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Credits

Director: Dr Philip McGowan Editor: Brett Cherry Design: Deborah Wilson Sub-Editors: Dr Lisa Bunclark, Dr Alison Vipond, Dr Angela Sherry and Dr Harriet Hutchinson Proofreader: Alison Norton SDG Research: Claire Assailly (Intern)

Women in Science: Forgetting to Remember team at the Celebrating Success awards.
Florence Jong is addressing antibiotic resistance in wastewater for her PhD at Newcastle University.
Spotlight on South East Asia.
Professor Nick Wright, Pro-Vice-Chancellor, Heidi Mottram, Chief Executive Officer, Northumbrian Water, Dr Russell Davenport, Reader in Environmental Engineering.
The Art of Milk animation by Gemma Burditt.
Welcome

From the Director, Dr Philip McGowan

This special theme issue of the Newcastle University Institute for Sustainability Annual Report showcases research that is tackling global challenges for the Sustainable Development Goals (SDGs).

The Institute for Sustainability is a catalyst for excellent interdisciplinary research across Newcastle University that is working for global sustainability. In this Annual Report we feature research projects that are helping to achieve SDG targets. They include collaborations with industry, the public sector and policy, and demonstrate how our world class research is making a positive impact worldwide.

This report brings together case studies of academic research that are engaged with civil society and play a vital role in resolving global challenges. We are leading the development of strategies that address flood management, antibiotic resistance and climate change adaptation; decarbonising energy in the built environment; working at the interface between science and policy for biodiversity; and measuring progress towards the SDGs. These are but a few of many examples of how Newcastle University is working with partners to achieve sustainable development locally, nationally and internationally.

A focus for both the engagement with partners, and targeting our work towards global grand challenges was our 2016 Institute for Sustainability Annual Conference in London: ‘Sustainable Futures: Research, Policy and Practice’. The conference brought together experts in policy, academia, industry, government and non-governmental organisations, to understand how academic research can inform policy for the SDGs. The conference was a major success, providing insights into why academics should become involved with the United Nations, and others working towards the SDGs, and bring research to policy for meeting SDG targets.

The report has three main sections: Civil Society, Policy and Industry, and interlinks the SDGs with specific research projects and outcomes. An underlying principle of the SDGs is that they are indivisible. The report supports the indivisibility of the goals through the depth and breadth of sustainability research at Newcastle University, as tackling one component can have consequences for another. We identify the relevance of our research to individual goals and targets. In this way we understand the bigger picture of academic research for sustainable development.

In addition we give an update on the sustainable campus of Newcastle University, which has been ranked as one of the greenest universities in the UK. We are proud that we are making such significant progress towards achieving sustainability through both our research, and in practice.

Looking forward, the work reported here is but the surface of challenges that sustainability researchers at Newcastle University are tackling, and the extent to which they seek to make a difference in the world today. They are working to create a sustainable society and planet for all, both present and future generations.

To learn more about the SDGs we encourage you to read resources available on the web such as the Sustainable Development Knowledge Platform sustainabledevelopment.un.org/sdgs as well as resources available on our website: www.ncl.ac.uk/sustainability/ourresearch/challenges.
Institute for Sustainability joins the UK’s biggest platform for sustainable development

The Institute for Sustainability is an official partner of the UK Stakeholders for Sustainable Development (UKSSD) (https://www.ukssd.co.uk/), a network of public, private and civic organisations addressing delivery of the UN Sustainable Development Goals (SDGs) in the UK. This partnership will enable Newcastle University researchers to work collaboratively with organisations from all sectors on specific sustainable development challenges and relay views and priorities directly to government. The platform also provides a unique opportunity to harness multi-stakeholder approaches to sustainability that are at the heart of research at Newcastle University. "The UN Sustainable Development Goals are a massive challenge and opportunity for academic researchers throughout the world. Becoming a partner of the UKSSD ensures that our important work in sustainability at Newcastle University makes the biggest difference possible in measuring progress towards and achieving the SDGs", says Prof Phil McGowan, Director of the Institute for Sustainability.

New Research Challenge – ‘Climate Change: Adaptation and Mitigation’

The Institute for Sustainability has extended its research challenges to include a new cross-cutting challenge on Climate Change: Adaptation and Mitigation. This will help enable the development of new research directions in climate change at Newcastle University, create new projects and support the development of innovative ideas. Climate change research at Newcastle University is multidisciplinary and widespread covering multiple areas from rainfall modelling to adaptation, ecological impacts, carbon mitigation and climate policy. It is at the heart of research programmes and initiatives to achieve global sustainability. Climate change is one of the primary drivers affecting all environmental systems on the planet that species depend upon for survival, therefore understanding its effects and developing ways to prepare for its impacts are essential. Associate Director of the Institute for Sustainability, Prof Rich Dawson says: “Newcastle University provides a distinctive research offering in climate change that is either tackling climate change challenges head on or is an issue that cuts across multiple strands of research. The purpose here is to tap into the Institute for Sustainability’s capabilities and resources to support and nurture cross-cutting research to provide a more coherent understanding of the climate system and how we live with it”.

Exploring justice and fairness in the everyday lives of urban dwellers

A new book edited by Prof Simin Davoudi and Prof Derek Bell, Justice and Fairness in the City, highlights how fairness depends upon local people and communities working towards it and demanding it. The book looks at how fairness affects areas including education and schools, transport and accessibility, green spaces and food, and participation. It examines how these affect communities in different ways and reminds us that fairness and justice are experienced and felt differently by different social and age groups. It features people who live and work in Newcastle, but explores issues that are relevant to all cities globally, including equality and sustainability. “We wanted to show how justice is related to various aspects of city life and why we need to think about fairness not only as an ideal goal, but also as something that we should pursue in our everyday lives”, says Prof Simin Davoudi.

National energy centre to make UK energy system smart, low-carbon and resilient

Newcastle University in partnership with Siemens and academic partners was awarded the £20 million EPSRC National Centre for Energy Systems Integration (CESI). Led by Professor Phil Taylor, CESI brings together energy experts from around the world to help unravel the energy network and understand future energy supply and demand. It seeks to understand how to optimise the energy network, drive down customer bills and inform future government policy. Academic partners for the centre are Heriot-Watt, Sussex, Durham and Edinburgh. CESI will be based at the Urban Sciences Building at Science Central, combining unique full-scale facilities such as the Energy Storage Test Bed and Smart Grid Lab. It will join two other national centres in smart data and ageing science also recently funded. “This new EPSRC centre will help equip the UK as it adapts to the changing mix of energy production and ensure it has a resilient infrastructure that can support domestic and industrial users”, says Philip Nelson, Chief Executive of the EPSRC. Website: www.ncl.ac.uk/cesi
Sound interventions for mitigating air pollution in India

A new research project led by Dr Anil Namdeo, Prof Margaret Bell and Dr Paul Goodman, Clean Air for Delhi Through Interventions, Mitigations and Engagement (CADTIME), seeks to understand how to reduce air pollution through affordable, effective interventions that consider and respond to future changes. It brings together a consortium of institutions including the Indian Institutes of Technology of Madras and Bombay, and experts from across India and the UK to address air quality issues for reducing the burden of illness for people in India as a result of air contamination. The project will develop an integrated action plan that details strategies and potential interventions for mitigating air pollution in both the city and surrounding region. It will be based on development of a sound understanding of the current contributing factors to air pollution across the domestic, transport, industrial and agricultural sectors, for Delhi, as well as forecasting of how those sectors will change across the short, medium and long terms. The project will develop modelling tools for collating emission inventories and how air pollution is dispersed, and collect policies and best practice for mitigation within the city and region.

Deep analytics for adapting infrastructure to big challenges

A major new research consortium that includes Newcastle University is partnering with government, business and industry to demonstrate the next generation of models, methods and tools needed to inform strategic infrastructure system decision making across scales from local to global. The project ‘MISTRAL: Multi-scale Infrastructure Systems Analytics’, works with a range of organisations including the National Infrastructure Commission, Greater London Authority, Network Rail and the Future Cities Catapult to provide decision makers with important insights for managing and investing in infrastructure. Infrastructure systems are interconnected across scales and prolific technological innovation is now occurring that will exploit, or may threaten, that interconnectedness, such as increased flooding due to climate change. In response to these challenges the project will also identify vulnerable points in infrastructure networks and evaluate cost of investing in reducing the risk of catastrophic failure. The aim is for the research to be used in infrastructure planning, design and analysis not just in the UK, but around the world, with an initial case study in Palestine in association with United Nations Office for Project Services (UNOPS). Project website: www.itrc.org.uk

Managing storm water as a resource for urban flood resilience

Water from major storm events could be collected and stored as a resource in cities rather than allowed to drain into the waste water treatment system. This research, part of the Achieving Urban Flood Resilience in an Uncertain Future project, will combine modelling approaches to ‘grey infrastructure’ (hydraulic) and the movement of water through the soil and vegetation (hydrologic). Researchers will determine how this would work in practice using the city of Newcastle as a testbed to calculate the long-term resource potential for storm water. The project builds upon previous research led by Prof Chris Kilsby from the Blue Green Cities project, going further in understanding not only how water travels during storm events, but above and below ground over time, looking at the water catchment as a whole. This research has large economic and ecological implications for how water is managed in cities, potentially relieving pressure on waste water infrastructure and drainage, while restoring rivers and streams in the urban environment using blue-green and green infrastructure. Project website: www.urbanfloodresilience.ac.uk

Joined-up approach for tackling land degradation and climate change needed

New findings from a study led by Prof Mark Reed and colleagues provide the first comprehensive synthesis of the links between global climate change and land degradation. Researchers highlight how the interactions and feedbacks between climate change and land degradation magnify risks to people and ecosystems across the world. They call for a more joined-up approach to tackling land degradation and climate change. Findings from the research will inform the work of the UNCCD’s (United Nations Convention to Combat Desertification) Science Policy Interface and other global programmes. The research was published by Routledge and UNCCD in a new book: Land Degradation, Desertification and Climate Change: Anticipating, Assessing and Adapting to Future Change. “It’s a vicious cycle and one that will affect everyone living on the planet if we don’t start doing more to avoid runaway climate change by properly looking after our land”, says Prof Mark Reed.

1. The Global Goals for Sustainable Development. 2. Simin Davoudi, Professor of Environmental Policy & Planning, Director of GURU. 3. Chris Kilsby, Professor of Hydrology and Climate Change. 4. Dr Anil Namdeo, Senior Lecturer in Transport and Sustainability. 5. CESI team. 6. Mark Reed, Professor of Socio-Technical Innovation.
Science Central secures multi-million pound deal with Legal & General

Legal & General Capital plans to support the £350 million Newcastle Science Central, one of the biggest urban regeneration projects of its kind in the UK. The unique deal will see financial services giant Legal & General becoming a long-term investment partner on Science Central alongside Newcastle City Council and Newcastle University. This builds on work that has already begun on Science Central, part of Newcastle’s Accelerated Development Zone, which has seen significant progress over the past year. The landmark building, The Core, opened in November 2014 and is full to capacity. Newcastle University delivered the first research labs in The Key which opened in February 2016. Construction of the university’s £58 million Urban Sciences Building is also near completion, and will open in summer 2017. In addition, design work is underway for a Learning and Teaching Centre and Newcastle Laboratory which will offer high quality, incubation and accommodation specifically geared to science-based commercial activities. The 24 acre mixed use development is set to create over 4,000 jobs, 500,000 sq ft of office space, and 450 new homes in the heart of the city.

