistical, approaches, and research examining both agricultural and forested land and change from images is demonstrating good results. Implementation of the Habitats Directive, and other EU regulations, can also be supported with the use of higher resolution imagery. Small scale land use changes within a peat bog were demonstrated by a project conducted for Friends of the Irish Environment, and welcomed by the Irish Government.

The Marine Strategy Framework Directive requires EU Member States to implement measures to achieve and maintain good environmental status of marine waters by 2020, and satellite imagery can be used to identify approaches to the regulation and management of natural marine resources and their anthropogenic uses. Ship detection and tracking from radar imagery, when combined with other sources of on-board ship information, has been successfully used to identify anomalous targets or behaviours of vessels at sea and events such as oil spills, with the Irish Naval Service and Coast Guard increasingly relying on this data feed. Deterioration in water quality and the presence of algal blooms can similarly be detected, as can other elements that might result in conflict associated with energy, fisheries or protected ecological zones.

With a growing archive of historic data, satellite imagery is increasingly being used to identify decadal trends in climate. The Global Climate Observing System has identified 50 Essential Climate Variables which require long term observations from in situ and remote platforms, with outputs of scientific importance, relevance to mitigation against and adaptation to climate related disasters, and with potential to contribute to legislative systems. Examples of work being undertaken at UCC include improved storm surge forecasting and derivation of global soil moisture products over the period 1978-2010.

Dr Fiona Cawkwell has been lecturing in Remote Sensing at UCC since 2006, and she currently leads the Earth Observation research cluster as well as co-ordinating the M.Sc. in Geographical Information Systems and Remote Sensing. Fiona is currently PI on an EPA funded project to develop the Irish Land Mapping Observation, with a focus on the use of satellite remote sensing for mapping Irish grasslands with a view to generating accurate inputs to greenhouse gas models, and she is a partner in a UCD-led project to similarly map forestry areas. Fiona has also worked on projects funded by the British National Space Centre and Friends of the Irish Environment with a focus on discriminating habitats and monitoring their change. Fiona works closely with colleagues at the Coastal and Marine Research Centre in Cork, where the remote sensing focus lies more on water-based applications of the technology.

Panel 4.B: *Gathering Information*

The Cause-and-Effect Problem in Regulated Environmental Monitoring

Dr. Rohan Sadler, Astron Environmental Services

Many jurisdictions worldwide have now adopted the IUCN's pressure-state-response (PSR) framework to demonstrate whether losses in ecological values are attributable to different management activities in highly complex and variable ecosystems. This is seen clearly in Australia's mining industry which is now committed by regulation to extensive long-term ecological monitoring to ensure the persistence of lease agreements. These requirements are largely novel, and require the development of a new set of ecoinformatic services: i) high tech data acquisition; ii) data warehousing; iii) scientific workflows and automated incident and compliance reporting; and, iv) the integration of diverse data and models to partition cause-and-effect, or model future sources of risk, in what can only be termed 'scientific analytics'. Here we describe one scientific analytical solution that integrates spatially explicit data with a spatially explicit population model for scenario testing of alternate management and population growth scenarios in weed management and population viability analysis. We then describe what an 'ideal' analytic solution to the cause-and-effect demonstration problem would look like, and highlight the gaps between current practice and desired end-point, one that integrates on-ground validation, remote sensing, modelling, economics and spatially explicit decision tools.

Rohan is a Senior Scientist at Astron Environmental Services. His background is in both ecosystems ecology and computational statistics. Before joining Astron, Rohan was a Research Assistant Professor in the School of Agricultural and Resource Economics providing advanced data management and modelling skills to regional scale plant biosecurity and biodiversity conservation projects. He specialises in modelling ecosystem dynamics through time using remote-sensed imagery. These landscape-scale dynamic models are then used as inputs for decision models, to optimise environmental surveillance or management decisions across landscapes.

Panel 4.B: *Gathering Information*

How the Law Supports Existing Models of Environmental Data Reuse

Laura German, University of Southampton

The future of the environment relies on accessible, good quality data that are assured as reliable, robust and fit for purpose. This enables: 1) policy makers to base future environmental management decisions on the best quality data; 2) researchers to reuse and build on prior, trusted research; and, 3) the general public to access data and observe transparent environmental management and research. This paper explores how the law currently supports environmental data reuse mechanisms on the Web.

The Web significantly impacts on the creation, dissemination and (re)use of environmental data through: its instantaneous speed of knowledge transfer; its vast and increasing storage capacity for data; its potential to reach a global audience; its ease of search (engines); and its ease of copy, cut and paste. Environmental data are no longer confined by print and restrained by physical delivery. In this digital age, these data are able to reach wider audiences than ever before. Although it is technologically possible to provide access to high quality environmental data on the Web, not all these vital data are accessible online or shared. Due to the increased amount of environmental data on the Web, it is also potentially difficult to distinguish good quality data from bad quality data. Environmental data are multi-disciplinary and multi-user – focused on climate change and rising sea levels to renewable energy sources and biodiversity. A number of specialists are required to independently verify the quality of each datum. There are such authoritative models of environmental data reuse in existence however - such as the 'Marine Environmental Data and Information Network' (MEDIN) <http://portal.oceannet.org>.

This paper focuses on MEDIN as an illustrative case study. It offers an existing, working model of data reuse that is based on data discovery in a digital age. It is the UK government mechanism for marine environmental data and information reuse. The online portal offers access to an 'authoritative' marine environmental discovery metadata catalogue that links to a number of trusted thematic data archives centres, including the British Oceanographic Data Centre and the Data Archive for Seabed Species and Habitats. This paper examines how the law is supporting the reuse of high quality marine data in the UK, between European Union member states and beyond. This occurs in two main strands at MEDIN: 1) legislation that mandates the reuse and/or access of certain types of environmental data, such as the INSPIRE Directive, Environmental Information Regulations, and the Freedom of Information Act; and, 2) the control over reuse of data and products, such as copyright and data licensing.

This paper presents key findings from semi-structured interviews conducted (in February 2012) with six individuals directly involved with MEDIN. It determines how these two strands of law support (and potentially hinder) the reuse of marine environmental data at MEDIN.

