



Plymouth University
**SUSTAINABILITY RESEARCH
REVIEW 2016**

**RESEARCH
WITH
PLYMOUTH
UNIVERSITY
SUSTAINABLE
EARTH INSTITUTE**



INTRODUCTION TO THE PLYMOUTH UNIVERSITY SUSTAINABILITY RESEARCH REVIEW 2016

Welcome to the Plymouth University Sustainability Research Review 2016 from the Sustainable Earth Institute.

This review highlights a selection of the research that has taken place over the past year at Plymouth University focusing on building a sustainable future. It is drawn from the Plymouth University abstracts submitted to Sustainable Earth 2016 which took place on 23 and 24 June 2016, and outlines staff and student research from a variety of disciplines at the University. The review is framed around the 9 challenges presented at the conference: health and wellbeing; biodiversity and conservation; cities and communities; water; energy; production and consumption; climate change; resources and education.

Each challenge begins with an overview focusing on the local, national and global context written by those who presented theme introductions at the annual conference. These are followed by abstracts which were submitted and presented at the event, along with news stories from throughout the year.

If this review inspires you to collaborate with us, or if you want to find out more, our team are here to help.

Please contact us at:

Tel: +44 (0) 1752 585816

Email: sei@plymouth.ac.uk

Website: www.plymouth.ac.uk/sustainable-earth

Twitter: @PlymEarth

While every effort is made to ensure the accuracy, relevance and up-to-date nature of the information contained in this publication, we cannot guarantee the information on the web links are always accurate or complete.

Sustainable Earth 2016: A global forum for connecting research with action (23 and 24 June, Plymouth University)



SUSTAINABLE EARTH INSTITUTE

The Sustainable Earth Institute is about promoting a new way of thinking about the future of our world.

We bring researchers together with businesses, community groups and individuals to develop cutting-edge research and innovative approaches that build resilience to global challenges. We link diverse research areas across the University including science, engineering, arts, humanities, health, business and education.

If you're an academic looking for a connection to industry, an organisation looking for academic research support or an individual who is inspired to work towards a sustainable future then contact us to find out how we can help.

We need to celebrate and recognise our complex, dynamic, and unique world – after all, good planets are hard to find.



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HEALTH AND WELLBEING

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Professor Janet Richardson

*Professor of Health Service Research,
Plymouth University*

Dr Clare Pettinger

*Lecturer in Public Health Dietetics,
Plymouth University*

Dr Lyndsey Withers

Devonport Lifehouse, Salvation Army

The presentation focussed on health impacts of climate change for the UK. For example: increased skin cancer and dehydration; effects of injury, loss of home / livelihood and longer term effects of returning to a damp house or anxiety / depression from flooding; food-borne disease and contamination; emerging infections and an increase of problems such as Lyme disease. Locally, in the South West, the landscape, weather and natural environment make us more vulnerable to some of these impacts. However our natural resources also provide us with significant health and wellbeing opportunities, that, if we can harness, may also have positive effects on the environment.

Physical activity is one of the most significant factors in improving health and wellbeing; we can use our beautiful assets by enhancing public space and getting people out into the wider natural environment. We have excellent coastline for health promoting activities (swimming, sailing, walking etc). However water quality monitoring around estuaries needs proactive action to limit waterborne diseases. Local projects exist that link our natural environment to outdoor activities for physical and mental wellbeing. Examples were provided that raise awareness about health promotion and illness prevention, making connections with environmental challenges and climate change.

CLIMATE CHANGE AND EMERGENCY MEDICAL SERVICES: A SYSTEMATIC REVIEW AND THEMATIC ANALYSIS OF THE LITERATURE

Author: *Mr Peter Allum*

Additional authors or affiliations: *Professor Janet Richardson and Dr. Andrew Nichols*

Background: There is a mounting body of evidence to suggest that climate change and global warming affects humanity, with particular impacts on human health, morbidity and mortality. Emergency Medical Services (EMS) are vital constituents of the healthcare structure and planning for their delivery should aim to incorporate 'environmental legacy' considerations.

Aim: This systematic review was thematically analyses published literature on EMS and sustainability by categorising papers according to their focus on effects; strategy; actions; and behaviour of the workforce. Methods: Healthcare databases AMED; CINAHL; Cochrane Library; Embase; Medline (EBSCO); Medline (Ovid); PsycInfo; PubMed; SOCINDEX; Web of Science were systematically searched for appropriate articles. Searches focussed on papers published between 2008 and 2014 and retrieved sources were quality appraised to inform the thematic analysis of their content.

Results: A total of 52 publications were retrieved for further scrutiny and quality review, 37 met the inclusion criteria. These papers were categorised and discussed according to their focus.

Conclusions: There is a small, yet emergent published empirical evidence base that evaluates worthwhile sustainability interventions and strategies for EMS systems. Focus now should be on a major impetus towards gathering further quality research evidence in order to implement the right strategies, share good practice and create win / win scenarios with sound financial savings and reduced carbon emissions that benefit the wider society. This also includes winning the hearts and minds of EMS employees by adopting and championing sustainability practices and campaigning for a cleaner, efficient and cost effective ethos in community emergency health.

THE FUTURE OF HEALTH, WELLBEING AND PHYSICAL EDUCATION: OPTIMISING CHILDREN'S HEALTH AND WELLBEING THROUGH LOCAL AND GLOBAL SUSTAINABLE PARTNERSHIPS

Author: *Dr Timothy Lynch*

Additional authors or affiliations: *Tim is the Vice-President (Head of Oceania region) for the International Council for Health & Physical Education, Recreation, Sport and Dance (ICHPER-SD). ICHPER was founded as a Non-Government Organisation (NGO) in 1958 and is officially recognised by UN*

The partnership story presents a Health, Wellbeing & Physical Education (HW & PE) initiative; 'Best Start: A community collaborative approach to lifelong health and wellness'. The initiative models the UN ideals contextualised into local schools and communities. What began as a pathway seed quickly grew to involve multi-stakeholder partnerships; Australian universities, schools, Australian Registered Training Organisations (RTO), the local health industry (local leisure and sports centre), Education departments, sport governing bodies at the national level, and a world leading international Initial Teacher Education

(ITE) university course in the UK. Sustainable partnerships are identified by the UN as essential for implementing the SDGs, which apply to all nations around the world. This is significant as Goal Three and Four of the SDGs directly relate to HW & PE. Data gathered from various stakeholders in this research project suggests quality physical education (QPE) is enhanced when partnerships are established. Hence, a sustainable earth from a health, wellbeing and physical education perspective requires sustained community relations.