Blue-green infrastructure provides city-wide benefits for reducing flooding

‘Blue-green infrastructure’ such as roofs, ponds, and water channels with ‘grey infrastructure’ such as culverts or flood walls, effectively reduce transport disruption during extreme rainfall events. Blue-green infrastructure uses natural processes to store rainwater and decrease the amount released onto roads and pavements. As a result, the depth of flooding is reduced which can make its impact more manageable. Research led by Prof Rich Dawson published in the Royal Society Open Science journal, found that greening every roof in the city of Newcastle could reduce travel disruption by over 25%. "We found that both traditional drainage measures and blue-green infrastructure led to a reduction in travel network delays. Blue-green infrastructure can provide city-wide benefits, whilst more traditional engineering solutions can provide substantial, but often more localised, benefits", says Prof Rich Dawson. Link to paper: rsos.royalsocietypublishing.org/content/3/5/160023

Action needed for restoring fish species to our planet’s coral reefs

The largest study of its kind in the global centre of marine biodiversity highlights the impact that uncontrolled fishing is having on the most biodiverse marine ecosystem - coral reefs. Fifty-nine species of finfish that were once common on Philippine coral reefs have now disappeared from the catches of many fishermen; these populations have declined over the last 65 years, according to the research led by Prof Nick Polunin. In the absence of any other continuous data, the research draws on the knowledge of Philippine fishermen, allowing the research team to depict trajectories of decline over the last 65 years. The team highlighted five species of finfish that are now fighting for survival – the green bumphead parrotfish, the humphead wrasse, the African pompano, the giant grouper and the mangrove red snapper. Coral reefs occupy less than 1% of the marine area but they are home to 25% of all known marine fish species. The study focused on five areas recognised for being the most species-rich in this very biodiverse region: Lanuza Bay, Danajon Bank, Verde Island Passage, Polillo Islands and Honda Bay. “Similar to the Newfoundland Cod, where we saw major stocks crash due to overfishing, these reef finfish populations have been overexploited and if we’re unlucky they may never recover”, says Prof Polunin.

Newcastle University commits to divesting from fossil fuels

Responding to calls from Newcastle University Students’ Union (NUSU) and representations from students involved in the Fossil Free movement, NUSU members pledged to embed Environmental, Social and Governance considerations into its investment strategy. Newcastle University will only use fund managers that are signed up to the United Nations Principles for Responsible Investment. It will also give preference to investment managers who preferentially invest in progressive companies that are working towards low carbon solutions and who will provide the university with reports on the carbon footprint of companies within its portfolio. The decision follows a review of all aspects of the university’s carbon-related activities, from the energy efficiency of its campus, to the work of the Institute for Sustainability. Prof Phil Taylor was interviewed by global radio station Public Radio International on how the university’s choice to divest was helping to set a precedent for other academic institutions. Link: www.pri.org/stories/2016-07-26/newcastles-biggest-university-says-no-more-coal
Weather radar zooms in on urban floods to prepare for extreme weather

Researchers at Newcastle University are creating the most detailed picture yet of rainfall and flood risk in Newcastle, thanks to a brand new weather radar. Located on the roof of the University’s 12-storey Claremont Tower, the radar will provide data to ten times the resolution than is currently available, and will be used to provide a unique understanding of urban flood risk in the city centre. Installation of the radar coincided with the fourth anniversary of the Toon Monsoon of 28 June 2012, and will show the intensity and amount of rainfall over the city, as well as how it flows and collects on the surface. The radar is the latest addition to the Urban Observatory, a ground-breaking project that monitors Newcastle at multiple levels such as temperature, wind flow, air pollution and traffic. Combining the data in this way will bring greater understanding of the impact of intense weather events on the city’s infrastructure.

Urban Sciences Building receives BREEAM Innovation Credit

The Urban Sciences Building at Science Central in Newcastle has received the prestigious BREEAM Innovation Credit for its innovative energy storage test bed. BREEAM is the world’s foremost environmental assessment method and rating system for buildings. The Innovation Credit is awarded to buildings that go beyond best practice in sustainability, demonstrating industry leadership in sustainability issues. Only 46% of the 98 applications received by BREEAM since 2008 have been approved. Over 24,000 buildings have been registered under BREEAM in the UK since its launch in 1990. The Urban Sciences Building at Science Central is a flagship development in Newcastle city centre due to be completed August 2017. It will house its nationally leading School of Computing Science, Open Lab, Smart Grid, Transport and Cyber Physical Systems Labs to champion world leading research in digitally enabled urban sustainability. Engineering and design consultancy for the USB was provided by Burohappold Engineering and the architect of the building is Hawkins/Brown.

One of the UK’s first ‘vehicle-to-grid’ chargers installed at Newcastle University

The electric vehicle (EV) charger allows energy to travel both to and from an electric vehicle’s battery providing energy and power services to the grid when it is parked. The research project is in collaboration with Enel, Nissan and Nuvve, who believe the concept could save £2.4 billion in electricity costs by 2030. The vehicle-to-grid charging point is linked to the Smart Grid Laboratory part of the National Centre for Energy Systems Integration, which will help understand what role EVs will play in future energy supply and demand. It is estimated there will need to be more than two million electric vehicles on the UK’s roads if the country is to meet its commitment to reduce carbon emissions by 2030. “Smart energy storage has the potential to be a real game changer as we move towards decarbonising the grid and EVs will play a key role in this”, says project leader Myriam Neaimeh.

‘Personalised agriculture’ boosts our fight against herbicide resistance

A simple test which can detect the presence of herbicide resistance in black grass could act as an early warning for farmers to help slow the spread of the UK’s most devastating weed. The ‘pregnancy-test’-style prototype detects a protein that is found in high concentrations in populations of black grass that have evolved resistance to multiple classes of herbicides. Sensitive enough to detect the molecule in the early stages of black grass growth, the aim is to help farmers make management decisions early in the crop cycle and prevent costly losses later on. As part of the Black-Grass Resistance Initiative (BGRI), the team are deploying cutting edge, multidisciplinary research to understand and combat the spread of this highly invasive and damaging weed. “It’s like a plague - the resistance is creeping up the country and our first line of defence, herbicides, are becoming less effective, just like antibiotics in medicine”, says Prof Rob Edwards, Director of the Institute for Agri-Food Research and Innovation (IAFRI), a joint venture between Newcastle University and Fera Science Ltd (Fera).

1. Examples of green roofs. 2. Richard Dawson, Professor of Earth Systems Engineering & EPSRC Research Fellow, Philip James, Senior Lecturer in GIS, Dr Jennine Jonczyk, Researcher in Water Resources, Mark Dutton, EM Ltd. 3. Coral reefs. 4. Myriam Neaimeh, Researcher in Transport and Energy. 5. Professor Rob Edwards, Head of School of Natural and Environmental Sciences.
Breaking up rainforests pushes species to the edge

While a small number of species have adapted to living on the boundaries of forests, the majority have declined and the negative impact on them extends far into the forest interior. Research covering over 100 species of reptiles and amphibians living in nine fragmented forest landscapes in Central and South America, has found that over 90% of all species were affected by the forest edge effect. Forest fragmentation acts on top of forest loss, as habitats are broken up into increasingly smaller, isolated patches. This in turn reduces the core area of favourable habitat for forest species. A new approach to forest conservation and management is needed to counteract these harmful impacts. “The findings have strong implications for conservation in fragmented tropical landscapes and suggest large forest patches will need to be conserved to protect forest-dependent species and avoid loss of biodiversity”, says Dr Marion Pfeifer, one of the lead authors and a Lecturer in Ecology, Conservation and Management at Newcastle University.

Waste CO₂ emissions could be harnessed as a fuel of the future

Researchers are working on an innovative technology that could convert carbon dioxide into a clean fuel, reducing the amount of the harmful greenhouse gas released into the atmosphere. The research project funded by the EPSRC aims to develop a process for converting waste CO₂ captured from industrial processes and use it for fuel production. The ground breaking technology is based on the use of energy from biological and electro-chemical sources. First, the organic matter in wastewater is broken down by microbes, generating a small amount of electrical energy to convert CO₂ to formate – a derivative of formic acid. This then goes through a SimCell reactor – a specialised reactor containing micro-organisms, where it is transformed into a liquid fuel with potential for transport or heating applications. “If we can harness CO₂ as a fuel source instead of allowing it to go into the atmosphere, it then becomes a resource rather than a waste product”, says Dr Eileen Yu, Principal Investigator on the project.

Leading marine scientist recognised by the European Aquaculture Society (EAS) for achievements

Prof Selina Stead, Dean and Professor of Marine Governance and Environmental Sciences, became the fourth recipient of EAS’s Distinguished Services Award for her notable contributions to areas as diverse as fisheries, aquaculture, marine protected areas, integrated coastal management and marine governance. The EAS is Europe’s leading member-based organisation with its headquarters in Belgium. Prof Stead’s work involves leading international teams of scientists in advising on marine policy to help keep our seas and oceans healthy. She is currently working in East Africa where she advised the Seychelles Government in its Blue Economy Strategy. This aims to focus economic growth and sustainable development towards long-term management of marine space, resources and the environment. “I am thrilled to be given this accolade as it’s an endorsement of Newcastle University’s commitment in making a positive impact on society worldwide”, says Prof Stead. EAS Website: www.aquaeas.eu

UK’s brownfields have potential to remove millions of tonnes of CO₂ per year

Urban brownfield soils have huge, untapped potential to remove carbon dioxide CO₂ from the atmosphere – provided we manage our soils more effectively. They could be a vital tool in the fight against climate change, researchers have discovered. Carbonation involves the combination of calcium – which is abundant in brownfield soils that contain demolition wastes such as concrete dust and lime – with atmospheric CO₂ to form calcium carbonate (calcite). As part of the EPSRC funded interdisciplinary SUCCESS project (Sustainable Urban Carbon Capture: Engineering Soils for Climate Change), the team surveyed 21 brownfield sites across Tyneside and Teesside. They found that one hectare of urban soil can absorb up to 85 tonnes of atmospheric carbon per year. “The UK has 17 million hectares of urban land. If only 700,000 hectares of this was managed proactively it could meet 10% of the UK’s annual CO₂ reduction target”, says Prof David Manning, Principal Investigator on SUCCESS. Project website: research.ncl.ac.uk/success

1. Dr Eileen Yu, Senior Lecturer. 2. Professor John Fitzgerald, Head of the School of Computing. 3. Selina Stead, Dean and Professor of Marine Governance and Environmental Sciences. 4. Indonesia wildfire. 5. Gemma Burditt, artist in residence at Berwick Visual Arts, funded by the Centre for Rural Economy and the Institute for Sustainability at Newcastle University. 6. Corallus ruschembergeni, one of many rainforest species forced to adapt to living on the edge of forest boundaries.
Wildfires in Indonesia are a public health crisis rooted in environmental catastrophe

Wildfires that ripped through forest and peatland in Equatorial Asia during the autumn of 2015 leading to 6,150 and 17,270 premature deaths respectively, were a direct result of the polluted haze due to global climate change, land use changes and deforestation. A study published in Scientific Reports used detailed observations of the haze from Singapore and Indonesia. The research analysed hourly air quality data from a model at a resolution of 10km. It showed that a quarter of the population of Malaysia, Singapore and Indonesia was exposed to unhealthy air quality conditions between September and October 2015. Researchers say it is imperative that action is taken to prevent forest fires and killer haze events in the future. Deforestation and drainage of peatlands makes for very susceptible conditions for fire and new efforts are needed to re-wet peatlands and reduce further deforestation in this region. “The wildfires of 2015 were the worst we’ve seen for almost two decades as a result of climate change, land use changes and deforestation. The extremely dry conditions in that region mean that these are likely to become more common events in the future, unless concerted action is taken to prevent fires”, says Dr Paola Crippa, lead author of the study.