Laura is in the third year of an interdisciplinary Web Science PhD at the Web Science Doctoral Training Centre, University of Southampton. She was awarded a 4-year studentship to study a Web Science M.Sc. and Ph.D. This is funded by the 'Research Councils UK Digital Economy Programme'. She obtained an M.Sc. with distinction in Web Science at the University of Southampton (2010) – this included computer science modules based on Web technology. She obtained an undergraduate law degree (2009) at the University of Southampton.

Panel 4.B: *Gathering Information*

Examining the Potential of Crowdsourced Volunteered Geographic Information for Environmental Observation and Regulation

Dr. Peter Mooney, National University of Ireland Maynooth and Dr. Andrea Ballatore, University College Dublin

Environmental regulation is as much about citizen participation as it is based on legal implementation by local, regional, and national agencies. In recent years crowdsourcing "has become a mega trend in recent years, fueling innovation and collaboration in research, business, society, and government alike" (Bott and Young, 2012). Crowdsourcing has moved from strictly the domain of open source software development and knowledge projects such as Wikipedia to a much wider set of application domains.

The near ubiquitous usage of smartphones and 'always-on' Internet has presented citizens with unprecedented opportunities to participate in: environmental decision making, local, regional and urban planning, etc. For example, last year the Finnish government setup a 'citizens initiative' which essentially allows for the crowdsourcing of proposals from the public which, if they generate enough support, means the government are forced to vote on them. Crowdsourced volunteering activities are going far beyond software development or simple information sharing. Today, crowdsourcing is used to create and increase collective knowledge, community building, collective creativity and innovation, crowdfunding, and civic engagement (Bott and Young, 2012). Powered by this widespread and increasing access to the Internet, mobile phones, and related communication technologies, the use of crowdsourcing for policy advocacy, e-government, (World Bank, 2011) and e-democracy has grown exponentially during the past decade. (Shirky, 2008)

The focus of our paper and contributions to this workshop is focussed on the importance that "place" and "space" have generated through the rise of social networking and user-generated content on the Internet. Citizens can geo-tag photos, videos, blog-posts, tweets, etc with their current location. The phenomenon of Volunteered Geographic Information (VGI) has grown from the concept of UGC and has seen, in recent years, hundreds of thousands of citizens work collaboratively in a crowdsourced model, to collect spatial information about the earth: from roads and rivers, and-parcels, environmental facilities, commercial and retail holdings, etc. Amongst the most famous and well supported projects in this crowdsourced model are OpenStreetMap, Wikimapia, and Google MyMaps. Communities are now generating very detailed maps and spatial databases of their own areas without the support of commercial mapping agencies or governmental mapping agencies. Research has shown that these crowdsourced VGI maps and databases are of very high quality (both spatially and temporally).

In our presentation to the workshop we will outline our current research work in understanding the communities behind the collection of VGI. This will describe work we have carried out in understand the cultural factors and semantics involved in VGI. Our hypothesis is that the types of patterns of community activity found in VGI should be used by environmental regulators to understand better the current needs and concerns of their local communities.

Dr. Peter Mooney has been working with GIS, spatial databases, open source software, and Internet technologies for over 10 years. He is a senior research fellow with the Department of Computer Science at NUI Maynooth and with the Irish Environmental Protection Agency (EPA). His work on Volunteered Geographic Information (VGI) at NUI Maynooth is amongst the first of its kind in the field of VGI and User Generated Content. With the EPA he is the Irish technical representative at a series of ongoing meetings with the EU Commission and European Environment Agency tasked with implemention of changes to data exchange protocols for various European Air Quality Directives.

Panel 4.B: *Gathering Information*
Overcoming Barriers to Obtaining and Evaluating Energy Consumption Data

Professor Elizabeth Wilson and Professor Alexandra Klass, University of Minnesota

While the U.S. economy has become steadily more efficient and now produces more goods and services with less energy, an estimated $130 billion in cost-effective annual energy savings go unrealized each year. This undermines the competitiveness of the American economy across global markets and hinders the ability to develop cost effective energy efficiency programs and standards.

In spite of over thirty years of local, state and federal programs offering energy efficiency incentives and educating residential, commercial, and industrial customers about cost-effective energy saving opportunities the impacts of these programs consistently fall short and future potential untapped. McKinsey estimates that $520 billion invested in non-transportation energy efficiency by 2020 could generate energy savings worth over $1.2 trillion, reduce end use energy demand by 23% of current projections and simultaneously provide over 1.1 billion tons of greenhouse gas reductions.

Energy demand management and energy efficiency are key components of the future electricity system. But deploying energy management technologies over multiple industrial sectors, in 100 million buildings and billions of end use devices, requires tremendous scale up in both project size and investments. While energy management has enormous potential to reduce electricity use, reduce the need to build additional power plants, and help to create a more economically and environmentally sustainable energy system, one crucial barrier stands in the way: information on energy consumption.

While emissions and electricity generation data are available at the boiler or plant level on an hourly basis through the EIA, EPA and FERC, energy consumption data is available only as estimates through quadrennial surveys. But even these do not happen regularly: the last Commercial Building Energy Survey (CBES) was done by the Department of Energy in 2003. Given today's sophisticated electricity system, the lack of data for energy management is striking.

This lack of data creates important information asymmetries and hinders market energy transparency. These market failures causes several problems:

Evaluating existing programs: Lack of energy consumption data makes it impossible to evaluate and compare current efforts. In 2011, utilities spent almost $7 billion on energy efficiency programs. But assessing and evaluating which programs are most effective is often stymied by lack of energy use data.

Targeting future energy management opportunities: Lack of energy consumption data makes energy management program design, planning, implementation, and evaluation much more difficult. Federal, state and local governments encourage energy efficiency through tax incentives, building standards, and appliance efficiency standards, spending vast sums of public money in the process. However, evaluating the efficiency and effectiveness of these programs often relies on modeled data, making evaluation of smaller efforts or comparing programs difficult.

Scaling energy management: Lack of energy consumption data makes targeting new opportunities and scaling up finance for energy efficient projects challenging and unable to benefit from large-scale investment.

This project outlines current energy consumption data availability, new opportunities with energy consumption data, analyzes analogous models and finally proposes new legal models and policy measures to make this critical resource available for future energy management.

Dr. Elizabeth J. Wilson is an Associate Professor of Energy and Environmental Policy and Law at the Humphrey School of Public Affairs at the University of Minnesota. Her research examines policies and institutions supporting energy system transitions. She holds a doctorate in Engineering and Public Policy from Carnegie Mellon University and was selected as a Leopold Leadership Fellow in 2011.