THE EFFECTS OF ENVIRONMENT ON EXERCISE AND ATTITUDES TOWARDS SUSTAINABILITY

Author: *Miss Aneta Nastaj*

Additional authors or affiliations: *Project supervisor – Sabine Pahl*

Mental and physical health problems are increasing, for example depression rates and obesity rates are rising. Studies suggest that mental and physical benefits result from spending time in nature and exercising. Motivation plays a key role in the uptake of exercise. The main objective of this study was to measure motivation to exercise in 3 environments' beach (blue), woods (green) and, urban (control). The hypothesis stated that motivation to exercise will be higher in the blue and green condition than in the control condition. A video of a beach or woods designed for cycling indoors was displayed using a projector in a laboratory. This allowed for an easy manipulation of environments and for collection of data. Sixty students from the Plymouth University participation pool cycled on a stationary exercise bike for 8 minutes in the laboratory setting and completed questionnaires. The questionnaires

measured physical activity and self-esteem before the cycle and perceived exertion, self-esteem, time perception, opinions about the cycle and attitudes towards sustainability after the cycle. Heart rate was measured every minute during the cycle. It is anticipated that self-esteem, motivation to exercise, and scores on sustainability scale will be equal but higher in the green and blue condition than in the control condition. If results match the anticipated results the findings would be advantageous in designing gym layout in order to motivate people to exercise harder and regularly. People's improved attitude to sustainable behaviour could result in more sustainable behaviour. More research would be needed to determine that.

THE ROLE OF PARTICIPATORY FOOD EVENTS TO ENGAGE 'MARGINALIZED' COMMUNITIES

Author: *Dr Clare Pettinger*

Additional authors or affiliations: *Rosemary Bonney, Julie Parsons, Carole Sutton, Miranda Cunningham, Richard Ayres, Andrew Whiteford, Gia D'Aprano and Gayle Letherby. This event was supported by ESRC festival of Social Science funding.*

Background: With food poverty currently a topical concern, urgent consideration needs to be given to marginalized communities to improve their food choices. The Food as a Lifestyle Motivator (FLM) pilot project (ISSR funded, 2014) explored creative methods for gaining insight into food experiences of homeless service users in Plymouth. The pilot findings have informed local practice and research is evolving to improve wellbeing and inform social sustainability. One strand of FLM explored 'the role of participatory food events to engage 'marginalized' communities'. A Stakeholder engagement workshop in November 2015, (ESRC Festival of Social Science event), brought together multi-disciplinary FLM team members with key stakeholders, including services users. Methods: Various food activities took place (education, 'photo workshop', cooking), evaluated using ranking scores and 'Participatory Action Research' (PAR) approaches (Minkler, 2010) to capture engagement. These included service user

surveys, and audio-recorded discussions with service providers. One question was standardised: "How do you think food events can enhance wellbeing of hard to reach/marginalized individuals?" Results: Over 100 individuals attended, including 35 service users. Analysis is ongoing, with preliminary results showing high participant enjoyment and improved food practices. Survey findings will be presented for n=8 service users; audio-recorded discussions will be presented for n=19 service providers. Implications: Preliminary findings indicate participatory food events are effective for engaging participants in important wellbeing dialogues. This work has great potential for informing implementation of local policies/practice that promote socially inclusive food activities as part of service provision. This could also inform 'alliance commissioning' and lead to improved wellbeing outcomes.

HUMANISING SUSTAINABILITY: AGENCY AND ALLIANCE IN THE ANTHROPOCENE

Author: *Mr Andy Whiteford*

Additional authors or affiliations: *None*

If humanity is to establish a lasting and sustainable presence on earth we need to move beyond the disquieted truce we currently seek and move towards a relationship with the Earth organised around conceptions of the 'Anthropocene' that bring together and bind a range of environmental and sustainability discourses in a way that emphasises their collective importance and relevance to humanity. Most importantly, it opens up spaces where the rapidly changing relationship between humanity and the natural environment can be re-imagined, revealing an imperative to integrate 'agency' into Health and Social Care that engages with adaptive strategies supporting individual and community responses to environmental change whilst simultaneously engaging with mitigation strategies, aimed at managing environmental change towards a sustainable, healthy and socially just future. My

educational practice in developing teaching and learning aimed at integrating Sustainability and Social Work is currently the focus of my Master of Arts in Education research dissertation. My enquiry is revealing and addressing a number of tensions and opportunities in building 'alliance' when dematerialised conceptions of culture and society, such as exist within health and social care, collide with potentially dehumanised conceptions of Nature and the natural that can prevail the earth sciences where for example, technological interventions render humans redundant or conservation measures barely tolerate human presence or exclude it completely. Both positions potentially diminish the need for human participation in Sustainability solutions. I will present preliminary findings from my research and test their wider relevance and contribution to a Sustainable Earth

Professor Stepehn Sterling (Professor of Sustainability Education), Dr Jane Grose (Sustainability, Society and Health Research Group), Dr David Pencheon OBE, Professor Janet Richardson (Sustainability, Society and Health Research Group) and Dr Tim Daley (Deputy Director, Sustainable Earth Institute)



NEWS

DR DAVID PENCHEON OBE VISITED PLYMOUTH UNIVERSITY ON 24 NOVEMBER TO DISCUSS POTENTIAL COLLABORATIONS WITH THE NHS SUSTAINABLE DEVELOPMENT UNIT.