Artist in residence explores challenges facing dairy farmers in Northumberland

The Centre for Rural Economy and Institute for Sustainability supported a new artist in residence at Berwick Visual Arts that examines the human story of Northumberland dairy farmers. The artist in residence Gemma Burditt is an animation director and illustrator of short films and music videos. During her residency Gemma worked with researchers at the Centre for Rural Economy and the Institute for Sustainability at Newcastle University, to document dairy farming in Northumberland, exploring the scale of factors that depend on their success from disease and nutrients in the soil to current European policies and subsidies. Now in its fourth year at Berwick Visual Arts, the residency provides the opportunity for an artist working in any discipline to question what and who is rural, and explore rural life and society beyond idyllic representations, whilst living and working in Berwick-upon-Tweed for six months. “Since Gemma’s work is animation it’s particularly appealing and highly accessible to a wider audience. It is an example of how art is not about how we solve problems, but how we should seek solutions because it reveals community relationships, their fractures, connections and what is important to them, which is why art should become more important in policy making”, says Dr Menelaos Gkartzios, Senior Lecturer at the Centre for Rural Economy.

Co-designing innovation for sustainability

Research led by Prof John Fitzgerald, Head of the School of Computing, is developing the technology used by multiple sectors in industry to pilot the next generation of sustainable advances that integrate the cyber with the physical. The tools and methods developed allow diverse design models to be co-simulated, enabling piloting of an innovation without actually producing the physical prototype. Areas of research include heating, ventilation and air conditioning (HVAC) for buildings and the electric vehicle industry. Prof Fitzgerald and colleagues at the Cyber Physical Systems Lab are working with United Technologies Research Centre (Ireland) to develop tools for co-designing the control and thermal performance of HVAC systems in buildings. This speeds up analysis of building designs to find the combination of physical design and control software that delivers an optimal level of thermal performance, increasing efficiency. The co-design technology is also helping the German company TWT design electric vehicle control technology that takes better account of range, environmental conditions and battery performance. Other applications include agricultural robotics and improved rail signalling. The research is part of the EU funded INTO-CPS project: projects.au.dk/into-cps/about-into-cps

Champion for ending fuel poverty in UK receives honorary degree

Jenny Saunders OBE, Chief Executive of National Energy Action (NEA), was presented with an honorary degree from Newcastle University in recognition of her efforts to end fuel poverty. Recognised for her work on driving policy and action for energy justice and end to fuel poverty, Jenny is also a member of the government’s Fuel Poverty Advisory Group, the energy regulator Ofgem’s Sustainable Development Group. She is a Non-Executive Board Director of National Grid Affordable Warmth Solutions Community Interest Company. Jenny is a trustee of NEA’s sister organisation, Energy Action Scotland. Having helped to establish a grant-making fund at the Community Foundation for Tyne & Wear and Northumberland to assist women to achieve their full potential, Jenny served on the Women’s Fund Committee for 5 years from 1999-2004. “We are very proud to work with such a fantastic organisation as NEA, led so brilliantly by Jenny Saunders, a Newcastle graduate”, said Prof Phil Taylor, who presented the award.
Awarded Projects

Reducing spread of multi-resistant bacteria in urban wastewater to protect public health

The spread of multi-antibiotic resistant bacteria is a major challenge for the water industry and community health. Research led by Profs David Graham and Jeff Errington is reconsidering the design of wastewater treatment plants with the specific aim of reducing antibiotic resistance released after wastewater treatment. The culprits are antibiotic resistant genes that can cause multiple forms of resistance and while many genes are reduced by wastewater treatment, the worst ones can sometimes actually increase after treatment. This is of large concern to public health as wastewater treatment systems are places where bacteria can evolve rapidly, influencing multi-resistance to antibiotic medicines.

The project will quantify the prevalence of multi-resistant bacteria in wastewater treatment plants, explain the genetic basis of their resistance, and then develop new treatment technologies that reduce levels of multi-antibiotic resistance in treated wastes.

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Sustainable diets for health and the environment

Finding a balance between cost, nutritional quality and environmental impact of food purchases is a major challenge for food policy. Using data from the UK’s Living Costs and Food Survey, Dr Wendy Wrieden and colleagues are developing a new framework to assess cost, nutrition and environmental characteristics of food purchases that uses an evidence-based approach for assessing nutritional and environmental sustainability. The evidence-based framework uses Life Cycle Assessment to quantify environmental impacts of foods purchased for household consumption, including greenhouse gas emissions and land use. The aim of the research is to come up with nutritionally sound dietary goals that also improve the environmental sustainability of household food. The research will identify the environmental ‘hotspots’ within the whole food supply chain, and healthy diets that are respectful of ecosystems, affordable, and optimise resources.

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Meeting future renewable energy demands with biomass

The current ways in which societies use energy resources require radical new ways to meet energy demands. Novel synthesis routes are needed for converting waste streams into essential fuel and chemical streams to fulfill the needs of society. Dr. Moritz von-Stosch is aiming to develop a rational and efficient computational approach for development of catalysts for biorefining applications, generating heat, power and chemicals from biomass. The approach combines hybrid models, data mining, machine learning algorithms and high-throughput experimentation. The development of new manufacturing processes critically depends on the design of new catalysts that convert biomass into renewable fuels and chemicals used in industry. Catalyst development is still carried out using trial and error methods, which are slow, undirected and unreliable. The ultimate goal of the project is to provide materials and energy in a sustainable way that will require a more efficient and entirely different use of natural resources.

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Second generation biofuels for revolutionising the energy and chemical industries

The potential for second generation biofuels as a renewable energy resource is a massive opportunity for energy economies throughout the world. This research project led by Dr. Sven Lahme focuses on plant-derived lignin, which is considered a ‘low-value’ waste or by-product from industry, including breweries and paper mills. Biofuels have advantages over other renewable energy sources such as wind and solar power as they can generate energy on demand, and lignin is currently too challenging to break down via other processes such as anaerobic digestion. Dr. Lahme and his research team in the BALIOMICS project will look into how bacterial communities break down lignin. If harnessed, this renewable energy resource has immense potential to help the world become independent of fossil fuels both for transportation and generation of electric power. Biofuels are seen as a key player in transitioning the world from fossil fuels to renewable energy. There are also a wide variety of uses for lignin in the chemical industry as compounds needed are normally derived using petrol.

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Why is it important to policy?
For the first time researchers have linked the supply chains of potassium (widely used as a fertiliser in agriculture) from ‘mine to mouth’ i.e. global sourcing all the way to the consumer in a city like Newcastle. The project worked with colleagues at the World Resources Institute and Massachusetts Institute of Technology to illustrate the global and urban metabolism of potassium needed to feed the city. This illustrates the impacts of local and global policy in the areas of mining, food production, distribution and consumption.

Challenge for the Sustainable Development Goals
To reach Zero Hunger (Goal 2) modern agriculture may be inadequate for feeding nine billion people by 2050 (Target 2.1), because it is dependent upon adding fertilisers to the soil artificially. In context of Responsible Consumption and Production (Goal 12), 90% of all potassium mined is used as fertiliser and once the food is consumed potash disperses into the water stream making it a major challenge for the sustainable management and efficient use of natural resources (Target 12.2). There are a small number of companies in only five countries that provide more than 80% of potash globally. All this is not sustainable in the long-term as more and more minerals must be added to the soil to obtain the same amount of nutrients and yield. This results in farmers getting less than what they are putting into the soil. For Sustainable Cities and Communities (Goal 11) in future, solutions for environmental impacts of feeding growing urban populations need to be found (Target 11.6).

What should be done?
- Mineral recycling helps reduce demand, preventing more minerals from being mined.
- Reduce the use and extraction of potassium and other valuable minerals for food production.
- Change agricultural practices and find alternatives that rely less upon mineral-based fertilisers.
- Sustainable consumption needs work such as reducing meat consumption as more fertiliser inputs are needed to grow animal feed, unless alternatives can be found.
- The UK could provide policy leadership in assisting developing countries in these areas, especially in Africa.

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The UK can develop scientific and policy leadership in assisting least developed countries, especially in Africa, to explore local alternatives for conventional mineral-based fertilisers and assist in searching for alternative potassium-bearing minerals in these countries.

Dr Natalia Yakovleva
Why is it important to policy?

Making sustainable food choices is essential to reducing people’s impact on the global environment. The online platform developed by Dr Panzone makes it possible to test policy and other interventions to see what effect it has on consumer behaviour, and helps shoppers who value sustainability make more informed choices. It is also of use to supermarkets who want to test policy interventions and potential ways of nudging consumers in a closed environment, and provide sustainable shoppers with a variety of choices. In using the platform to test sustainability interventions the aim is to help people choose the things they do want, assisting them to make better choices by removing potential mistakes and misconceptions driven by lack of knowledge or distracting shopping environments.

Challenge for the Sustainable Development Goals

The carbon footprint of food products is usually not labelled and shoppers that value making sustainable food choices normally have little guidance. There are different estimates, but generally there is agreement that food currently accounts for around 30% of total greenhouse gas emissions in Western economies. For achieving Climate Action (Goal 13), buying sustainable food products is a pathway to a low-carbon future that will help achieve carbon reduction targets by integrating low carbon food shopping into national policies (Target 13.2). To encourage more sustainable shopping behaviours for Responsible Consumption and Production (Goal 12), in the long-term the sustainability of food products needs to be better understood as providing such information would ensure that people are aware of lifestyles in harmony with nature (Target 12.8). If barriers to sustainable consumption are removed, shoppers are incentivised to reduce their carbon footprint, which will help maximise the contribution to Zero Hunger (Goal 2), and reduce the carbon footprint of the supply chain to ensure food production systems are sustainable (Target 2.4).

What should be done?

- Design a shopping experience that values protection of the environment by reducing barriers to sustainable consumption. This might include making low-carbon options cheaper than high-carbon ones (through taxes or discounts), but also more accessible during the choice task (e.g. more visible, or grouped in specific aisles).
- Ensure consumers can access the carbon footprint and nutritional value of products in the market to help shoppers make smarter choices.
- Use tools like the online platform to understand how people make food choices based on information provided and personal goals and expectations.
- A key element of policy interventions is not only whether it works, but what are the long-term consequences of the changes made?

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Measuring up to the SDGs in the UK

Research Team: Dr Graham Long (PI), Craig Johnston & Hattie Cansino

Why is it important to policy?

The Sustainable Development Goals (SDGs) are applicable to developing and developed countries alike, but they require translation specific to countries’ individual contexts. Countries are committed to implementing the Goals in a way that ‘leaves no one behind’ and that respects the ‘integrated and indivisible nature’ of the SDGs. This research project led by Dr Long for the first time looks at how many of the SDG indicators are applicable to the UK, and what the measurements tell us about where the UK sits in respect of the ambitions expressed in the global targets. It provides a full table of results of over 170 indicators – containing over 100 pages of data – sweeping global, regional and national metrics and data that map onto the SDG indicators, from government and non-government sources.

Challenge for the Sustainable Development Goals

There are a range of complex issues that must be tackled to implement the SDGs in the UK, including balance and connection between domestic and global UK response. To be successful the country must promote policy coherence and integration across the SDGs; acknowledge the relevance of comparisons between the UK and other countries; and encourage participation of the world’s poorest and most marginalised to ensure no one is ‘left behind’.

What should be done?

- National implementation plans must address clear targets and data for the SDGs.
- Consider how SDG targets and other metrics are aligned e.g. Human rights treaties, Aichi biodiversity targets and indicators.
- After assessing data and performance gaps, mapping of policy gaps is an important next step.
- To determine particular policy outcomes further deliberation and reflection is needed on the SDG targets and the UK’s wider national agenda.

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Professor Richard Dawson was invited to No 9 Downing Street to meet with Oliver Letwin MP to contribute to Parliament’s review of National Flood Resilience. The review was established following Storm Desmond and the 2015/16 winter floods, and looked to assess how the country can be better protected from future flooding and increasingly extreme weather events. The National Flood Resilience Review published in September 2016, assesses the resilience of key local infrastructure: energy, water, transport and communications.

The Flood Resilience Review considered access to infrastructure and emergency response routes, especially if they go over bridges. “Our response plans are usually premised on the assumption of business as usual but of course during flood events it is anything but business as usual. If your emergency pumps and emergency generators are all too far away, or key transport routes become blocked, then they might as well not be there in the first place”, says Professor Dawson.