Panel 4.B: *Gathering Information*

An Argument for a GIS Contaminated Land Inventory for the Republic Of Ireland

Padraic Mulroy, Principal, Mulroy Environmental

To date, Ireland has no national soil protection policy nor does it have any national soil quality and/or remediation standards. In an inventory of contaminated land sites carried out by the Irish EPA in 1999 and presented in a CARACAS publication, the number of contaminated land sites in Ireland was conservatively estimated at a relatively modest 2,000 to 2,500. This number was derived from an inventory of contaminated land sites in the petroleum retail sector, at various industrial sites, at closed landfill sites, timber treatment yards, scrap yards, railway yards and former gasworks sites. In comparison, the number of contaminated land sites in the UK is estimated at possibly over 100,000. It is stated that the number of brownfield sites or facilities with contaminated land legacies in Ireland is significantly less in Ireland than those of most other more industrialized European countries such as the UK, due to Ireland's relative late arrival into the industrial age. The Northern Ireland Environment Agency (NIEA) carried out an inventory of potentially contaminated land and have stated in 2011 that they have indentified a number in excess of 14,000 sites. This number was revised upwards from 12,000 in 2009. Mulroy Environmental carried out an 'in-house' inventory of key industrial sectors. This in-house inventory suggests that the NIEA contaminated land database number is correct. As such, it is likely that the Rep. of Ireland has over twice the number of potentially contaminated sites as that of Northern Ireland i.e. >30,000.

The value of having an inventory of potentially contaminated land available to the public appears to have been underestimated within the Republic of Ireland. A review of the introduction of environmental legislation in the Republic over the past 20 years (particularly the Waste Management Act, 1996) would indicate that there is an unease within the regulators at the introduction of a freely available inventory. The primary reason for this would appear to be a fear within regulators of drawing the wrath of the property development and real estate sectors due to 'property blight'. A secondary reason would appear to be legal ambiguity over the true purpose of Sections 22 and Section 26 of the Waste Management Act, 1996.

The value of having a publically administered GIS based system which would list properties that have been potentially contaminated in the past can not be argued against. This list would ideally draw on the extensive experience of the UK Environmental Agency with regard to work previously carried out on various industrial sectors (i.e. the EA have drawn up a list of 30 industrial profiles). This would provide potential buyers with a clear indicator of whether a Phase I Site Audit should be carried out by an environmental consultant as part of Pre- purchase Due Diligence work. The scenario of an investor or developer purchasing a property in the Republic of Ireland that has, after contract completion turned out to have contamination is very common. This is a scenario that can be avoided.

Padraic Mulroy has over 17 years experience in environmental consulting and has considerable project management experience in contaminated land assessment, environmental impact assessment, planning applications, waste licensing and permitting, waste facility design, extractive industry, infrastructural projects and energy generation facilities. He is a Chartered Scientist with the UK Science Council and a professional member of the Institute of Professional Soil Scientists (IPSS) and the Institute of Engineers of Ireland (IEI). Padraic is a member of the Specialist in Land Condition (SiLC) Register. This professional register provides a formal accreditation process for senior professionals involved in issues of contaminated and brownfield land. Padraic has experience of working as an expert witness in court and at oral hearings and is a member of the Round Hall 'Irish Bar and Expert Witness Register'. He is also a member of the International Association of Hydrogeologists (IAH), the Association of Petroleum and Explosives Administration (APEA) and the British Land Reclamation Society (BLRS).

Panel 4.B: *Gathering Information*
The Role of Non-Governmental Organisations

Dawit Dagnew Kebede, GIZ Energy Coordination Office and Addis Ababa University School of Commerce

Many developing countries are confronted by many challenges when it comes to information access and participation in knowledge networks. Obvious challenges are limited access, low literacy rate, lack of media competence to use the ICT. Newer ICT offer an immense opportunities towards environmental regulation formulation and implementations for developing countries. Although the development of ICT infrastructure and implementation are promising, many challenges still need to be addressed. Significant challenges, for example are, funding and policy advice, local and international NGO's can support and take leading role in creating enabling environment for the use of ICT for environmental regulation to put in place by funding, developing projects which can improve the use of ICT thorough integrated technical training and ongoing capacity development interventions subsequently strength the potential of ICT.

Apart funding role, NGO's has great potential in advising government on use of ICT for environmental policies and regulations, and programs; bring issues related to environment to different level, enabling government, civil society and the private sector to participate and work collectively towards enhanced sustainable environment.

Ethiopia is a vast country endowed with abundant renewable energy resources. Only 14 percent of its 84 million inhabitants have access to electricity. For the 71 million people living in rural areas this figure is less than two percent, which is seriously limiting the country's growth and development. The absence of other affordable power sources, people still rely on traditional forms of energy, such as firewood, which leads to increased deforestation, soil erosion as well as health problems. To combat this situation, appropriate renewable and environmentally friendly energy resources are demanded. GIZ Energy Coordination Office (GIZ ECO) helps to improve access to modern energy services in Ethiopia. Recently GIZ ECO makes an important contribution to the use of ICT for sustainable renewable energy development processes in the country by developing a web-based and GIS-enabled energy database and at updating the country's energy sector data

I will give insight case analysis on how GIZ ECO funded and support the Ethiopian government initiated energy sector mapping and database development project to build the country's energy sector database and management capacity through developing digitalized energy sector database. The database anticipated facilitating up-to-date information access mainly for policy development, planning and coordination within the energy sector thorough the provision of up-to-date and reliable data as well as contribute to private sector development and participation in the energy sector. The first phase of the project has already put in place.

Dawit Dagnew is currently working as Knowledge Management Office at GIZ ECO. He obtained his first degree in Business Administration and Information Systems from Addis Ababa University College of Commerce. He start his carrier as and ICT expert and he has done intensive work with development organization as well as government partner offices in ICT. His scholarly works are in the area of ICT and business development. Furthermore, works with and advocates open source applications.

As a development worker Dawit is advocator for sustainable development and poverty reductions programs.

He is also actively working on creating and promoting online and face-to-face information exchange platforms and actively working on community of practice in the renewable energy sector through GIZ. He is a principal player of Talk Energy Ahead platform in Ethiopia. He is currently perusing a post graduate study in Marketing Management spanning with both research and development practices.