David is the Director of the NHS Sustainable Development Unit. He was previously Director of the NHS Eastern Region Public Health Observatory from 2001 to 2007, serving the East of England.

He has worked as joint Director of Public Health, a Public Health Training Programme Director in the East of England and with the NHS R&D programme. David has also worked in China in the early 1990s with Save the Children Fund (UK). Prior to that he was clinician in secondary care.

The event was hosted by the Sustainability, Society and Health Research Group and the Sustainable Earth Institute, and involved a number of presentations from University researchers about their work on health and social care. Presentations were from a range of backgrounds including food, clinical waste, app development and virtual reality.

The Food as a Lifestyle Motivator project was started in 2014 by Plymouth University researcher, Dr Clare Pettinger. The project explores how creative methods can be used to get an insight into how food affected the lives of people using a Plymouth homeless centre. In this image, a Devonport Lifehouse resident shares his favourite food. **Image credit:** Fotonow CIC



BIODIVERSITY AND CONSERVATION

BIODIVERSITY AND CONSERVATION

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Dr Mick Hanley

Associate Professor, Biology, Plymouth University

Extreme weather events are a familiar occurrence, but when combined with sea level rise, storm surges pose a major flooding threat to European coastlines. Climate models suggest that the incidence of extreme flooding events is set to rise, imposing a significant economic cost to local, national and regional infrastructure. The University of Plymouth is at the forefront of scientific understanding of how flooding affects coastal habitats and how an understanding of ecology can be used to protect coasts from flood risk. Our research shows that together immersion and salt stress have marked impacts on the species composition of coastal grasslands such that key species are excluded from sites where seawater flooding becomes more frequent; these losses might well affect subsequent community resilience

and provision of essential ecosystem services. Where 'hard engineering' needs to be employed to defend coasts, we recommend that it should consider not only impacts on local inter-tidal species but that it should be done in conjunction with much cheaper 'soft' ecosystem options; salt marshes, sand dunes, and mangrove forests have an unparalleled ability to absorb wave energy. This integrative approach provides a sustainable, cost effective solution to immediate and long-term coastal defence needs.

LICENSED TO KILL FOR BIODIVERSITY INVASIVE NON-NATIVE SPECIES REFORM

Author: *Mr Jason Lowther*

Additional authors or affiliations: *None*

EU and domestic laws directed towards the problems posed to established ecosystems by invasive non-native species of fauna and flora have been the subject of considerable review and enhancement in the past two years. This paper examines the basis of the change in policy and law that has put 'invasive' in the spotlight – with a focus upon both the EU's 2014 strategy and the UK Law Commission's report in the same year. It locates the policy and legal developments within the general framework of biodiversity protection and enhancement in the EU and UK territories, and considers the likely impacts on landowners and other 'responsible' stakeholders in complying with both the established legal

system prior to the recent developments; and the contemporary changes brought about by amendment and legal innovation. In addition, issues, in particular, of animal welfare has become a significant factor in circumstances where the law permits the culling or elimination of certain species: an issue which when applied to a very native species, the badger, has proved exceptionally controversial and polarising; and which has resulted in clarificatory litigation. Evaluating the purpose of the law, the proportionality of its obligations, and the reality of changing ecosystems will inform any assessment of the success of the measures.

INTERNATIONAL TRADE STRATEGY AND ENVIRONMENTAL SUSTAINABILITY

Author: *Miss Catherine Bennett*

Additional authors or affiliations: *None*

This paper will examine international trade policy focussing primarily on the trade policy of the EU, and its effect on sustainability in relation to the environment and biodiversity. It will advocate the need for corporations to take a leading role in driving sustainability forward which is why international trade policy in particular is a critical tool in achieving a more sustainable outcome. The EU view is that Environmental quality is considered central to health and well-being and so it integrates environmental concerns in its other policies. The EU's commitment to the environment will be considered in relation to the inclusion of climate change and energy sustainability within the Europe 2020 Growth targets. Analysis of EU trade policy during the period 2010 – 2015 against extracts from sample agreements which were

negotiated primarily during that period demonstrates the relationship between the strategy and the outcomes in the agreements. A similar exercise in respect of the new approach under the current EU Trade Policy launched in October 2015 for the next five years, alongside extracts from sample trade agreements in the process of negotiation or adoption will show a real change in approach, but is this mere lip-service to greater emphasis on environmental sustainability or more? The paper will close by questioning whether current international trade policy is in harmony with the 7th Environment Action Programme and whether integration of environmental concerns into current trade policy is enough to protect the environment and biodiversity or whether a radical new approach is both required and feasible.



NEWS

SNAILS SELECT SOURCES OF FOOD BASED ON DISLIKE FOR SMELLS RATHER THAN ACCEPTABLE TASTE – STUDY (APRIL 2016)

Harnessing naturally occurring chemicals could be used as a means to protect crop seedlings being eaten by common pests, a study suggests.

Research led by Plymouth University and the University of Southampton analysed the feeding preferences of hundreds of snails when presented with several different cultivars of oilseed rape seedlings.

It showed the invertebrates were more inclined to choose seedlings based on their dislike of naturally-emitted scents rather than employing taste as their primary method of choice.

Scientists say the research, published in the Annals of Botany, represents a key area for further investigation to discover methods of crop protection which do not have lasting environmental impacts.

Read more: www.plymouth.ac.uk/news/snails-select-sources-of-food-based-on-dislike-for-smells-rather-than-acceptable-taste

NEWS

LECTURE ENCOURAGES PEOPLE TO LEARN MORE ABOUT REWILDING (JANUARY 2016)

Author and broadcaster George Monbiot and Alan Watson Featherstone, founder and director of charity Trees for Life, were the keynote speakers at an event on Friday 15 January.

Hosted by the Network of Wellbeing and the University's Sustainable Earth Institute, the event explored the social, ecological and wellbeing benefits of rewilding to habitats across the globe.

Rewilding includes large-scale conservation projects aimed at restoring and protecting core wilderness areas, with previous initiatives involving the protection or reintroduction of apex predators and keystone species. It can also include smaller urban initiatives from wild patches in gardens to green corridors connecting parks and other areas.