Professor Dawson also led the Infrastructure Section of the UK Climate Change Risk Assessment. Enshrined in UK Law is the need to undertake a Climate Change Risk Assessment every five years. He led the work on identifying threats from climate change to the UK’s infrastructure. Essential to managing flood risk are strategies where government, communities, local authorities and private sector work together to enhance the nation’s resilience. The Government recently accepted all conclusions made by the Assessment on protecting infrastructure, and have recently announced a package of investment in temporary flood barriers to specifically protect critical infrastructure such as electricity substations.

**Multi-stakeholder governance for Climate-Energy-Food Security Nexus**

Professor Sally Shortall from the Centre for Rural Economy at Newcastle University is leading a project funded by the ESRC through the Nexus Network on how climate change and future energy availability may affect food and farming systems in Northern Ireland. The project is in collaboration with Dr Wayne Foord and Professor John Barry (Queen’s University Belfast). Extreme weather events, and the risks of passing climate ‘tipping points’, pose serious threats to global food security. Industrialised food systems are also critically dependent on supplies of cheap, fossil energy (oil and gas), projected to decline over the next decades. Working with a range of stakeholders including the Institute for Global Food Security, Department of Agriculture Environment & Rural Affairs (Northern Ireland), the AgriFood & Biosciences Institute and Friends of the Earth, the project combines action research with multi-stakeholder scenario planning. This means providing a context for policy learning and being a catalyst for collaborative actions.

“The research seeks to learn more about how government agencies, businesses, voluntary organisations, and researchers can work together more effectively to address challenges involving climate change, energy, agriculture and food production, exploring shared understandings and actions”, says Professor Shortall.

**Further info:** www.ncl.ac.uk/cre/research/current/theenergyclimatefoodsecuritynexus
Future holistic flood prevention and management strategies

Key Message: Flood management schemes at the catchment scale not only reduce flood risk but are more cost effective than flood defences alone.

Dr Paul Quinn joined the Environment, Food and Rural Affairs Committee in UK Parliament as a special advisor to an inquiry into future flood prevention in a changing climate. The inquiry ran until August 2016 and a Government response outlines its findings and recommendations. The report concluded that a large-catchment trial of the effectiveness of natural flood management approaches such as installation of leaky dams, tree planting and improved soil management, should be carried out. This should take place alongside other measures such as farmland being used to store flood water and appropriate incentives to recompense farmers. Flooding last winter affected many communities across the UK, costing more than £5 billion and disrupting thousands of people’s lives and businesses. Dr Quinn is one of the UK’s leading researchers and campaigners for new catchment based methods to address flood management, as well as an expert in conveying the threat of increased rainfall to multiple audiences.

“It’s impossible to prevent all flooding but natural flood management measures such as tree planting and storing and slowing water in leaky dams and on floodplains help protect local communities more effectively than traditional approaches. A long-term holistic plan, such as that set out in this report, is needed urgently if we are to better manage the risk that flooding presents”, says Dr Quinn.

The EFRA committee’s report and government response are available online:
- The EFRA committee’s report: goo.gl/onAolK
- Government’s response: goo.gl/cgZw78

Improve wastewater and sanitation globally to stop antibiotic resistance

Key Message: Stopping drivers for antibiotic resistance requires a concerted international effort to improve water quality and sanitation in the developing world, preventing the global spread of resistance.

Professor David Graham is helping to shape US health policy around antibiotic resistance. He was invited to present evidence to the US Presidential Advisory Council on Combatting Antibiotic-Resistant Bacteria (PACCARB) in Washington DC last month, Professor Graham is one of a handful of world-leading experts who has been asked to help shape the new “One Health” strategy set up to address the threat of antibiotic resistance (AR). Highlighting the critical link between regionally inadequate waste management and the spread of AR genes and bacteria, Professor Graham stated that current policy underestimates the importance of improving water quality at global scales as key to curtailing AR in health systems around the world.

“Our research shows that regionally poor water quality is very likely a major driver in the global spread of antibiotic resistance; maybe as important as use of antibiotics. But there is a gap in current health strategies to address this there needs to be clear global strategies in place to improve waste management and water supplies, and also increase international environmental monitoring”, says Professor Graham.
Newcastle University Recognised for its World Ranking Sustainable Campus

For the fourth year in a row Newcastle University has been ranked as one of the greenest universities in the UK by the People and Planet University Guide, placing eighth overall. It has developed a range of initiatives for providing sustainable travel for all (Target 11.2), substantially reduce waste generation (Target 12.5), increasing energy efficiency (Target 7.3) and water-use efficiency (Target 6.4), and greening the campus (Target 11.7). The People and Planet University League is published annually and ranks universities on a variety of ethical and environmental metrics. Newcastle University is making outstanding progress for sustainability including Carbon Management (100%), Environmental Policy (100%), Waste & Recycling (75%), and Ethical Investment (60%).

The university received the highest score of all research intensive universities and is the first to reach the top ten list in five years. It also ranked 10th in the UI GreenMetric World University Ranking for 2016, a green university league table in which hundreds of universities participate from all over the world. Newcastle University was a finalist at the 2016 Green Gown Awards in the Student Sustainability Champion and Continuous Improvement categories. It was also presented with a Highly Commended award in the Research and Development Institution category for its flood risk management work in response to recent extreme weather events, building resilience and adaptation to climate hazards (Target 13.1). The Green Gowns recognise the exceptional sustainability initiatives being undertaken by universities and colleges.

“By setting a strong foundation of environmental policy and strategy, Newcastle has been able to make great progress in carbon management, waste reduction and sustainable food. People & Planet rate Newcastle University as one of the leading universities tackling campus sustainable development,” says Hannah Smith, People & Planet Co-director, Research and Campaigns.

Sustainability on Campus Key Facts:

- Introduction of smart water meters is saving 28,000 m³ of water per year with more savings to be realised in coming years.
- Three buildings have been retrofitted with LED lighting saving 306,000 kWh of electricity per year.
- Heating pipework insulation is saving 1.4 million kWh per year with further savings to be expected once the programme is complete in 2017.
- Invested in on-site renewable energy systems including rooftop PV arrays and rooftop solar thermal.

Sustainable urban water management – protecting the campus and city from flooding

Newcastle University actively manages surface rainwater through a series of ‘rain gardens’, absorbing water from the surrounding area and acting as a soak away, rather than contributing to existing sewers in times of heavy rainfall. This is especially important for Newcastle University, which sits between the Town Moor and the City; therefore sustainable surface water management is the university’s civic responsibility, helping to mitigate urban flooding.

Cycling

The Estates team have been busy transforming the university campus to provide additional cycle facilities, increase pedestrian prioritisation throughout the campus and limit vehicle movement. In partnership with the Go Smarter to Work initiative cycle maintenance sessions, cycle commuter training and other sustainable transport sessions are available on campus. The university has invested £210,000 per annum over the last three years on sustainable travel infrastructure, which includes cycle racks, cycle lockers and cycle charging facilities.

Electric vehicles

Newcastle University has a total of 14 installed electric vehicle charging points on campus. This includes a vehicle-to-grid charging point, one of the first of 10 capable of providing energy to the National Grid. The vehicle-to-grid charger is linked to the Smart Grid Lab part of the National Centre for Energy Systems Integration (CESI). It will be used to help researchers and industry understand what role EVs will play in future energy supply and demand.
Stopping mass species extinctions: Interview with Dr Philip McGowan

The world stands at the brink of the sixth major extinction event as a result of human activities that are responsible for catastrophic environmental change. Despite targets in place for halting mass species extinctions, there is still much progress to be made in conserving species vital to life on Earth.

Dr Philip McGowan has extensive experience in international biodiversity conservation, working in countries throughout the world. He is co-chair of the Species Survival Commission Policy Subcommittee of the International Union for the Conservation of Nature (IUCN) Species Survival Commission. The IUCN is an intergovernmental organisation that is the global authority on the status of the natural world and the measures needed to safeguard it.

In this interview Dr McGowan explains the progress of current international policies in place for biodiversity and how they connect to the Sustainable Development Goals.

What is the UN Convention on Biological Diversity CBD and how does it relate to or differ with the SDGs?

CBD is an internationally legally-binding treaty with three main goals: conservation of biodiversity, sustainable use of biodiversity and the fair and equitable sharing of genetic resources, which is the genetic information contained in the genes of plants, animals and microorganisms. CBD adopted a strategic plan for biodiversity that runs from 2011 to 2020. It has 20 targets which are known as the Aichi Biodiversity Targets. These cover everything from mainstreaming biodiversity to controlling invasive species, increasing and enhancing the value protected areas, halting species extinctions and mobilising more resources for biodiversity. 192 countries plus the EU have signed up to CBD. Two of the SDGs relate specifically to biodiversity: Goal 14 Life under Water and Goal 15 Life on Land. A range of targets in these and other Goals are based on, or influenced by, some of the Aichi Biodiversity Targets of the CBD.

How is the world doing with CBD targets now?

There was a mid-term review published by the CBD Secretariat in 2014-15. Although conservation action has increased, the scale of the pressures were increasing at a greater rate. We're doing more but the problems are greater.

What does the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) need to achieve?

My main concern is to increase the capacity for science to inform policies that affect the natural world and we have a very long way to go to build capacity at this ‘interface’. IPBES has four functions: doing assessments, capacity building, knowledge generation and policy support tools. A huge challenge in maintaining biodiversity is that policy-making and management could be critical at many different scales: anything from local, national, regional, all the way through to global. If you’re able to build capacity and understand what the needs are, at those different levels, you could be much more responsive to the challenges and problems for decision makers. We are working to support this key function of IPBES.
How do species ‘red lists’ account for the possibility that the Earth is heading towards the ‘sixth mass extinction event’?

The IUCN Red List is a system for assessing the probability of extinction facing species. For example, it identifies which species are closest to global extinction each year: they are classified as Critically Endangered. It also documents global extinctions. The increasing numbers of Critically Endangered and Endangered species suggests that more species will become extinct over a shorter time scale than has been the case over much of time. The exceptions are five periods in geological history where one-off events have led to the extinction of more than 70% of species in part of the planet, and these have been termed ‘mass extinctions’. The difference now is that the extinctions in this sixth event are predicted to be widespread across the planet, and if these predictions come true we could be losing an awful lot of species by 2050 and the impact on ecosystem functions and, therefore, people, are not yet known.

What are the pressures really threatening species?

It tends to be loss or change of habitat and overexploitation. We’re also beginning to see rapid increases in emerging issues like invasive species and wildlife disease. Living in a globalised economy means pressures are now being spread much more quickly than they would have been in the past, and to many more places. The big challenge is that the way our economy works will keep these pressures increasing.

What can be done?

The key thing is to really work hard across the science-policy interface, so the science we produce can give countries the best chance of meeting what are hugely ambitious political targets. Biodiversity is very complicated for policymakers to tackle. It’s difficult to capture all of it in targets. The fact that halting species extinctions is an outcome of CBD is a brilliant, hugely important political statement. But achieving this is going to be difficult and will need more than the ten years of CBD’s current 2011-2020 Strategic Plan. We are much better at understanding where to put effort and in what form it should take so that extinctions are halted and the declines of our most threatened species reversed. This will help ensure that our ecosystems continue to function properly.

Does thinking or strategy around national and international conservation need to change to meet the Aichi targets?

There have been global agreements on biodiversity for more than 40 years, with work plans to try and achieve their targets, but they were often perceived as outside the political mainstream. Now biodiversity targets are fully incorporated into the SDGs, which were signed by heads of state. Given four decades of global biodiversity agreements, it would be very helpful to see where their objectives, and their policy processes, now overlap, and what scope there is for improving coherence between them rather than competing for resources.

What about reaching the SDGs?