Panel 5.A: *Privacy Issues*

Cross-Fertilisation Between Fundamental Freedoms and a Clean Environment: The Legal Hook of Data Protection Legislation

Raphaël Gellert, Vrije Universitiet Brussel

In its 2020 strategy, the European Commission lays the foundations for a new strategy of growth for Europe that would be smart, sustainable and inclusive. The digital agenda flagship initiative places Information and Communication technologies (ICTs) at the heart of this strategy, as a critical enabler to achieve such growth.

The progressive development of smart grids is a good example. By providing citizens with smart meters capable of reading consumption data at very high frequencies and communicating such data to energy providers, it was thought to help consumers have a better control over their energy consumption, thus showing the critical role of ICT innovation in environmental regulation.

This contribution strives to highlight a few critical elements.

First, it will discuss on the compatibility between models of ICT growth that seem to be antithetic to those purported by the 2020 Horizon initiative. Indeed, as legal critics have shown, like most ICT innovations the smart grids model is built around the principle of "data maximalisation" (fundamentally opposed to the EU data protection Directive principle of data minimisation). One has to wonder whether such a principle can actually be effective in leading towards growth that is smart and sustainable.

Second, the contribution goes on to wonder on the fruitfulness of an approach that tries to tackle environmental issues through data processing operations. In fact, privacy and data protection legislations can only grasp the legal issues spurred by smart grids in terms of how they affect citizens' liberties. The issue here is that of the correlation between the safeguard liberties and models of economic growth that are sustainable.

This leads to final reflections on whether legal cross-fertilisation between data protection law and other legal principles such as the principles of precaution and sustainable development might be instrumental in truly achieving the goals put forward by the 2020 Horizon.

Raphaël Gellert is a full-time researcher and a Ph.D. candidate at the LSTS (law, science, technology, and society) research group of the law faculty of the Vrije Universiteit Brussel (VUB). Since his arrival at LSTS, he has written on privacy, data protection (especially in the context of the EU-FP7 project PRESCIENT), discrimination, and accountability. He is now preparing his Ph.D. on the application of the precautionary principle to data protection legislation from a cosmopolitical perspective. Raphaël Gellert has a law degree from the Université Libre de Bruxelles (2008) and a European Master's Degree in Human Rights and Democratisation (2009).

Panel 5.A: *Privacy Issues*
ICT and Perspectives of Privacy

Dr. Asher Vaturi, Max Stern Yezreel Valley College

Developments of future monitoring ICT tools such as remote sensing, surveillance cameras, smart houses and advanced sensors are important to secure our social and natural environment. However, it is well known that these technologies might cause several considerable injuries to privacy of residents and their freedom.

The aim of this study is to discuss how modern societies perceive privacy in this changing technological environment. It tries to evaluate the vulnerability of this value regarding new ICT technologies.

The study suggests possible changes in the privacy perception of European citizens since the 1990s. it analyzes the challenges among the ethical and legal frameworks resulting from these changes. These possible changes are associated with part of European Commission regulation on the fundamental protection of individuals with regard to the processing and free movement of personal data.

Dr. Vaturi is a senior member in FIRS2T (The Future Insight Research Security, Society and Technology) and is leading activities in Environment, Energy and sustainable development as well as cooperation with municipalities. He has a Ph.D. in urban planning is the head of Sustainability study program at The Max Stern Yezreel Valley College, and is a member of the FIRS2T team in EPI Jerusalem. Dr. Vaturi's research focus is on environment, urban policies, universal design and socio-economic aspects of different social groups such as disabled and old people. He has experience in EU projects including OPET Network, POLIS, EFONET, PERFECTION and others in FP7. He was a senior partner to the "Train the Trainers" EU's education program for decision makers in the energy sector.

Since 2012, Dr. Vaturi serves as the head of technology innovation committee of Israel Clean-Tech international convention. He focuses mainly on emerging energy and water technologies and their implications among different economic sectors.

Panel 5.A: *Privacy Issues*

Environmental Protection and Data Protection Law: Clouding the Debate?

Professor Burkhard Schafer, SCRIPT Centre for IT and IP Law,
University of Edinburgh

Data protection law. ICTs and environmental protection are uneasy bedfellows. Recently, the tension between Data Protection and Smart Grid Communication has attracted particular attention. In this discussion, there is a direct connection between the need to collect certain types of data (usage of energy for instance) and the possible privacy risks for individuals. After shortly presenting this debate, comparing UK, German and pan-European approaches to the problem, this paper will take a different tack. Can environmental protection arguments play a much more generic role to limit data protection principles, where the privacy risk is both more abstract and much more indirectly linked to environmental concerns? One example that will be at the centre of this talk is cloud computing. Are the promised environmental benefits of moving computing capacity to the cloud a sufficient justification to increase an abstract data protection risk for customers of services moving into the cloud? We will discuss how this more abstract case of balancing environmental protection and data protection law can also yield insights into the issue of smart metering.

Burkhard Schafer studied Theory of Science, Logic, Theoretical Linguistics, Philosophy and Law at the Universities of Mainz, Munich, Florence and Lancaster. He joined Edinburgh University School of Law in 1996, and was awarded the Chair in Computational Legal Theory in 2010.

He is currently Director of the SCRIPT Centre for IT and IP law, working mainly on issues such as privacy compliant software architecture and more generally the scope and limits of representing legal concepts directly in the internet infrastructure. As a member of the RCUK funded CREATE centre for Copyright and the creative economy, he also carries out comparative legal research into the digital economy, new business models and regulation through code.

Panel 5.B: *ICT and Environmental Management*

Regulation Enhancement with the Use of Information and Communications Technology for the Environmental Management and Monitoring of Waste Water Treatment Plants

Josephine Treacy, Limerick Institute of Technology

This paper will discuss two case studies utilising information technology to enhance regulatory environmental monitoring and management requirements in the vicinity of Limerick and Charleville Waste Water Treatment Plants. The Urban Waste Water Treatment Directive (S.I. 254 of 2001) and the implementing regulations have been the primary legislative instruments concerning discharges from urban waste water treatment plants. The regulations have obligations for Local Authorities in respect of the collection, treatment, and monitoring of urban waste water.