After the event Cara Clancy, a PhD Candidate from the School of Geography, Earth and Environmental Science, wrote a blog about rewilding which examines its concept and practice.

Find out more about the event: watch the recording and read the blog at www.plymouth.ac.uk/research/institutes/sustainable-earth/rewilding

George Monbiot and Alan Watson Featherstone
Friday 15 January 2016
Plymouth University



George Monbiot and Alan Watson Featherstone

CITIES AND COMMUNITIES THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Dr Katharine Willis

Associate Professor, Architecture, Plymouth University

“Sometimes the media gives us the impression that we (cities) are terminal patients, because of problems of global warmth or the ozone layer. And the people, they don’t understand that they could change this situation for the better if they could act locally in a city. Cities are not problems. They are solutions.” - Jaime Lerner, Urban Planner and former mayor, Curitiba, Brazil

Cities are the sites of global challenges that demand local change. Transformations in urban economies, new technologies, and responses to environmental change are reshaping the distribution of power, resources, and information in cities. These transformations are reshaping and enabling new forms of spatial and social relations and the built environment in cities.

To address these challenges, cross-cutting approaches are required to enable transitions to resilient, smart and inclusive ways of living. This needs to involve the academia, public and private sector working together with local communities on real world problems. Only through this approach can we develop solutions to enable resilient, adaptive and socially inclusive cities.

At Plymouth University urban challenges are being addressed through collaborative approaches

to research. This includes research across disciplines (from architecture, transport, digital arts and health, to energy and sociology) and in collaboration with city partners (city governance, industry and third sector). Importantly it also involves working closely with local communities and stakeholders to co-create research-based solutions that deliver impact locally.

For example we are working with local villages in Cornwall to look at how superfast broadband can support social inclusion and more sustainable communities, and a project in Plymouth is working with housing providers to reduce energy consumption through the use of a game platform for householders.

If we think about cities as solutions, not problems then we have the potential to imagine other ways of living and inhabiting that can deliver local responses to global challenges.

EUROPEAN SUSTAINABLE DEVELOPMENT DECISION MAKING

Author: *Dr Nikolaos Apostolopoulos*

Additional authors or affiliations: *Professor Panagiotis Liargovas and Jean Monnet, Chair in European Integration and Policies, University of Peloponnese*

This research aims to create a framework so through a specific methodology, the European Union can attain the goals of Europe 2020 more effectively leading its economy to sustainable growth. Policy making can foster sustainability to a great extent by applying a bottom-up approach which combines an explicit methodology of social-network modeling and decision-making. Sustainable development integrates environmental, social and economic aspects. Sustainable development is closely related to the crucial role of the community even more so in the local field. By employing a multi-criteria methodology

two scenarios of social-network modeling are developed: the one is “direct democratic” and the other “pre-defined bottom-up”. The aim of these two scenarios is to effectively activate social networks so as to establish a foundation for mutual interest among the economy, society and the environment. Citizens’ participation in decisions related to sustainable development through social-networking procedures constitutes an indispensable part of the suggested approach no matter which of the two scenarios is applied. This research aims to create a tool for our sustainable common future.

HARMONISING HOMEOWNERS ASPIRATIONS TOWARDS SUSTAINABLE HOUSING: AN EXAMINATION USING THE MULTIPLE SORTING TASK

Author: *Dr Satish Basavapatna Kumaraswamy*

Additional authors or affiliations: *None*

The emerging world has empowered large and powerful consumer oriented demographics, which are aspirational and aimed at achieving western living standard and moving away from a traditional communitarian social model. In the domain of sustainable housing, it is critical to understand the social and cultural values, which enable us to propose a bottom up and localised solution for the sustainable housing strategies. This research focus on testing homeowners’ preferences on one aspect of the housing, threshold or boundary condition, which is qualified by an multiple sorting task (MST) analysis. The MST enables the participants to sort representation of the building as simulation of the real environment and sorting allows researchers to conduct surveys without preconception, which will otherwise influence the judgement of the respondents. This analysis was further triangulated with study-model performance tested by

sophisticated environmental simulation and fieldwork studies to help propose sustainable housing strategies. The methodology adopted has been critical to supporting the architectural response to the cultural and economic condition on one hand (social methods) and the climate responsive, traditional design and simulation models (environmental design methods) on the other. Different sets of fieldwork were conducted that involved archival searches and detailed interaction with architects, builders and homeowners. In total, 240 respondents answered a questionnaire survey and 146 semi-structured interviews were conducted. This research demonstrates how MST can be used as a research tool in understanding the social perception and economic aspirations of the homeowners, which have direct bearing on the acceptability of sustainable design and construction strategies.

IMAGINING AN ALTERNATIVE: HOW NOVELS HAVE EXPLORED SUSTAINABILITY

Author: *Dr David Sergeant*

Additional authors or affiliations: *English and Creative Writing and Sustainable Earth Institute Operating Team, Plymouth University*

To bring about change we need first to be able to imagine it; picturing precedes practice. So why not learn from how some of the most accomplished and rigorous imaginers around have tried to conceive of alternative communities: from the paths they've taken and the problems they've already encountered? This presentation will discuss how three novelists from the last 120 years have, at different points, tried to use

literary form to explore the possibility of alternative communities and ways of being: societal, economic, environmental. Their detailed and persistent imaginings can provide insight into issues which are of pressing relevance to anyone concerned with sustainability: for instance, into the challenges posed by questions of scale (individual/communal; local/global) and the gaps between conceptualisation and action.

ADAPTING THE COLLABORATIVE LEADERSHIP FOR SUSTAINABILITY PROGRAMME FOR COMMUNITY ACTIVISTS IN PLYMOUTH AND INUIT PEOPLE IN RIGOLET, CANADA.