If we don’t get biodiversity right then at some point in the future all of the SDGs are going to be irrelevant because we won’t have a functioning planet. We should, therefore, be looking to see how we can use the biodiversity targets to achieve truly sustainable development for the world. The challenge is that targets that prioritise biodiversity do not tend to be the political vote winners, because the timescales we need to think over are in decades, rather than the four to five year lifetime of a particular government. But the SDGs do have shared opportunities. For example, working towards gender equality may well lead to wiser use of natural resources, because of women’s influence on decision making governing them. The more that we understand such opportunities, the greater the likelihood that a genuinely intergrated and science informed response to the challenge of the SDGs will make significant progress.
The 2016 Institute for Sustainability Annual Conference – ‘Sustainable Futures: Research, Policy and Practice’, brought together a range of experts in sustainability and sustainable development from countries in Europe and Asia. Newcastle University researchers presented alongside practitioners in business, industry, NGOs (non-governmental organisations) and government.

Held in London, one of the world’s hubs for national and international policy, the conference forged a new way of connecting research to policy. The format, which was mainly discussion based, allowed delegates to deliberate on how academics can inform and influence the often daunting world of policy with the aim of working towards the SDGs.

The Institute for Sustainability Annual Conference showcased sustainability research from Newcastle University to a wide range of stakeholders as well as engaged with key actors and organisations in national and international policy. The Keynote speaker Patrick Paul Walsh, Professor of International Development Studies at University College Dublin and Senior Advisor to the UN Sustainable Develop Solutions Network, gave an excellent talk on the need for academic research in meeting the SDGs.

There were many take home messages from the discussions that could be summed up into two main themes: how academics can get involved in the SDGs and how to bring academic research to policy:

- Academics have a large role to play in not only measuring progress for the goals, but understanding their interlinkages.
- Many researchers and organisations may be unaware that they are actually working on the SDGs, making it important to raise awareness about them.
- Although all UN countries have signed up to the SDGs, delegates found that there needs to be a drive within and outside of universities to publicise the Goals more widely. For universities it’s about promoting the SDGs at all levels and connecting them with research that addresses them.
- There is no ‘one size fits all approach’ to engaging with policy and every country has different mechanisms and opportunities for getting involved, but it is important to explore all of them. There are knowledge deficits within policymaking where academic researchers could have greater input.
- Every opportunity for creating new partnerships or collaborations are invaluable for research to policy and timing is crucial.
The SDGs are indivisible. We need to understand their interlinkages and find ways to pair them up.

Prof Patrick Paul Walsh, Senior Advisor to the UN Sustainable Development Solutions Network

There are big questions that need to be answered for the SDGs by academia and there are also trade-offs, which is why they need to be integrated as a package. Scientific discoveries need to impact people on the ground.

Dr Ruth Fuller, WWF-UK

How we engage with stakeholders around a particular problem in sustainability is essential, this is why communicating research in an accessible way is of great importance.

Uma Rajarathnam, Enzen Global

Understanding the context in which you’re presenting research is key. The process of research informing or influencing policy consists of lots of marginal gains rather than one big solution to solve problems.

Prof Phil Blythe, Chief Scientific Adviser at the Department for Transport
What was the focus of the research project?
Exposure to air pollution in both indoor and outdoor environments was assessed in a representative population in rural Northern Tanzania, working with the Ifakara Health Institute. Participants in the research included miners of the mineral tanzanite and members of their families, such as women who are exposed to biomass fuels when cooking. Both residents’ and miners’ exposure to particulate matter (PM) was tested and recorded, in total 800 hours of data were collected monitoring levels of PM10 (particulate matter between 1-10 microns in diameter), the threshold for respirable particles. Residents and miners were regularly exposed to PM levels well above the World Health Organization (WHO) guideline for PM exposure (50 μg/m^3) raising risk of COPD (chronic obstructive pulmonary disease) and other health ailments.

Why is it important to civil society?
20% of people identified with COPD globally do not have a history of smoking, and it is often an undiagnosed condition. In developing countries rapid urbanisation, poor ventilation and heating of homes, the use of biomass fuels and poor working practices also represent risk factors. The research project found that air pollution in homes as well as inside mines is potentially a large contributing factor, and both groups were identified as ‘high risk’. In the case of preventing miners’ exposure, simple practices like water sprinkling during and after blasts, improving ventilation in mines, and provision of protective dust masks would significantly reduce their exposure to PM pollution.

How is it addressing challenges of the Sustainable Development Goals?
For Good Health and Well Being (Goal 3) the research addresses ways to reduce life threatening illnesses and deaths from air pollution (Target 3.9) in identifying both the environmental problem: residents’ exposure to indoor air pollution’ and potential solutions: interventions for reducing indoor air pollution; provide safety provisions and implement health safety measures in mines. In creating Decent Work and Economic Growth (Goal 8) the recommendations from the project, if taken, would promote safe and secure working environments (Target 8.8), ensuring that workers are not exposed to dangerous levels of air pollution inside mines.

Key Findings:
• Indoor residential data shows that residents were in an environment that regularly exceeded 100 μg/m^3 45% of the time.
• For mines daytime levels of PM10 were found to regularly exceed 1000 μg/m^3, these levels were recorded 56% of the time near drilling activities.
• Both exposure to indoor and outdoor air pollution was found to be high and in mines at extremely high levels (20,000 μg/m^3) over extended periods.
• Average concentrations recorded at the mines were higher than those from residences, but only by a factor of 1% in the case of ‘indoor’ residential levels versus ‘rear of shaft’ mine levels.

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Understanding potential impacts of traffic pollution on urban agriculture

What was the focus of the project?
Understanding the perceived risk from traffic-related contaminants to produce grown in urban areas. Air quality sensors and NO2 traps were deployed to measure air contaminants, and the impact of biochar was tested, which can be used as a potential low-cost solution to minimise contamination and sequester carbon dioxide. Researchers from the Bio-informing Urban Gardening (BUG) project worked with residents and the Greening Wingrove Project, a community organisation in Newcastle that uses locally-based initiatives to tackle global-scale issues. The research project was ‘co-created’; community residents worked with scientists from experimental design and analysis to sample collection and dissemination of findings to the wider community.

Why is it important to civil society?
Urban agriculture, including allotments and vertical gardens, have a major role to play in producing food to feed cities. Perceived risk of contamination potentially discourages communities from using urban soils to grow food. Heavy metal pollution is known to reduce soil health and affects plant uptake of nutrients, and consumption of contaminated crops can lead to serious health problems. The project enabled residents to monitor the quality of the spinach they grew in their urban vegetable gardens. This helped them understand what if any impact traffic pollution had on urban vegetable produce over time and test ways to potentially mitigate it.

How is it addressing challenges of the Sustainable Development Goals?
To reach Zero Hunger (Goal 2) sustainable food production systems and resilient agricultural practices (Target 2.4) need to be implemented that will help feed the world. The BUG project demonstrated that it is possible to promote Good Health and Well-Being (Goal 3) by addressing public health concerns about car emissions through real time monitoring of urban agricultural systems, to understand environmental and health impacts of air contamination to reduce any risk of deaths and illnesses (Target 3.9). For Responsible Consumption and Production (Goal 12), combining ‘citizen science’ with community-based urban agriculture addresses sustainable management of natural resources (Target 12.2). Moving towards local agricultural food systems helps to make Sustainable Cities and Communities (Goal 11) by reducing their environmental impact (Target 11.6).

Key Findings & Outcomes:
• All measurements taken for contaminants were low and not of public health concern.
• No accumulation of heavy metals was found for plants sampled over five months and were well below World Health Organization limits.
• Biochar was found to improve availability of nutrients in soils but during this short-duration experiment – no significant difference in yield or heavy metal concentrations were detected.
• Concentrations of contaminants can change very quickly in urban areas as air quality can vary due to short term events, such as acceleration of cars and buses.

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Sustainable supply chains for flower harvesting

Research Team: Dr Alex Hughes (PI)

What was the focus of the research project?
The research conducted by Dr Alex Hughes in collaboration with Prof Cheryl McEwan (Durham University) and Dr David Bek (Coventry University) worked with flower harvesters in the Cape Floral Region (CPR) of South Africa, evaluating a sustainable supply chain from field to market by partnering with the Flower Valley Conservation Trust. The CPR is a global biodiversity hotspot with around 9,000 plant species native to the region. The flowers are harvested according to a Sustainable Harvesting Programme, arranged in ‘Cape Flora’ bouquets by local workers and sold to domestic and international markets.

Why is it important to civil society?
The research was essential in understanding how sustainable wildflower harvesting benefits local economies in South Africa and conserves native plant species. Dr Hughes’ team worked with communities who harvest fynbos plants to develop a flower guide translated into local languages, Afrikaans and isi-Xhosa, as well as English. The guide describes what species of flowers can be picked and how to pick them. It helps harvesters understand the difference between the many different types of fynbos plants to avoid picking flowers that are scarce. The project is an exemplar for how to work with communities and organisations to make supply chains sustainable and to practice conservation of biodiversity.

How is it addressing challenges of the Sustainable Development Goals?
For Decent Work and Economic Growth (Goal 8), the research exemplifies that the creation of fair jobs, trade and conservation of biodiversity is not only possible, but profitable, improving job creation, entrepreneurship, creativity and innovation (Target 8.3). It helps to reach No Poverty (Goal 1) by reducing the proportion of people of all ages living in poverty by half (Target 1.2). To reach Responsible Consumption and Production (Goal 12), the project encourages sustainable management of natural resources (Target 12.2) and contributes to Life on Land (Goal 15) through sustainable use of land by conserving important sites for biodiversity (Target 15.1.2). It also demonstrates how locally managed practices in sustainability encourage economic prosperity and environmental protection.

Key Findings & Outcomes:
• The flower supply chain is an example of ethical trade as local sites of production must adhere to environmental and social standards.
• The project has led to a guide for sustainable harvesting that benefits the ecosystem.
• Demonstrating that ‘sustainable wild flower harvesting’ works for both the ecosystem and economy discourages unsustainable practices such as developing the land for grazing or vineyards, and convinces landowners to conserve natural resources.
• The project successfully engaged with well-known supermarkets who sell the Cape Flora bouquets.

Website: www.flowervalley.org.za

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What was the focus of the research project?
The research project supported the participation of rural communities in local and regional development policies. It created a new method for assessing the landscape in Chile led by rural communities, incorporating their values in landscape assets. The Centre for Rural Economy at Newcastle University collaborated with Centro Regional de Innovación Hortofrutícola (CERES) and Pontificia Universidad Católica de Valparaíso in Chile. Researchers organised workshops that focused on participatory approaches such as action research and oral histories, along with creating a knowledge exchange on rural development issues in England and Chile.

Why is it important to civil society?
The project worked with a diverse range of collaborators in Chile including artists, natural scientists, social scientists and government. Making the voices of rural communities in Chile heard creates opportunities resulting in wider national awareness for restructuring rural development policy. As a result of the project, community groups were formed that focused on issues of importance to them. Researchers developed a method for landscape evaluation inclusive of the rural communities of Quebrada Alvarado and Melosillas, covering agricultural, ecological, socio-cultural, architectural and geographical dimensions. A Manifesto for the Development of Rural Areas in Chile was produced, that describes actions which need to be taken to develop a new rural policy in Chile that responds to the needs of rural communities.

How is it addressing challenges of the Sustainable Development Goals?
This research funded by the British Council created effective knowledge exchange with multiple civil society partners to enhance sustainable development (Partnerships for the Goals Goal 17, Target 17.16) in Chile. Rural communities are in many ways stewards of the land making them essential to protecting, restoring, and promoting sustainable use of terrestrial ecosystems. Partnerships with rural communities in Chile allowed the project to help build their capacity to improve Life on Land (Goal 15), particularly mountain ecosystems (Target 15.4). Since rural communities are at the centre of making agriculture sustainable in ending hunger and achieving food security (Goal 2 Zero Hunger), local and regional development policies inclusive of them contributes to sustainable food production systems (Target 2.4).