The first case study involved the development of an environmental management system, involving a step by step approach for more efficient operations of both treatment plants. During this case study knowledge regarding current monitoring and compliance and daily operations were obtained. The study showed there was very little data management in the smaller waste water treatment plant compared with the larger waste water treatment plant. Both treatment plants had a gap in knowledge regarding monitoring both imported waste water from external contractors and waste water at source. A common problem in relation to data collection systems showed retrieval of certain information can prove to be time consuming and troublesome. These findings showed a need for an economical easy to use software package that would assist in monitoring of treatment plants and the harmonisation of operations in waste water treatment plants. Based on this information an online specification of requirements was drafted for a 'Quality Management System'. A template for a software system was designed. During the pilot deployment data was gathered for three main categories including incoming inspection, maintenance and alarms. This information was inputted into the software design template. Excel was used to generate a recommended output from the software. The study also entailed a review on related to the advantages and disadvantages of the proposed software package template.

The second case study involved the deployment of wireless sensors based on Zigbee technology in the vicinity of Limerick Waste Water Treatment Plant and Charleville waste water treatment plant. Wireless sensors for the study of pH and temperature in water and air odours monitoring for ammonia and hydrogen sulphide were evaluated. The wireless pH and temperature sensors were deployed in the secondary outfall at the Limerick waste water treatment plant. The wireless hydrogen and ammonia sensors were deployed at the sludge treatment plant at Charleville waste water treatment plant. The wireless odours monitors were compared with conventional radiello passive diffusive samplers. Hydrogen sulphide was detected by both the conventional method and the wireless hydrogen sulphide sensor. The highest concentration of hydrogen sulphide found at this site was 5 ppmV and a correlation coefficient of 0.9242 was obtained between the wireless sensor and the conventional chemical method of analysis.

The conclusion of this paper will discuss the importance of controlling and evaluating regulatory requirements of a waste water treatment plants by combining interdisciplinary science namely computer science and environmental analytical science.

Graduate of the Limerick Institute of Technology and University College Cork in the area of Environmental Analytical Science. Lecturer in Environmental Analytical Chemistry at the Limerick Institute of Technology since 2003. Course leader of the Higher Certificate in Environmental Analytical Science. Lecturing level 6 to level 9 in the area of Environmental Science, Environmental pollution and Control, Environmental forensics, Instrumentation, Spectroscopic and Complimentary Methods, Advanced Pharmaceutical Technology, Biotopics and Real-time monitoring in Pharmaceutical PAT and Environmental Systems. Previously worked with Cork County Council in the area of environmental management, monitoring and control. Research interests include monitoring and management of environmental management systems, such as waste water treatment plants, drinking water treatment plants and landfills. Other interests include studying resource recovery from waste. Other interests include the development of analytical techniques including real-time sensors to study air, water and soil ecosystems.

Panel 5.B: *ICT and Environmental Management*

Using Standard ICT and GIS to Facilitate Better Nutrient Management Planning on Irish Farms

Sarah Mechan, Stan Lalor, Oliver Shine and David Wall, Teagasc

The Agricultural Catchments Programme (ACP) has developed a novel information management system to collate and manipulate multiple farm nutrient source and geo spatial data sets for coordinating nutrient management planning on farms. Farm fertiliser planning is mandatory under European Union (EU) Nitrates Directive rules (Statutory Instrument (S.I.) 610 of 2010) in Ireland. This legislation constrains the application of nitrogen (N) and phosphorus (P) in organic manures and chemical fertilizers on farms; and coupled with increasing costs of fertilizers since 2000, farmers are being challenged to re-evaluate their fertilizer input strategies in order to achieve higher levels of use efficiency of these nutrients. To achieve this, the development and implementation of a farm nutrient management plan (NMP) is a trusted tool. Historically, developing an NMP for a farm has been a time consuming task, demanding the collection of data from a number of disparate sources, and resulting in complicated and lengthy spreadsheet outputs.

Soil fertility and nutrient management underpins any successful farming enterprise. However, responding to agronomic, environmental, legislative, economic constraints on nutrient management can be challenging, especially in mixed farming systems which dominate in Ireland. The farmer or land manager's focus is often diverted away from the practical nutrient management task by the administrative paper work and data management needed to generate a legally sound fertiliser plan for his farm. This presents opportunities for ICT Researchers to work with farmers, agronomists and policy makers to overcome these mainly technological limitations.

This paper discusses the development of a novel prototype farm nutrient data management system which aims to facilitate better farmer buy-in, usability, and improved nutrient management practice leading to increased nutrient use efficiency and recovery on farms. It links up disperse farm system and geo-spatial datasets and challenges common ICT systems to extract and manipulate their most useful components as data moves along the nutrient management planning flow pathway. In this research existing ICT technologies were re-evaluated and linkages between these technologies and the data sets they capture were established. The new system combines data from; several comprehensive digitised geodatabases, soil analysis results retrieved using a laboratory information management system (LIMS) and farm nutrient application event data captured in a Nutrient Management Recorder (NMR) MS Excel spreadsheet. These data sources were stored centrally on a Document Management System (DMS) - MS SharePoint, which facilitates the development of a centralised relational database by providing a secure data holding warehouse.

This innovative technology also offers the facility to create maps representing the numerical data outputted from these NM plans. Maps can facilitate spatial representations for application rates for individual fields on a whole-farm basis making it easier to know where best to apply fertilizers and other compounds.

Sarah Mechan studied in Dundee where her background is in bioinformatics and data analysis in plant science and conservation. She has spent several years working in both the public and private sectors ensuring data integrity and consistency for numerous databases and products including GIS systems.

Sarah has been the Data Manager with the Agricultural Catchments Programme at Teagasc for 5 years where her core role within the project is to continuously develop and maintain an information management system to ensure the most efficient data capture and integration from multiple sources including data collection via telemetry, surveys, GIS data and imagery.

Panel 5.B: *ICT and Environmental Management*
Changing Consumer Behaviour Through Information Provision

Joe Durkan, Sustainable Energy Authority of Ireland

In 2009, over 6,000 smart meters were deployed in homes and businesses throughout Ireland as part of a national pilot to determine the most cost beneficial and effective way of achieving a full scale national smart metering rollout.

The pilot was lead by the Commission for Energy Regulation (CER), the independent body responsible for overseeing the regulation of Ireland's electricity and gas sectors in Ireland. The CER established a steering and a working group for the project comprising of representatives from the Department of Communications, Energy and Natural Resources (DCENR), Sustainable Energy Authority of Ireland (SEAI), the Northern Ireland Authority for Utility Regulation (NIAUR) and Irish Gas and Electricity Industry Participants.