Author: *Ms Michelle Virgo*

Additional authors or affiliations: *Enrico J Wensing PhD, Research Faculty, Department of Environmental Science and Policy, George Mason University, Fairfax, VA*

Eliciting action and social change at the community level is key to transitioning societies towards better futures. In this paper we introduce "Community Classrooms for Sustainability", a community-based learning programme adapted from the Collaborative Leadership for Sustainability co-curricular course for Plymouth University students. Community Classrooms have been piloted with community activists from a neighbourhood in Plymouth which has been affected by the development of an Energy from Waste plant and Inuit people in the far north of Canada who are affected by climate change. Key to the successful adaptation of the programme was the communication of key concepts which included constructivist approaches, complexity, distributed leadership, social identity and self-transcending world-views, in ways that are meaningful and of practical relevance to the learners. This was achieved by placing an emphasis on active

learning such that the students could experience themselves as collaborative leaders for sustainability and by facilitating reflective processes that enable learners to relate the course concepts to their own experience using their own language and cultural references. The programmes, which have been piloted with small initial cohorts, can be shown to have fostered a social identity in sustainability and tapped into a collective intrinsic motivation to participate in generating better futures for all. They have helped to instil skills and strategies for collaborative exploration and consensus-based approaches to addressing community problems. The approaches used are of relevance to the development of pedagogies for deep learning in leadership education and education for sustainability, both in higher education and in community contexts.

NEWS

GOVERNMENT HOUSING ADVISER APPOINTED A VISITING PROFESSOR AT PLYMOUTH UNIVERSITY (MARCH 2016)

A renowned expert on housing and planning issues is to work closely with students and academics at Plymouth University as part of a new appointment.

Lord Matthew Taylor of Goss Moor, the former MP for Truro and St Austell, advised both the last Labour government and the coalition on planning and housing policy and has served on a number of high profile national bodies.

Now students will be able to benefit from that extensive experience as he has been made a Visiting Professor within the University's School of Geography, Earth and Environmental Sciences.

As part of his appointment, he is likely to contribute to both undergraduate and postgraduate programmes, as well as working with academics to develop research themes and individual projects.

He will also work closely with the Sustainable Earth Institute, which stages a range of public events aimed at increasing awareness and knowledge about a range of issues affecting society and the environment across the UK.

Read more and watch a talk given by Lord Taylor, entitled: Will Garden Villages Solve the Housing Crisis? www.plymouth.ac.uk/research/institutes/sustainable-earth/will-garden-villages-solve-the-housing-crisis



Lord Matthew Taylor

WATER

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Dr Peter Downs

Associate Professor in Physical Geography, Plymouth University

Mitigating the adverse ecological impacts downstream of large dams is a taxing challenge. Whereas unsafe or obsolete dams can be removed, viable dams require measures that allow the downstream water body to sustain 'good' or 'good potential' surface water status under the EU Water Framework Directive. In the River Avon (Devon, UK), gravel augmentation is being trialled as a measure to mitigate the presumed effects of the Avon Dam on salmonid populations, with the benefits assessed using a combination of habitat mapping, fish surveys and several new sediment monitoring technologies. A combination of seismic impact plates and RFID-tagged particles are being used to establish the mobility rates, dispersal distances and settling locations of transported gravels, and so assist in determining appropriate volumes, frequencies and locations for future augmentation. 150 tagged particles of augmented (42 mm) and native (55-58 mm) sediments were

added to a pilot gravel augmentation in autumn 2014. In the relatively dry winter that followed, 17 small floods mobilised a majority of the augmented load with 58% of the material passing over an impact plate situated just downstream. Tracer recovery is challenging but indicated that particle transport distances were proportional to the flow energy applied, but only weakly size-related. Initial conclusions suggest that augmented particles are easily entrained and were starting to settle in depositional locations, but many were transported beyond the augmentation reach. Analyses indicated that continued augmentation could progressively replenish sediment storage in the reach but would require far greater volumes of added material.

FEATURED PROJECT: IMIXSED

Professor Will Blake

Professor of Catchment Science

Siltation presents a credible threat to river basin ecosystem service provision and water security. River silt originates, however, on catchment hillslopes and the primary driver for mobilisation and translocation downstream is soil erosion on agricultural land where loss of this finite resource threatens food security. Knowledge of sediment source and transfer dynamics in river catchments is critical to inform management policy decisions to maintain and enhance future food and water security.

Identification of the source and behaviour of different types of sediment is critical if we are to design effective management plans. Cutting edge nuclear techniques have been developed to trace river silt back to source, in a jointly Coordinated Research Programme between the UN Food and Agriculture Organisation and the International Atomic Energy Agency. However, these new techniques have led to a step change in data complexity. While these datasets capture real world complexity in time and space, the conventional statistical approaches to quantify sediment provenance do not. This severely limits the power of the new tracing techniques.

Advances in ecological source models based on Bayesian statistics, however, offer a solution. New models e.g. MixSIAR have been developed that can deal with the complexity in a quantitative way and, if tailored to specific river basin sediment data, could help us address the above challenge.

The central goal of the IMIXSED Project (Integrating isotopic techniques with Bayesian modelling for improved assessment and management of global sedimentation problems) is therefore to marry together the strengths of isotopic sediment tracer technology in the EU, with ecological source apportionment models developed by US scientists, to deliver a powerful tool to combat threats to global food and water security.

The tool will be showcased through its application in Tanzanian lake catchments and Ethiopian water-supply catchments where diffuse sediment and nutrient pollution from agriculture currently threatens food, water and, through siltation of HEP dams, energy security.



NEWS

UNEXCEPTIONAL FLOODING CAN CAUSE SIGNIFICANT EROSION, STUDY SHOWS (SEPTEMBER 2015)

Exceptionally large floods are not necessary to trigger the creation of gorges within hard rocks such as granite, according to a new study involving Plymouth University.

Researchers from Spain and the UK used a combination of archive images and survey data to demonstrate how the diversion of water down an overspill channel from a dam in North West Spain had a profound impact on its surroundings.

It showed there was rapid erosion in the six years following the dam's construction, with just five flood events creating a new gorge more than 270m long, 160m wide and 100m deep.