Key Findings & Outcomes:
• Chile needs a rural development policy that integrates not only the economic and productive dimension, but considers ecological and social dimensions to respond to the needs of rural areas in relation to their particular contexts.
• It is paramount to prioritise social inclusion of rural areas, as well as vulnerable groups like women, young people, or senior citizens in Chile, i.e. actions are required whose underlying principles aim for the improvement of inhabitants’ wellbeing.
• The experiences of rural communities have ecological, social and cultural resources that need to be understood and valued as both have potential for development.

The full manifesto from the project, predominantly arguing for a bottom-up shift in the governance of rural development policy in Chile, is available online: centroceres.cl/ukproject-en/stage-3-difusion

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What was the focus of the research project?
The project aimed to develop appropriate guidance for sustainable gardening by comparing the blood lead levels of gardeners whose plots have high concentrations of lead, with neighbouring non-gardeners. Urban soils for growing food in cities such as allotments may be contaminated with lead from industry or domestic sources. The research controlled for other potential sources of lead that gardeners may have been exposed to such as working with lead paint or the use of lead pipes for drinking water.

Why is it important to civil society?
Lead is a 'chronic toxin' that has potential for causing a range of adverse health effects, including impacts on neurodevelopment. 5-15% of ingested lead is absorbed by adults and up to 40% in children. This makes it a potentially serious public health threat. For soils with lead concentrations above current guideline levels, which is most soil in the UK’s urban areas, it may be possible to still use the land to grow food, rather than for other kinds of development. This would allow communities to make use of some underutilised brownfield lands to contribute to feeding growing urban populations in a healthy and sustainable way.

How is it addressing challenges of the Sustainable Development Goals?
For achieving Zero Hunger (Goal 2) allotments have a major role in providing safe, nutritious and sufficient food all year round (Target 2.1), and in helping to make Sustainable Cities and Communities (Goal 11). They are an example of small-scale agriculture that provide sustainable food production systems that improve land and soil quality (Target 2.4). The more common allotments and other forms of urban agriculture become, especially in cities, the more likely communities can work together to make world hunger history. For Good Health and Well Being (Goal 3), contamination is a potentially serious risk to the health of populations, but if its exposure is better understood it would help quantify the actual risk it has to health within an urban agricultural context (Target 3.9).

Key Findings & Outcomes:
- Within the context of this study, the soil lead concentrations on allotments at approx. 800 mg/kg, much higher than the ‘acceptable level’ established by government (80 mg/kg), did not result in blood lead levels of concern to health for gardeners.
- The research controlled for various potential lead sources and exposure factors finding that older study participants had significantly higher blood lead concentrations.
- Gardeners did have slightly higher blood lead levels than controls. Amount of time spent on their allotment site was the largest contributing factor.
- The results of the research will be used to explore best approach to modelling blood lead levels in adults accounting for behaviour and diet.
- Further research is needed for lead exposure to children on allotments, including their eating habits, and for soil to plant concentration factors in order to develop new soil guidance values of lead on allotments for the UK.

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Using renewable energy to prevent post-harvest food losses in Africa

Research Team: Sir Joseph Swan Centre for Energy Research

What was the focus of the project?
Solar energy and agricultural biomass are major sources of renewable energy in sub-Saharan Africa, with high potential for drying crops to prevent post-harvest losses. Working with colleagues in South Africa, Kenya, Ghana and Sierra Leone, the project designed a new facility that farmers can use to dry their crops. Air inside the facility is heated through solar energy, and this can be supplemented by combustion of waste biomass collected from markets. The drying facility can be integrated with evaporative cooling to provide chilling. Researchers have built solar drying units in Kenya and Ghana. In addition, in Sierra Leone researchers are working with fishing communities to develop solutions for keeping fresh fish using solar ice making systems. They are also looking at alternatives to fish smoking using wood from the mangroves since this is unsustainable and damages the local environment.

Why is it important to civil society?
Up to 50-70% of crops grown in African countries are lost before they reach the market. Farmers tend to dry their crops outdoors, with risk of ruining them if it rains. The solar drying facilities enable farmers to dry their crops, including fruits and vegetables, in a more efficient way, which adds value to their food products. Because the facilities are run by local businesses, they help boost struggling rural economies and create local jobs.

How is it addressing challenges of the Sustainable Development Goals?
The project is working towards Affordable and Clean Energy (Goal 7) in Africa, especially by providing universal access to affordable, reliable and modern energy services (Target 7.1) and increasing its share of renewable energy (7.2). This project is addressing a wide range of challenges including Zero Hunger (Goal 2) by helping to double agricultural productivity and incomes of small-scale food producers (Target 2.3); Decent Work and Economic Growth (Goal 8) by making available decent work for all women and men (Target 8.5); Responsible Consumption and Production (Goal 12) by contributing to halving per capita global food waste, reducing post-harvest losses (Target 12.3); and Life on Land (Goal 15) by preventing the burning of valuable ecosystems (mangroves) and enabling progress towards sustainable forest management (15.3.1).

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To come up with solutions for the developing world you must produce technology that uses renewable energy sources in an innovative way, but is also cost effective and capable of utilising local skills and materials so they are truly sustainable.

Professor Tony Roskilly
Community-led water management in Africa and Asia

Research Team: Dr Geoff Parkin (PI), John Gowing & Philip James

What is the focus of the research project?
The project seeks to improve the availability and management of groundwater in Sub-Saharan Africa, India and Nepal to monitor water catchments at multiple scales. Working with river basin authorities in Ethiopia and World Wildlife Federation (WWF) in Tanzania, researchers will tackle key water management issues through transparent use of data. The project will focus on two river basins, one each in Ethiopia and Tanzania, working with communities, environmental organisations, industry and government.

Why is it important to civil society?
Data-sharing platforms help integrate and present information in ways that support decision making at all levels, but their design needs to be user-driven to facilitate their adoption. Researchers will work with stakeholder groups representing community, ecosystem, business, and governance interests, identifying their needs using a participatory approach. The project will address issues of data scarcity in catchment water balance assessments by integrating independent sources of information from community-led monitoring (hydrological ‘citizen science’), and recent developments in remote sensing. It will enable stakeholders to visualise and interpret technical information for water management.

How is it addressing challenges of the Sustainable Development Goals?
Sustainable water management is crucial to sustainable development, especially where water is scarce in drier parts of the world. Communities have a vital role to play in identifying and monitoring fresh water resources which are central to health, livelihood and economy (Goal 17, Target 17.16 Multi-stakeholders). For Industry, Innovation and Infrastructure (Goal 9), the project is working with stakeholders to implement quality, reliable, sustainable and resilient infrastructure (Target 9.1) for monitoring water catchments. There are currently remote sensing tools at our disposal to understand water catchments, but the data needs to be combined with local monitoring to manage water at the catchment scale. Integrating data on water in this way not only makes Clean Water and Sanitation (Goal 6) possible, but a reality for communities facing water scarcity.

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What was the focus of the project?

The project investigated how blue-green infrastructure features in cities could mitigate flood risk and enhance the environment using the city of Newcastle as a testbed. The project used an interdisciplinary approach to identify and evaluate the multiple benefits of blue-green infrastructure. Work Package 2a of Blue-Green Cities tested a new storm sewer network model. The model for the first time linked gullies/drains and sewer pipes with surface water flow. This allowed researchers to model the impact of blue-green features on flooding such as permeable pavements and surfaces, green and blue roofs, swales and water butts in areas of Newcastle.

Why is it important to civil society?

Flooding is one of the biggest hazards facing cities, especially as heavy rainfall events are increasing due to climate change. Developing holistic approaches to storing water using blue-green features enhances cities’ resilience to drought as well as flooding. Outputs from the Blue-Green Cities project have been integrated into the city of Newcastle, along with a Blue-Green Vision that city stakeholders have committed to follow and work in partnership to implement more blue-green solutions. In Newcastle and Portland, Oregon USA, the multiple benefits of blue-green infrastructure were mapped across the city and findings shared with local authorities, water companies and citizens. The project also led to collaboration and knowledge exchange with stakeholders in Ningbo China, including academics, government departments and water companies, to help them develop blue green features. The project is an exemplar for how academic research can engage with civil society and industry to develop co-created solutions to local and global challenges for managing urban flood risk in cities.

How is it addressing challenges of the Sustainable Development Goals?

For Clean Water and Sanitation (Goal 6) managing water at the surface of urban environments potentially increases water-efficiency across all sectors addressing flooding as well as water scarcity (Target 6.4). The project found ways the role of local communities can be supported and strengthened (Target 6.B) to enhance flood management by implementing blue-green features in their neighbourhoods. This enables the urban environment to become resilient using blue-green infrastructure (Goal 9 Industry, Innovation and Infrastructure) to mitigate flooding, making the city sustainable in the face of extreme weather events (Goal 11 Sustainable Cities and Communities), through effective public, private-public and civil society partnerships (Goal 17 Partnerships, Target 17.17).

Key Findings & Outcomes:

- Researchers reproduced observed depths of flooding and flows into the sewer network of Newcastle using a high resolution model of the city (CityCAT), which simulated storm events such as the ‘Toon Monsoon’ in 2012.
- Widespread implementation of blue and green features mitigates flooding, particularly in areas upstream of at risk locations.
- The planned installation of a green swale was found to have far-reaching benefits across the city.
- The GIS mapping tool from the project is openly available and transferable to other cities.

Project Website: www.bluegreencities.ac.uk

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Industry

Dragonfly approach to stabilising floating wind turbines

Research Team: Dr Wenxian Yang (PI), Dr Wenye Tian, Prof Longbin Tao & Dr Bing Ji

What has been developed?
A new passive stabilisation technique for floating wind turbines based on the separate muscles used by a dragonfly to manoeuvre in flight. It suppresses the motion of the floating wind turbine caused by wind and waves by up to 50%. It could make possible offshore wind generation at depths greater than 90m deep.

Why is it important to industry?
The technology has large potential to impact the offshore wind industry if it is successfully commercialised. It is also applicable to sea keeping which is essential to vessels that install offshore wind turbines. In the UK alone the installed capacity of offshore wind is expected to increase from 5.07GW to 10GW by 2020.

How is it addressing challenges of the Sustainable Development Goals?
For Affordable and Clean Energy (Goal 7) offshore wind power has a large contribution to make in decarbonising the world’s energy supply, substantially increasing the share of renewable energy in the global energy mix (Target 7.2). To achieve Industry, Innovation and Infrastructure (Goal 9) the technology developed by Dr Yang could upgrade infrastructure and retrofit industries to make them sustainable (Target 9.4). This innovative technology could make wind power more efficient, helping to expand infrastructure for clean energy technology in both developed and developing countries that have capacity for offshore wind.

Key Findings:
• The passive stabiliser greatly suppresses the motion of the floating wind turbine caused by wind and waves by about 50% in 50m depth water.
• Stabilising off-shore wind turbines using this technique reaches the desired stability without sacrificing power generation efficiency.
• The design improves the turbine’s power generation efficiency and minimises the risk of catastrophic sink in extreme weather.

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Using the ‘dragonfly’ approach enables floating wind turbines to have stable motion under harsh sea and weather, making them applicable to a wide range of offshore environmental conditions for generating renewable energy.

Dr Wenxian Yang
During a large scale marine oil spill like Deepwater Horizon, aerobic microbes are the first responders that start cleaning up the oil at the surface of the water column. Stimulating these microbes to degrade the oil is one of our best defences in preventing oil spills from turning into disasters.

Dr Angela Sherry

Cleaning up oil spills

Research Team: Dr Angela Sherry (PI) & Prof Ian Head

What has been developed?
A range of biotechnologies for the treatment and detection of oil spills. For example, nanoparticles called ‘SmartGates’ are capsules that deliver nutrients to microorganisms directly at the oil surface. The nutrients stimulate the microbes to clean up the oil more effectively, including in oil polluted beach sediments.