The customer behaviour trial was a key element of the pilot. The aim of the customer behaviour trial was to ascertain the potential for smart meter enabled, energy efficiency initiatives to drive behavioural changes that would, in turn, reduce or shift peak electricity demand and reduce overall electricity consumption. The trial sought to determine the effect of smart meters, in conjunction with time of use tariffs and informational stimuli (detailed bills, in-home displays etc)

The trial was one of the largest ever carried out to focus exclusively on the behaviour of customer in response to various stimuli / time of use tariffs. The trial was designed so that participants were nationally representative and that the results would be statistically significant.

Over a period of 18 months, half hourly electricity consumption data for more 5,000 residential participants was collected and analysed. In addition, socio economic and attitudinal information was collected from the participants in a series of pre and post trial interviews.

The presentation will examine the impact of various methods of information provision (detailed billing monthly and bi-monthly, in home displays etc) to enable customers to modify or reduce their electricity consumption.

Joe is a mechanical engineer and the programme manager for SEAI's smart grid and smart meter programmes, focusing on demand side management. He is currently leading the Customer Engagement workstream in Ireland's National Smart Meter Programme for the rollout of gas and electricity smart meters.

SEAI is one of a number of stakeholders who are involved directly in the collaborative effort of delivering the NSMP. SEAI's main involvement is focused on improving the understanding of consumer attitudes relating to smart meters and the associated drivers and barriers affecting energy behaviour.

Joe managed the customer behaviour trials for the large pilot project that was conducted prior to, and resulted in, the decision to rollout smart meters in Ireland.

Panel 6: *Enforcement*

Distributed Sensor Networks: the Key to Democratising Environmental Regulation Enforcement

Professor Dermot Diamond, Dublin City University

The quality of the air and water is of intrinsic importance for sustainable social and economic development, and for safeguarding individual and community health. In recent years, progressive global directives have been implemented in Western society (e.g. through EU directives) with regard to urban air and water quality monitoring. The focus of such legislation has been on providing a framework for monitoring the impact of expanding urbanisation, based on increased industrialisation, which generates greater population densities, and associated effects such as vehicular volume, intensive agriculture, and waste generation. Numerous initiatives are being undertaken to improve the standard of urban air quality, and to minimise the impact of human activity on water quality. However, an inherent challenge within each of these initiatives is the provision of high-functionality yet low-cost sensors to accurately monitor the levels of specified target species in air and water. The focus of our research is to deliver both evolutionary improvements in sensor capabilities (capable of generating a positive impact in a short time frame), and in parallel, seek to generate revolutionary breakthroughs in the science underpinning chemical sensing and biosensing (longer term, higher risk). In this paper, I will show how this parallel strategy is having very significant impact, and could provide a very rewarding model for other groups working across various aspects of environmental research. Examples will include autonomous sensors for monitoring greenhouse gases (carbon dioxide and methane) generated from waste decomposition in landfill facilities, and autonomous sensors for monitoring nutrient levels in water. This platform technology has a proven capability for deployments of up to 13 months with fully automated operation. This technology could also be easily adapted for distributed monitoring of gas emissions, for example from gas field pipelines, around fracking sites, and waste treatment facilities. A transmission architecture based on GSM communications allows remote data acquisition, enabling wireless sensor networks to report to a local base-station, from where the data can be relayed via the internet to any global location. Data storage, visualisation, analysis and backup can be performed using free cloud-based tools such as Google Fusion Tables. Such cloud-based approaches open the way to location independent (provided internet access is available) user friendly, low cost services to many interested parties, ranging from specialist engineers to local communities, which, in turn, could provide the basis of the democratisation of enforcement of environmental regulations.

Dermot Diamond received his Ph.D. and D.Sc. from Queen's University Belfast (Chemical Sensors, 1987, Internet Scale Sensing, 2002), and was Vice president for Research at Dublin City University (DCU), Ireland (2002-2004).

He has published over 180 peer reviewed papers in international science journals, is a named inventor in 13 patents, and is co-author and editor of three books, *Spreadsheet Applications in Chemistry using Microsoft Excel* (1997) and *Principles of Chemical and Biological Sensors*, (1998) both published by Wiley, and *Smart NanoTextiles*, Materials Research Society Symposium Proceedings, Volume 20, 2006.

Professor Diamond is currently director of the National Centre for Sensor Research at DCU (www.ncsr.ie) and a Principal Investigator with the Adaptive Information Cluster (AIC), a major research initiative in the area of wireless sensor networks founded by Science Foundation Ireland (see www.adaptiveinformation.ie).

Panel 6: *Enforcement*

Advancing the Right to Water and the 'Right to Know' through Telemetry Innovation in South Africa

Nathan J Cooper, University of Lincoln; and Dr. Andrew Swan, Leeds Metropolitan University

South Africa's groundbreaking constitution explicitly confers a right of access to sufficient water (section 27) and a right of access to information (section 32 - referred to as the right to know). But the country is officially 'water-stressed' and around 10% of the population has no access to on-site or off-site piped or tap water. So a disconnect exists between this right and the reality for many and the reasons for the continuation of such discrepancy are not always clear. While barriers to sufficient water are myriad, one significant factor contributing to insufficient and unpredictable access to water is the high percentage of broken water pumps. Previous studies have reported that between 20% and 50% of all hand operated water pumps installed on the African continent are broken, or out of use. Monitoring and maintenance of pumps, which in South Africa is the responsibility of local municipalities is often ineffective, in part due to the distances between municipal centres and rural communities and the consequent costs of site visits, as well as breakdowns within the local bureaucratic system.

The emergence of new telemetry that can remotely monitor water applications constitutes a novel and cost-efficient alternative to undertaking regular sites visits. SALT technology (sustainable, alternative, low-cost telemetry) has been developed specifically to monitor the performance of water pumps and to communicate this information swiftly and cheaply to water service providers, using SMS messages. Data on the performance of water pumps could also be made available to the public online. This is an example of how ICT can be used for environmental regulation, as well as in the governance of socio-economic rights: helping to optimize water allocation by improving communication and strengthening accountability.