While such change might be expected in cases of extremely large flood events (for example glacial lake outburst floods), this case study suggests it can also be caused by small to moderate events, with the structural pattern of the bedrock being the primary control on landscape change.

Read more: www.plymouth.ac.uk/news/unexceptional-flooding-can-cause-significant-erosion-study-shows

NEWS

MILLIONS OF PLASTIC PARTICLES FOUND IN COSMETIC PRODUCTS (AUGUST 2015)

Everyday cosmetic and cleaning products contain huge quantities of plastic particles, which are released to the environment and could be harmful to marine life, according to a new study.

Research at Plymouth University has shown almost 100,000 tiny 'microbeads' – each a fraction of a millimetre in diameter – could be released in every single application of certain products, such as facial scrubs.

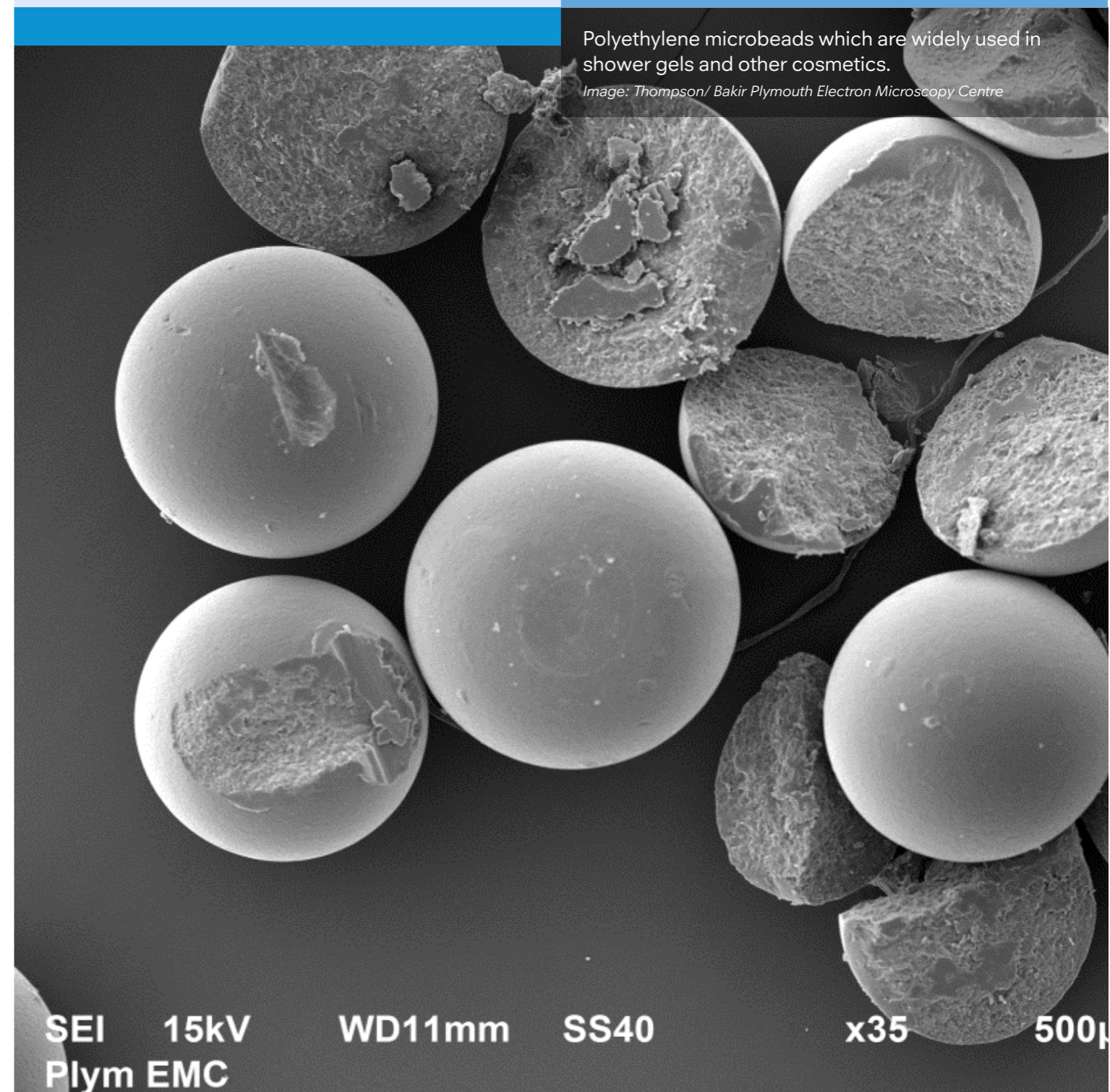
The particles are incorporated as bulking agents and abrasives, and because of their small size it is expected many will not be intercepted by conventional sewage treatment, and are so released into rivers and oceans.

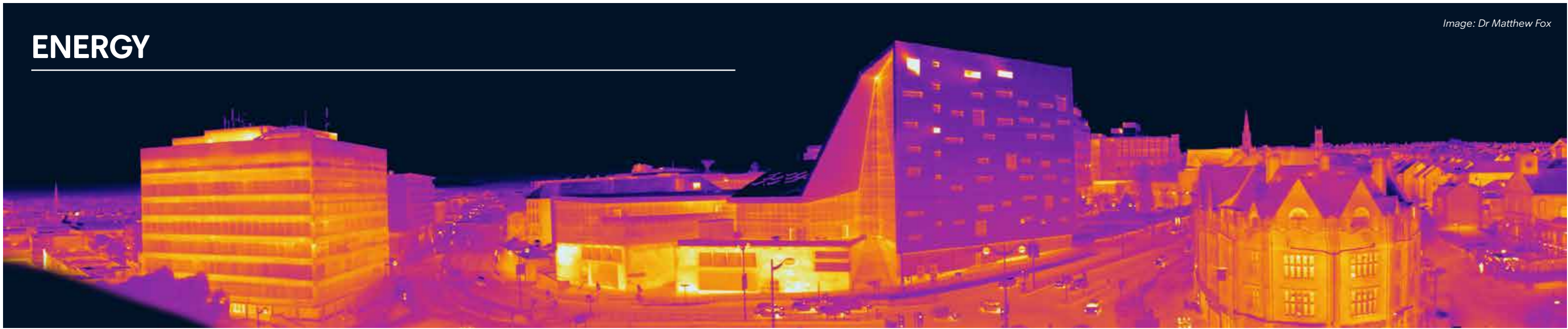
Researchers, writing in Marine Pollution Bulletin, estimate this could result in up to 80 tonnes of unnecessary microplastic waste entering the sea every year from use of these cosmetics in the UK alone.