Why is it important to industry?
The SmartGates technology enhances bioremediation of oil spills, potentially reducing their impact on marine ecosystems. While fertilisers have traditionally been used to enhance biodegradation of oil they may not be the most effective way of cleaning up spills, as the nutrients are easily washed away. The SmartGates were also field tested in the ocean, as part of the Kill Spill project, under the supervision of two oil spill response teams (Maritim Miljø-Beredskap (MMB), Norway and Environmental Protection Engineering (EPE), Greece).

“During KillSpill we learned that there are some interesting new ways of using biosensors for “early warning” purposes (the bio-buoy) and also some very interesting subjects around oil-contaminated sediments (oxy-gel) which we think might be very helpful to speed up the process of restoring the environment on the coast”, Håkon M. Ones, Advisor operations, MMB AS.

How is it addressing challenges of the Sustainable Development Goals?
While the world must reduce its dependence on fossil fuels, especially oil as a fuel source, for Industry, Innovation and Infrastructure (Goal 9), technologies need to be in place to eliminate the hazardous impacts of oil spills if they cannot be prevented (Target 9.4), and upgrade its technological capabilities (Target 9.5). For Sustainable Consumption and Production (Goal 12) these technologies help reduce pollution from oil spills that have devastating impacts on marine life and society (Target 12.4). The technologies developed are highly applicable to safeguarding ocean health and marine biodiversity throughout the world (Goal 14 Life Below Water, Target 14.1 reduce marine pollution).

Key Findings:
- There’s no ‘silver bullet’ for cleaning up oil spills but it is possible to increase the amounts of nutrients available to microbes that biodegrade oil.
- Bacteria that are present when hydrocarbons are released into the marine environment can be stained fluorescent and detected with a microscope.
- To monitor microbes that degrade hydrocarbons from oil spills, buoys with biosensors can be deployed across a marine environment to track the movement of oil plumes.

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Advanced cooling for electric vehicles and renewable energy generation

Research Team: Dr Richard Law (PI), Prof Volker Pickert, Prof Adam Harvey & Iain Ditchburn

What has been developed?
A cooling technology that significantly enhances heat transfer for cooling insulated-gate bipolar transistors (IGBTs), one of the major components in the drive units for electric vehicles, wind turbines and in inverters for solar panels. The current cooling techniques available are becoming limited in their heat removal rates, which is hindering further technological progress. The technology oscillates flow of water or other liquid coolant forwards and backwards to rapidly cool the IGBT chip with a heat removal rate of up to four times higher than standard liquid cooling technologies.

Why is it important to industry?
The technology has large potential to prevent breakage or failure of IGBTs, increasing efficiency and potentially extending the lifetime of EV drive units and renewable energy generators. The amount of heat dissipated from an IGBT varies quickly over time. For example by easing off the accelerator an EV dissipates less heat, but in some cases can drop suddenly from 60 to 30°C: this thermal cycling can cause damage to the IGBT over time. Controlling heat removal from the IGBT allows for control of the actual IGBT temperature, keeping it at a constant temperature and removing heat as needed.

The technology is relatively simple to build and the components can be produced using 3D printing technology.

How is it addressing challenges of the Sustainable Development Goals?
The uptake of IGBTs has increased widely because of the rise in use of renewable energy technologies, therefore innovations in cooling IGBTs could improve their use in a variety of different contexts, helping to further the widespread use of clean energy generation and electric vehicles. Extending the lifetime and efficiency of IGBTs addresses Goal 7: Affordable and Clean Energy by increasing the share of renewable energy in the global energy mix (Target 7.2), and it applies to Goal 9: Industry, Innovation and Infrastructure because it encourages greater adoption of clean technologies (Target 9.4). Zero carbon vehicles are essential to meeting Sustainable Cities and Communities (Goal 11), especially sustainable transport systems for all (Target 11.2).

Key Findings:
- The use of oscillatory water flows significantly enhances the rates of heat removal compared to steady flows. There is also potential to significantly improve control of the chip temperature.
- Without varying the water flow rate, the heat removal rate can be varied by up to 50% by simply altering the oscillating condition, thus showing the potential of this technology for increased thermal control.
- In an IGBT there are multiple chips (20+) and a cooler could be placed underneath each one for maximum temperature control.

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Oscillatory baffled heat exchanger produced on a 3D printer.

We’ve proved the concept of using this technology to significantly enhance the range of water cooling of electronic components, and with further research hope to drive towards a commercial product.

Dr Richard Law
Upgrading waste heat to useable energy

Research Team: Prof Tony Roskilly (PI), Sir Joseph Swan Centre for Energy Research

What has been developed?
An integrated thermo-chemical fluid and storage system that upgrades low-grade heat from industrial waste heat, solar thermal or geothermal sources, that can be stored and used for a range of purposes including power, heating and cooling.

Why is it important to industry?
The ability to economically utilise low-grade heat and deliver energy has enormous potential for industrial applications. Low-grade heat (below 150°C) accounts for 50% or more of the total heat generated by industry. This is the equivalent of 40 TWh annually, or enough to heat 2 million homes per year. There is also great potential to use solar thermal and geothermal energy for similar purposes. The majority of technologies capable of utilising low-grade heat have very low efficiency and are not cost effective, but with the technology being developed it is possible to recover heat and store it without loss using thermochemical fluids. This provides an excellent way to offset carbon emissions, reducing heating, cooling or power demands by using heat that is renewable or from a source that would otherwise go to waste.

How is it addressing challenges of the Sustainable Development Goals?
Taking advantage of renewable and waste heat as a resource would substantially increase resource-use efficiency for industrial processes (Goal 9 Industry, Innovation and Infrastructure, Target 9.4). It addresses Responsible Consumption and Production (Goal 12) by offsetting a range of energy demands, enabling industry to achieve sustainable management and efficient use of natural resources (Target 12.2), while also helping the world achieve Affordable and Clean Energy (Goal 7), and double the global rate of improvement in energy efficiency (Target 7.3). Integrating thermal recovery and storage into the energy network would improve it overall by reducing further pressure on energy demands, which are expected to increase in the future. The solution is cost effective and a systems approach results in a variety of commercial applications.

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Rice straw for anaerobic digestion

Research Team: Sir Joseph Swan Centre for Energy Research

What has been developed?
A process for using rice straw which is widely available in Asia and a number of other rice producing countries for the generation of biogas through optimised anaerobic digestion. When rice straw goes to waste it biodegrades resulting in the release of methane, a potent greenhouse gas and is often burned, leading to a large source of air pollution.

Why is it important to industry?
91% of rice is grown and consumed in Asia and this results in approximately 550 million tonnes of straw produced each year. Using rice straw as a feedstock for generating biogas has huge potential for the agricultural and energy sectors, especially since it is possible for it to be converted to energy on its own without the use of other materials to co-digest it, such as animal manure. Biogas in turn can be used for crop drying, generating electricity or combined heat and power. Pretreatments of rice straw have been investigated by researchers along with feed rates. The process could make rice straw a sustainable energy resource, and be used to recover silica, a key ingredient for numerous products in industry and a replacement material for cement, which is very energy intensive to produce.

How is it addressing challenges of the Sustainable Development Goals?
To reach Affordable and Clean Energy (Goal 7), rice straw could make anaerobic digestion a large part of the renewable energy mix by 2030 (Target 7.2). As rice straw currently goes to waste and is the source of a widespread environmental hazard when burned or allowed to decompose, using it for biogas production offsets carbon emissions and transforms it into a valuable energy resource (Goal 12 Responsible Consumption and Production). For Life on Land (Goal 15), preventing the burning of rice straw would help improve the conservation of terrestrial ecosystems and the services they provide (Target 15.1).

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Sustainable practices for microbreweries

Research Team: Dr Chris O’Malley (PI), Sharon Joyce & Prof Sandra Edwards

What has been developed?
The Stu Brew research team has tested new ways microbreweries can reduce their ecological footprint by using grain and yeast wastes as a resource, and optimising cleaning procedures using the craft beer industry in North East England as a case study.

Why is it important to industry?
While the craft beer industry continues to grow rapidly around the world, there are ways in which it could reduce its impact on the environment, and also reap savings by reducing energy and water usage. A novel drum drier was designed to produce optimal conditions for drying yeast which can be used as an animal feed, reducing impacts on drainage infrastructure. Brewing grains were tested as a potential fuel source for a biomass boiler, and excess liquor from soaking grains in hot water (mash) was evaluated for anaerobic digestion. The research also found that chemical usage can be reduced in cleaning without compromising tank sterility.

How is it addressing challenges of the Sustainable Development Goals?
The craft beer and the brewing industry more widely has a large role to play in integrating sustainability into its manufacturing practices and infrastructure (Goal 9 Innovation, Industry and Infrastructure). This allows it to minimise use of natural resources and any polluting impacts on the environment, including upgrading infrastructure to make it sustainable (Target 9.4). The availability of high-tech and low-tech options make it possible now more than ever for breweries to develop a sustainable business model contributing to Sustainable Consumption and Production (Goal 12). Through efficient use of natural resources (Target 12.2) it helps to halve global food waste (Target 12.3). While individual craft breweries may have relatively small ecological footprints in comparison to their larger competitors, collectively they can work together to make the whole brewing process more sustainable overall by enhancing production methods.

Key Findings:
• After the barley grains are soaked in hot water to extract the sugars for the brewing process, any leftover ‘last runnings’ has high conversion to methane (biogas).
• Yeast from brewing can be used as an animal feed but must be heated to over 60°C to inactivate the yeast cells. Optimum yeast drying was obtained using a drum dryer designed at Newcastle University.
• Low-cost mechanical methods of pressing, followed by a passive drying system, can be used to increase the spent brewer grains’ lifetime and reduce transportation costs.

A Sustainability Practice Note about the research is available online: goo.gl/QPRPDt

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Individually the environmental footprint of a microbrewery is quite small. But if we can convince the network of breweries that we have engaged with to make one or two small changes to how they operate, we can start to make a positive impact on improving the sustainability of the industry as a whole.

Dr Chris O’Malley
Decarbonising energy in the built environment: Interview with Dr Sara Walker

Dr Sara Walker is Associate Director of the UK’s National Centre for Energy Systems Integration (CESI) at Newcastle University. The Centre is working to deliver smart, flexible energy infrastructure that empowers customers and gives them greater control of their energy use. It is working with industry to reach emissions targets to create a sustainable low-carbon future. Dr Walker is working on building energy performance models and building stock models to consider building energy futures that contribute to Goal 11 Sustainable Cities and Communities.

How do we address energy usage and carbon emissions in the built environment?
In Europe about 45% of our total energy use is associated with buildings. But it’s not just the building itself, it’s the way we use the building and the kinds of activities that go on inside of it that are relevant. In the UK around 60% of our energy use in the home is down to space and water heating. If we can improve building fabric and behaviour we’re going a long way to reducing our energy consumption and associated greenhouse gases (GHGs).

What are the main sources of energy loss in buildings?
One quarter of energy loss is through the roof. There is somewhere between 15-20% heat loss through windows. We can address these losses by improving the fabric of the building, and ventilation by reducing air change in the building, which reduces our overall demand to heat the space. A good way of tackling energy loss is through prefabrication, including ventilation and the fabric itself.

What is prefabrication?
Prefabrication means that you can get all of the building fabric, all of the services built in a contained unit and make it air tight before you get it to site. It is a more robust and quality controlled way of creating buildings. The prefabrication we’re working on at Newcastle University is not just for new builds, but for retrofitting existing homes. It improves quality of the building fabric and quality of the air tightness to reduce heat loss.

Is this applicable to people living in a range of different environmental conditions?
Yes, in the UK we tend to look at building fabric from the point of view of trying to reduce heat loss and the same for ventilation. For other countries in say South America or Africa you’re trying to reduce heat gain instead of heat loss because you’re in a more tropical climate, but the principles are the same. It’s just that the heat flow you’re trying to stop is from inside-out instead of outside-in.