Methodology

Drawing on empirical work in rural Kwa-Zulu Natal, as well as early field-testing of the SALT prototype, this paper considers the real life problems experienced by many South Africans regarding access to sufficient water. It then explores the potential that SALT technology has to increase fulfillment of the right to water by improving the functioning of existing infrastructure and by supporting freedom of information. It is hoped that this dual approach (offering water service providers improved monitoring information, and making this information publically available) could result in a more efficient, responsive and transparent system of water allocation.

The authors have begun to explore opportunities for further interdisciplinary research at this nexus of ICT and regulation, and would welcome input and collaboration from interested parties.

Nathan Cooper holds an LL.B. in Law and an M.A. in International Political Economy, both from the University of Sheffield. Upon graduation he worked for two years as a legal advisor for a Trade Union law firm, advising particularly on human rights issues in relation to employment. He then moved to South Africa to manage a community development project established by a development NGO. The aim of the project was to generate employment and encourage entrepreneurship amongst people living in informal settlements.

He returned to the UK in 2008 seeking to apply this practical experience to academic research and started reading for a Ph.D. His thesis considers the extent to which legal measures can realise the right to water for everyone in South Africa. It is due to be submitted in December 2013. Concurrent with the PhD he has published in the areas of constitutional law, human rights and development, and new water technologies. He began a permanent lectureship at the University of Lincoln in September 2012.

Panel 6: *Enforcement*

Groundwater Monitoring: Reconciling Cost Effectiveness, Legal Requirements and Enforcement Realities

Andrew Allan and Professor Chris Spray, University of Dundee

In the second and third implementation reports on the Water Framework Directive, the European Commission drew attention to gaps in the monitoring networks that must be established by member states under art.8. Groundwater monitoring networks should provide a reliable picture of groundwater levels and a 'coherent and comprehensive' overview of chemical status so that anthropogenically influenced long-term upward trends in pollutant levels can be tracked.[1] Confidence in this overview should be such that "the uncertainty from the monitoring process should not add significantly to the uncertainty of controlling the risk",[2] with densities being sufficient to allow assessment of the impact of abstractions and discharges on levels in groundwater bodies at risk.[3]

The fact that the legal requirements for the quality of monitoring networks are set out in very vague terms highlights the many variables that can influence the design of monitoring networks. However, the quality of a monitoring network as part of the armory of environmental regulators is potentially of crucial importance. If, as part of enforcement proceedings, a regulator takes an offender to court and relies on conclusions derived from monitoring networks, a defendant may be entitled to question those conclusions. If the credibility, reliability or relevance of a monitoring network can be undermined, because it is too sparse, for example, this could have dramatic consequences on the ability of a regulator to ensure compliance with legal standards. Some recent Spanish cases have rejected GIS-derived data as evidence. On the other hand, it can be ruinously expensive to set up a monitoring network in remote areas and regulators must therefore balance the cost effectiveness of these networks against the chance that a court might question their fitness for purpose. This presentation will look at practice around the world on the ways these are balanced (e.g. Finland, Australia, Scotland, Spain), examine how courts have treated evidence from models and monitoring networks, and make recommendations on how practice might be improved.

[1] WFD, Annex V, paras.2.2 and 2.4.
[2] CIS Guidance Document no.15 on Groundwater Monitoring, 22.
[3] Ibid., and WFD, Annex V.

Andrew Allan is a lecturer in National Water Law. His research interests concern national water allocation frameworks and governance of water resources, and include implementation of IWRM, flood management, participatory irrigation systems and the effectiveness of governance regimes. In addition to his research responsibilities, he supervises research students and teaches on the LLM programes.

Panel 6: *Enforcement*

EU Regulation of Fishing Vessel Monitoring Systems: *Lex specialis ab initio*

Professor Ronán Long, National University of Ireland Galway School of Law

The paper reviews developments in EU law as they apply to fishing Vessel Monitoring Systems (VMS), which is a specialist and well-defined area of the law applicable to the common fisheries policy. There is a brief description of the legislative origin of the principal provisions in the EU regulatory code. This is followed by an analysis of the impact of EU legislation on international best practice and the progressive development of international law on the application of satellite-based technologies to the tasks of fishery law enforcement and vessel surveillance globally. The paper mentions some of the legal issues concerning the use of VMS evidence, as well as the division of jurisdictional responsibility between the flag State, coastal and port State. The paper concludes by highlighting some recent trends on the harmonisation of EU law on the use of automated information systems in conjunction with VMS with a view to improving compliance by industry with the law underpinning the fisheries policy.

Ronán Long holds the Jean Monnet Chair of European Law at the School of Law at National University of Ireland Galway, and was the first recipient of the Michael Manahan Research Fellowship. He is author/co-editor of six books and many articles and papers on oceans law and management. He worked previously for the European Commission (1993–2002) and the Naval Service in Ireland (1981-1993). During his time in the European institutions, he worked on the regulation of vessel monitoring systems and the application of new technologies to the tasks associated with fisheries law enforcement and compliance in the Member States and pursuant to international agreements with third countries. Recent projects focus on natural resource management in Africa and he sits on a number of international advisory bodies on the Law of the Sea. He is currently working on the reform of EU law concerning fishing vessel safety.

Closing Plenary: *Rapporteurs' Report*

Dr. Kieran Hickey, School of Geography and Archaeology, National University of Ireland Galway

Dr. Su-ming Khoo, School of Political Science & Sociology, National University of Ireland Galway

Dr. Kieran Hickey is from Cahir, Co. Tipperary, a town dominated by a castle, abbey, the River Suir and the Galty Mountains. It was impossible to grow up without an interest in all things geographical and to know and understand the environment of the town and its hinterland from a physical and human perspective. One of the best ways to know your own place is to explore other places and come back to it with a fresh perspective and gain new insights. As a result I have studied and worked in Armagh, Cork, Coventry, Kilkenny, Maynooth, Oxford and Scotland. I have been fortunate to have travelled to many European countries including Iceland, Slovenia, Croatia and Turkey aswell as Eqypt, Dubai, China, Japan, Australia, New Zealand, Cuba, the USA and Canada.

My main research focus falls under the heading of historical and current climate change. Particular foci have been on patterns of storminess, historical and contemporary climate change in Ireland and elsewhere, hurricanes, coastal vulnerability to climate and sea-level rise in Ireland and elsewhere and the natural and cultural history of wolves in Ireland.