Read more: www.plymouth.ac.uk/news/millions-of-plastic-particles-found-in-cosmetic-products

Polyethylene microbeads which are widely used in shower gels and other cosmetics.

Image: Thompson/ Bakir Plymouth Electron Microscopy Centre





ENERGY THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Professor Steve Goodhew

Professor of Environmental Building, Plymouth University

Dr Matthew Fox

Architect and Owner, Thermal Imaging IR

There are many local, regional and global drivers for being mindful of how we generate and use our energy. According to the United Nations one in five people lack access to a supply of reliable electricity and 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating. Emissions related to energy production and use is the dominant contributor to climate change, accounting for around 60% of total global greenhouse gas emissions (UN 2016). Therefore reducing the carbon intensity of energy is a key objective in long-term climate goals

The papers being presented and discussed at the Sustainable Earth 2016 marketplace demonstrate the focus and breadth of Plymouth University's energy related research include;

- Fuelling the Community: The role of community based wood-fuel co-operatives
- Making solar gain visible
- Exploring relationships between housing conditions, energy consumption, health and well-being among social housing tenants.
- The university campus as low-carbon learning tool

To complement these Dr Matthew Fox architect and owner of Thermal Imaging IR will show the recent developments in thermal imaging that can help locate areas of buildings that can be improved to lower their energy demand.

UN (2016) Sustainable Development Goals; Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all

<http://www.un.org/sustainabledevelopment/energy/>

FUELLING THE COMMUNITY: THE ROLE OF COMMUNITY BASED WOOD-FUEL CO-OPERATIVES IN PROVIDING SUSTAINABLE FUEL RESOURCES AND THEIR WIDER CONTRIBUTION TO COMMUNITY ENGAGEMENT IN ENVIRONMENTAL MANAGEMENT

Author: *Dr Roger Cutting*

Additional authors or affiliations: *Mr Alan Dyer*

The Hill Review (2012) suggests almost 9 million people, including 1.5 million children, in the UK will be living in fuel poverty by the end of 2016 with rural communities experiencing a depth of fuel poverty twice that of urban areas (Hill, 2012). However, across England a number of community based wood-fuel co-operatives have been established, with the intention of providing an alternative and sustainable fuel source, managed, produced and utilised by the community (Small Woods Association, 2009; Bell and Cutting, 2015). Government support for community programmes is in place, indeed, "Community engagement in the energy sector will be vital to our mission of the development of energy in the UK" Greg Baker, Minister of State for Climate Change (2013) Focusing on Axewoods Wood-Fuel Co-operative in East Devon, this presentation explores the motivations and mechanisms by which the co-operative has been

initiated along with respective aims, governance and membership. It evaluates the development of local and sustainable wood-fuel resources and the establishment and legitimisation of wider collective learnt experiences through the operation of the co-operative in relation to the development of skills, wider environmental commitments and the empowerment of a community to engage in fuel harvesting and processing. The implications and management of Charlara dieback, also known as Ash dieback, at community levels combined with Local Authorities woodland asset transfers to community groups (Guardian, 2014; Plunkett Foundation, 2016) suggests a review of the contribution of such groups to localised sustainable fuel securement and wider environmental management is timely and apposite.

MAKING SOLAR GAIN VISIBLE

Author: *Dr Julie Goodhew*

Additional authors or affiliations: *Goodhew, Fox, Pahl and Goodhew*

Solar power deployment is important in achieving the UK government's 2020 target of having renewable energy sources provide 15% of the UK's final consumption. Whilst photovoltaic (PV) generation is a popular form of renewable power, the UK government recognises that to maintain this support, more collective take-up is required and there could be increased use of solar gain as well as solar PV and solar thermal.

Investors in solar energy systems need to believe in the efficacy and realistic nature of this natural power source. Imagery can shape perceptions of real-world issues and thermal imaging can provide visual evidence of solar gain. Previous research has shown that using thermal visuals with householders promoted the uptake of energy efficiency actions (Goodhew, et. al, 2015). Thermal imaging cameras

provide images showing infrared radiation and the apparent surface temperature of a building. Time series imaging enables the observation of transient changes in material properties, providing a visual of the natural resource in relation to the building (Fox et al, 2012).

We present a time series thermal visualisation tool showing the effect of solar gain on buildings taken over a 24 hour period (imaged every 5 minutes). Secondly, we present the results of a laboratory study which evaluated the impact of viewing this visualisation, compared to a digital time-lapsed photograph of the same buildings over the same 24 hour period. This laboratory study tested the effect of viewing the images on the antecedents of energy related behaviours, especially efficacy, knowledge and perceived benefit.