What is an example of an approach to architecture that addresses thermal comfort?
The vast majority of good approaches to architecture is called ‘vernacular architecture’, where you’re adapting the architecture to be appropriate to the local climate. So you want your building to respond very slowly instead of swinging upwards and downwards like outside temperature does. It’s about architecture appropriate to your environment.

What role do prefabricated homes have in the wider energy system?
What prefabrication enables us to do is look at ways in which we can operate more of a plug-n-play operation with the technology. For example, your energy services could be part of an energy centre for the house. The delivery of heating is the same but you could replace a gas boiler with an air source heat pump, and access the services quite easily through plug-n-play. The energy system as a whole can consider how we deliver the same services with slightly different energy technologies and pathways. But we need to take a broader picture. If we need to reduce our GHG emissions, how do we do that? Do we electrify heat demand? Do we go for hydrogen? Heat networks with community combined heat and power? If we get the design right on the pre-fab then we can gradually change the technology to meet the same energy demands.

Could we feasibly decarbonise energy now?
It really depends on how you count your GHGs. I believe that it is possible with technologies available that you can provide the same energy services that do not emit GHGs at source. I think it is technically possible to do this with renewable electricity, energy storage and arguably with grid interconnectors, but are those GHGs emitted in a different country? It’s about how you do your accounting. Which is why it would be very difficult to reach zero GHGs. 80% reduction in emissions is more feasible if you account for GHGs associated with the mining of core materials.

For more information on Dr Sara Walker’s research and CESI visit www.ncl.ac.uk/cesi
### Air Quality

**Key findings:**
- The study addresses the challenge of forecasting accurately the concentration of NO₂ to enable local authorities to mitigate or even prevent exceedances of concentration limits through real-time traffic management.
- The ability to forecast exceedances of legal pollution limits can be enhanced by requiring traffic management actions when the predicted concentration exceeds a lower threshold than the normative one.
- Air quality protection needs to be fine-tuned through the introduction of further tools and actions for predicting extreme pollution events, and managing traffic in real time in order to prevent concentration peaks.


**Key findings:**
- Affordable processing of indoor air quality and energy data is needed to realise systems for real time monitoring that will better respond to occupants’ needs.
- More progress has been made for air quality and energy sensors in the built environment rather than in management.
- The challenges for building energy management systems are availability of sensors, cost and quality, and availability of deployment services.

### Consumer Carbon Footprint

**Key findings:**
- Research explores the process consumers use in assessing whether a food product has a high or low carbon footprint. On average, participants were able to correctly categorise products by their carbon footprint.
- Perceived carbon footprint discrepancy is largest for fruit and soft drinks, while meat and dairy, fish and eggs were perceived as more sustainable than they actually are. Investment in reputation, such as certified labels, can more accurately inform consumers about environmental impacts of food products.
- Joint proactive actions may prevent or limit the damage that one member of the chain could cause to others, protecting agents along the supply chain as well as consumers.

### Antibiotic Resistance

**Key findings:**
- Reducing non-therapeutic antibiotic use in agriculture can reduce environmental antibiotic resistant legacies, allowing an environment to recover over time.
- Antibiotic resistant genes in animal manure and humans are historically interconnected. In Denmark where non-therapeutic antibiotics were banned, levels declined in soils with manure.
- Antibiotic stewardship must improve across medical, agricultural and environmental sectors to mitigate antibiotic resistance.

### Biodiversity

**Key findings:**
- The current Himalayan PA network underrepresents Galliforme species threatened with global extinction by 58%.

**Key findings:**
- Protected Areas (PA) in the Philippines are not appropriately positioned to protect areas of particular importance for biodiversity, and management systems in place do not allow PAs to function effectively.
- Lack of management plans, dedicated budgets, operating management boards or even Congressional approval undermines efforts to promote biodiversity conservation in 38,000 km² of protected land.
- PA authorities must now acquire sufficient capacity to develop and implement biodiversity-led management plans in direct line with the targets they set.

### Biogas
Blake LL, Halim FA, Gray C., Mair R, Manning DA, Sallis P, Hutchinson H, Gray ND. (2017) Evaluating an anaerobic digestion (AD) feedstock derived from a...

• Autoclaving Municipal Solid Waste produces separate streams of recyclable materials (from non-source segregated waste), and a high quality biodegradable material which can be used e.g. for anaerobic digestion (AD).

• The potential for biogas production from MSW in anaerobic digestion (AD) per tonne of waste material is comparable to that of agricultural waste.

• Approx. 10.4 million tonnes of MSW could be diverted from landfill and used for generating biogas instead.

• The process would produce around 3.1 million tonnes of a solid product (digestate material) akin to compost or soil fertilizer.

Climate Adaptation

Key findings:
• Provides a rapid approach to identify and prioritise the most critical locations for flood risk management intervention, and prioritise limited financial resources to improve transport network resilience.

• Green roof infrastructure and traditional engineering interventions like culverts or flood walls can together work to reduce transport disruption from flooding.

• Protecting the top critical location from flooding results in an 11% reduction and city-wide deployment of green roofs achieves a 26% reduction in person delays.

European-wide Urban Flood Model

Key findings:
• The study is the first pan-European analysis of urban flooding and calculates the percentage of area flooded for 571 European cities for a 10-year return period for hourly rainfall.

• Cities with lower percentage of flooding are in the north and west coastal areas of Europe, while the higher percentages are seen in continental and Mediterranean areas.

• Hourly rainfall records need to improve to create better estimates for flooding in Europe as a whole.

Climate Change

Key findings:
• UK extreme precipitation intensities decline at temperatures above about 22°C. Similar observations have been made around the globe.

• A warmer future climate may be more favourable to extreme precipitation, but simulations indicate that this does not extend to the warmest summer days.

• Regional surface temperatures cannot be used alone to extrapolate changes in extreme precipitation intensity.

Conservation

Key findings:
• Provides a strategic approach to making a decision about whether ex situ management (i.e. protecting endangered species outside their natural habitat) is appropriate as part of a species conservation strategy in any given context.

• Guidelines can be applied across all taxonomic levels and to biosamples as well as living individuals.

• Comprehensive strategic planning for species needs to be undertaken as early as possible.

• It is important that any conservation activities, including ex situ management, target the causes and/or consequences of specific threats to species survival.

Coral Reefs

Key findings:
• Increase or shift in sea surface temperature is the dominant cue in Indo-Pacific reefs for Acropora corals to spawn, but its relationship with reproductive timing was not significant.

• The impact of climate change on coral reproductive timing might be minimal relative to species that rely on absolute temperatures.

• Tropical species appear to be more sensitive to small climate fluctuations than assumed previously.

Ecology

Key findings:
• The criteria for species definition does not exist in the bacterial world and while many have been identified their associated functions are often
unknown.

- Do away with the ‘species concept’ for microbes and instead identify entities that can be ‘individualised’ and make sense in terms of ecology to understand and describe their coupled interactions.
- Candidate entities for this new paradigm could be individual cells, or organisms that live together within the same habitat or functions of genes, proteins or metabolites to help understand diversity in the microbial world.

Ecosystem Services


Key findings:

- Place-based PES (Payment for Ecosystem Services) schemes can mitigate negative trade-offs between ecosystem services more effectively, and may become an increasingly important component of future environmental governance.
- PES schemes more holistically represent understandings of the social, economic and biophysical attributes that shape a given place, and represent the needs and priorities of multiple stakeholders.
- Despite growing interest in PES among the international policy community, the potential for PES schemes to alleviate these pressures remains unrealised because of social, cultural and environmental trade-offs that are often inherent, but unrecognised in scheme design.

Fuel Cells


Key findings:

- Future research on Anion Exchange Membrane (AEM) materials and degradation should be conducted at pH closer to neutral and in an oxygen saturated environment, which is closer to ‘real-world’ conditions.
- Stability of AEM is mainly influenced by structural changes during radiation grafting. Use of different base polymers had minimal effect.
- When the concentration of dissolved oxygen in the solution is increased, the rate of membrane degradation due to ion-exchange capacity (IEC) loss is also increased.

Community-based Water Management


Key findings:

- In sub-Saharan Africa, groundwater level monitoring networks are essentially non-existent when it comes to shallow groundwater – the resource which is used by the majority of poor rural communities.
- Reliable and consistent measurements can be obtained by local residents improving hydrometeorological monitoring, who benefit from a greater understanding of their local hydrology.
- This increased understanding and empowerment of communities is at the relevant scale required for effective community-based participatory management of shallow groundwater and river catchments.

Marine Energy


Key findings:

- Using the power plant of an existing vessel as a case study, over a projected 30-year period, emissions released to air and freshwater were found to be significant.
- Approximately 85% of the total environmental impacts of a power plant on-board a RoRo cargo ship were caused by diesel engines, auxiliary generators, propellers and shafts.
- Full life cycle phases of power plant should be managed appropriately to avoid shifting the burdens from one impact to another.

Oil Spill Cleanup


Key findings:

- The review provides a comprehensive analysis of the research on bioelectrochemical remediation of oil spills and of the key parameters involved in the process.
- Electrobioremediation is clean, has lower operational costs than alternatives, high selectivity towards target compounds, and can be used to monitor oil spills.
Main issue to be faced in the near future will be the scale-up of electrobioremediation from lab scale reactors to field scale systems.

Organic Farming

Key findings:
- Shallow non-inversion tillage at less than 10cm deep had the lowest impact on yield (5.5%) compared to deep inversion tillage, and enhances soil quality compared to conventional tillage.
- Organic practices can enhance carbon uptake with ley crops and manure or compost.
- ‘Strategic tillage’ at critical stages in crop rotation may be best to manage weeds and crop diseases.
- Reduced or no-till systems for organic farming improve uptake of soil mineral nutrients and have more efficient cycling of nutrients.

Pesticide Resistance

Key findings:
- The wild tomato species studied (L. pimpinellifolium) represents a source of genetic resistance to the whitefly (T. vaporariorum), a well-known tomato plant pest.
- The introduction of whitefly resistance genes could potentially aid the continued and more effective production of tomato plants in the future.
- The whitefly prefers commercial species of tomato potentially because it represents a better food source due to a lack of resistance mechanisms.

Solar Energy

Key findings:
- Considers a representative UK residential power network under different PV (photovoltaic) penetration levels, and identifies the power factor variation and possible approaches for its improvement.
- Power factor is a major parameter which decreases with an increase in penetration levels, and reaches close to zero at 40% PV penetration. Zero power factor means that the substation transformer is only supplying reactive power and no real power.
- The power factor of the distribution feeder has to be improved so as to enable higher penetration of PV systems and reduce the losses of the feeder.

Policy Strategies for Sustainable Cities

Key findings:
- Study uncovers the degree of importance of innovative technologies and how they could contribute to achieving future targets for urban sustainability at the sector and system levels.
- Managing population growth, resource availability and pollution increases effectively requires a profound change in how cities operate.
- Achieving more ambitious metabolic performance of renewable energy seems to be easier at the system level than at the water-sector level, up to a performance of 60% improvement.
- Nutrient recovery for phosphorous exceeds that for nitrogen, which in turn exceeds the attainability of water use targets.

Sustainable Cities

Key findings:
- Integrating more than one type of urban planning policy is needed for cities to have a ‘sustainable urban metabolism’ that provides co-benefits in terms of economic cost and environment.
- For urban development policies to be effective they need to target actors outside landowners or developers, such as end-users.
- Urban development policies need to understand the social context of unsustainable behaviour to be effective at making cities sustainable.
Institute for Sustainability

Key Facts

Directly funded

14 interdisciplinary projects

16 schools in 3 faculties

53 researchers

18 external organisations in 9 countries

1/4 of academic staff choose to take part in institute activities

Supported

18 externally-funded interdisciplinary projects

with £4.5m value over 18 months

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