Dr. Su-ming Khoo's research and teaching interests stem from an interest in different meanings of globalization and development and the contestation of those meanings along North/South lines and the challenge of development after 'post-development'. Most of my research and course material engages with development theory and political economy of development, with an emphasis on alternative approaches including human development, human rights and sustainable development. I have particular interest in issues of citizenship, culture, decolonization, ecology, democratization and knowledge advocacy within the political economy of development. I convene a PhD research group on human rights and development. Recent research also includes contesting globalization in, and through, higher education.

About the Ryan Institute at the National University of Ireland Galway

The Ryan Institute for Environmental, Marine and Energy Research, has been established in 2010 from a strategic merger of the Environmental Change Institute (ECI) and Martin Ryan Institute (MRI) for Marine Science.

The Ryan Institute has been established to:

• develop a high-quality capability in priority areas of environmental, marine and energy research

• support interdisciplinary research across all colleges within NUI Galway

• promote collaborative research with other universities and research institutes within Ireland and overseas

• foster interaction with policy making bodies, regulatory authorities and other stakeholders

• encourage research and research interactions with industry

• educate graduate students with requisite skills for work in the environmental, marine and energy sectors

• publicise research activities to schools, state agencies, industry and civil society

Our location near the North Atlantic Ocean is a strong driver of the research priorities within the Institute. Our emphasis is on (1) understanding and prediction of climate, ecological, terrestrial and marine system changes, (2) innovation in energy-efficient technologies and bioenergy, (3) R & D in aquaculture, fisheries, offshore renewable energy resources and biodiscovery, (4) development of technologies for monitoring, modelling and mitigation of environmental pressures, and (5) provision of scientific and technical information to guide socioeconomic and policy decisions.

The context of economic insecurity and increasing competition for natural resources requires solutions based on integrated scientific, technical and socio-economic research. This is a time to bring together our pool of experienced researchers and motivated graduates, supported with excellent facilities, to interact in creative ways with the private sector, state agencies and civil society. The agenda of the Ryan Institute is nothing less than a significant national and international contribution to research in some of the pressing issues of the 21st century around the environment, energy and food security, economic resilience, and social cohesion.

About the Whitaker Institute at the National University of Ireland Galway

The Whitaker Institute for Innovation and Societal Change is inspired by the legacy of pioneering statesperson Dr. T.K. Whitaker, and aims to adopt a similarly innovative, multidisciplinary and transformative approach to the challenges currently facing business and society, both in Ireland and internationally.

Over 200 members make up the faculty, creating the largest critical mass of business and social science researchers in Ireland, with expertise spanning across the College of Business, Public Policy and Law and the College of Arts, Social Sciences and Celtic Studies. Subsuming the University's Centre for Innovation and Structural Change (CISC), the Whitaker Institute builds on a decade of research-excellence and policy-focused contributions supported by over €11 million in competitive national and international research funding.

The Whitaker Institute for Innovation and Societal Change applies a multi-perspective research approach to business and social issues, with an impact-led focus at the core of its endeavours. One of its key values is the promotion of a sustainable and inclusive society, influenced by the broad dissemination of rigorous and relevant research. Furthermore, the Whitaker Institute seeks to continue the tradition at NUI Galway of critically pursuing knowledge discovery that stimulates academic debates and opens public conversation to advance the greater good.

The Institute is named in honour of eminent economist and former Secretary of the Department of Finance, Dr. T.K. Whitaker, who played a central role in devising the economic plan that set Ireland on the road to regeneration in the early 1960s. Drawing inspiration from his unparalleled service to Ireland, the newly formed Whitaker Institute has over 200 members and serves as the country's largest research body focused on contemporary and relevant business, social and policy issues.

For further information please visit our website at www.whitakerinstitute.ie

About the School of Law at the National University of Ireland Galway

The School of Law has a long and distinguished tradition of law teaching and research which dates back to the mid-nineteenth century. It is a tradition that the School is extremely proud of and strives to maintain.

The School of Law is comprised of full-time professors and lecturers, together with part-time teaching staff who are academics specialising in particular subject-areas or practising solicitors and barristers. There are approximately 500 students studying law to degree level.

The School links with Universities in Europe and in the United States afford interested students the opportunity to pursue part of their law studies abroad. Students of the School also participate in moot trial competitions at both national and international level, and the student law society is active in organising guest lectures and debates.

School members are engaged in research in a number of fields including human rights, legal theory, criminal law, commercial law and media law. Research projects, international conferences and guest lectures are organised under the auspices of the Irish Centre for Human Rights. The School of Law is constantly working to attain the highest quality in teaching and research.

Notes

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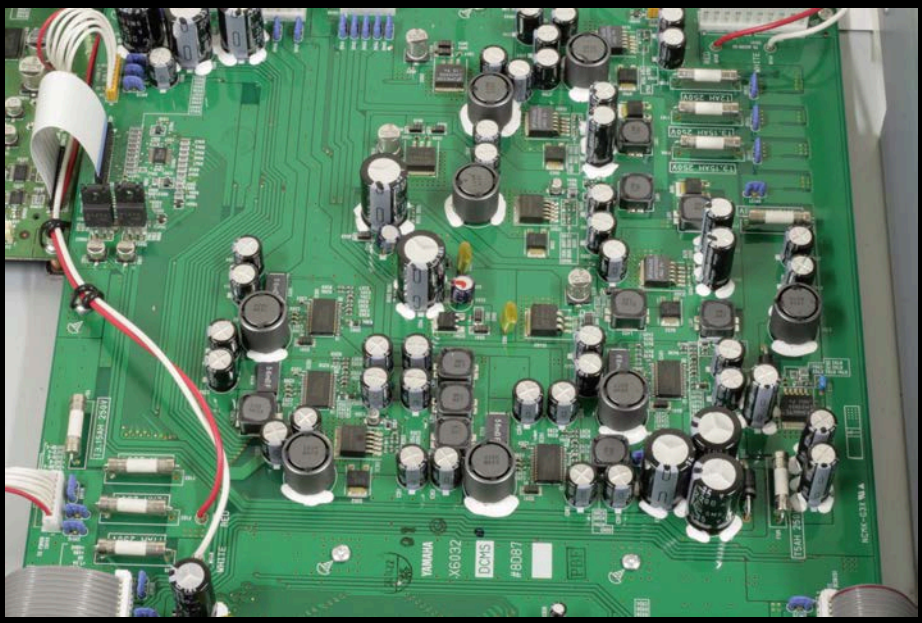

Regulation
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