EXPLORING RELATIONSHIPS BETWEEN HOUSING CONDITIONS, ENERGY CONSUMPTION, HEALTH AND WELL-BEING AMONG SOCIAL HOUSING TENANTS: FINDINGS FROM THE ENERGAWARE PROJECT

Author: *Dr Sabine Pahl*

Additional authors or affiliations: *Christine Boomsma, Rory Jones and Alba Fuertes*

A key concern for social housing tenants is how to achieve adequate levels of warmth and comfort in their home within a limited household budget. The multi-disciplinary EnerGAware project (energaware.eu) aims to develop a game that can help social housing tenants to reduce their energy consumption by increasing energy understanding and providing behavioural strategies. The first phase of this research project included a large tenant survey to capture responses from over five hundred social housing tenants in South-West England; findings from this survey will feed into the game development. The survey measured social housing tenants' perceptions of their home; energy-related attitudes, beliefs and behaviours; socio-demographics, health and mental well-being. The results are indicative of a strong negative effect of condensation, damp and mould problems on tenants' self-reported health and

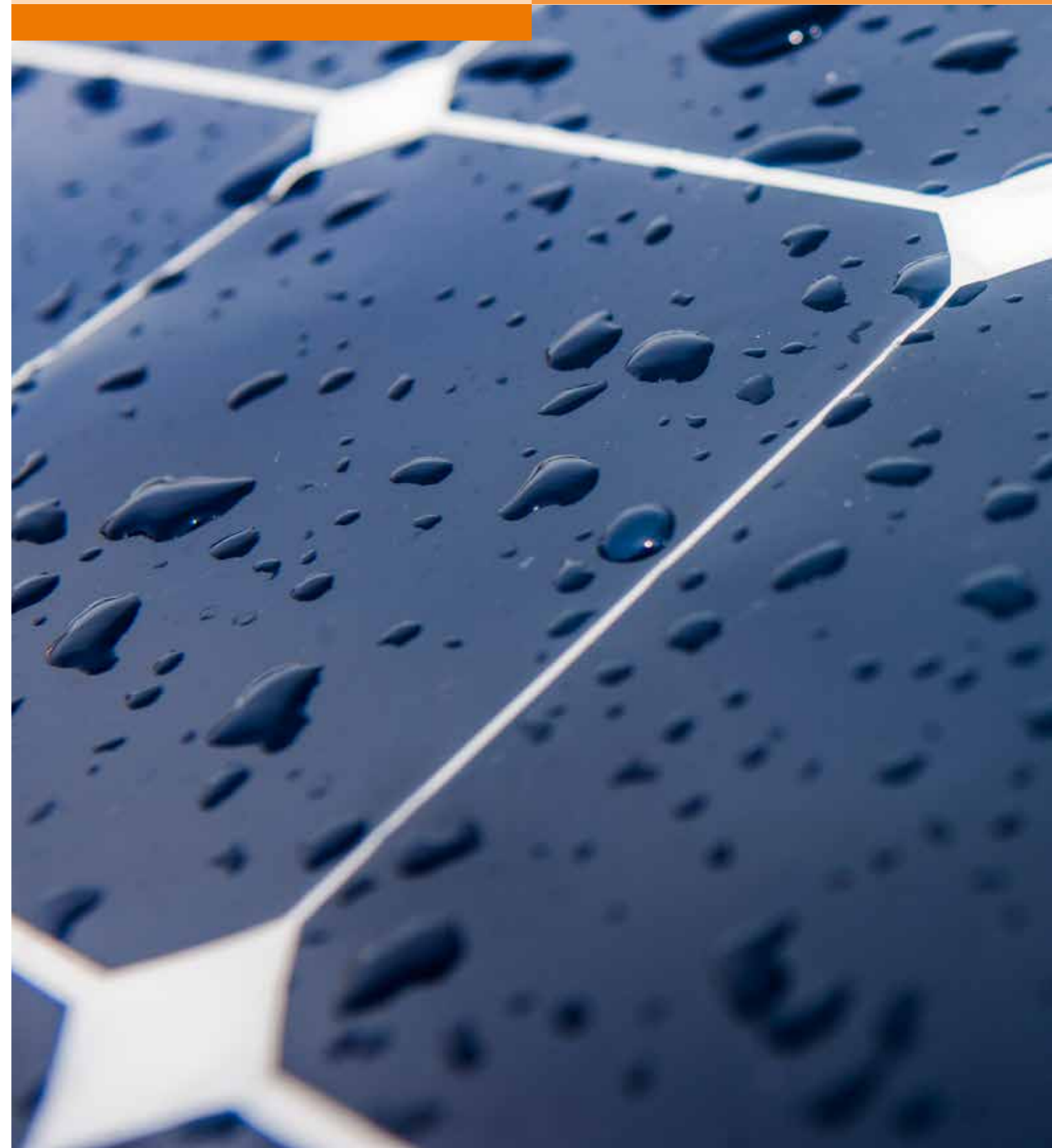
well-being. Being able to keep comfortably warm in winter was also an important factor, while issues with overheating were associated less strongly with health. Worries about energy bills also had a negative effect on health and well-being, and tenants reported better health if they felt satisfied with their home. Further relationships between housing conditions, energy-related beliefs and behaviours, and health and well-being are explored. The survey findings provide an insight into the important inter-linking factors that surround health, well-being and energy use in this sample of vulnerable tenants. We discuss the implications of the findings for the development of the EnerGAware game and other initiatives aimed at helping social housing tenants manage their energy use and ensure a comfortable home.

NEWS

Serious game is a climate solution (November 2015)

A Plymouth University lead initiative, EnerGAware, has been promoted internationally by Climate Action and Solutions COP21 as a 'climate solution'.

EnerGAware is a €2 million project funded by the European Horizon 2020 programme, and will see building performance analysis experts from Plymouth University working alongside leading housing provider DCH (formerly Devon and Cornwall Housing), EDF Energy and partners across Europe.



RESPONSIBLE CONSUMPTION AND PRODUCTION

RESPONSIBLE CONSUMPTION AND PRODUCTION THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Dr Victoria Hurth

Associate Professor in Marketing, Plymouth University

Paul Winterton

Managing Director, Langage Farm

How we consume and how we produce are interconnected, most notably through the marketing function. Our consumption and production patterns drive global sustainability issues such as ocean acidification, top soil erosion, climate change and wellbeing inequality - and at the same time are fundamentally affected by them. We are faced with ever challenging reminders of the near-term limits to finite resources, and in positive response, the commitment to the circular economy is growing, with investment packages by the EU and new laws in China to support this. Notably we are seeing a raft of targeted interventions in, and by, business to tackle both what and how they produce, and to whom and

how this is marketed. The International Integrated Reporting Council and Blueprint for Better Business are two examples, making real head-road into how major companies view their very reason for being and the strategic threat to that by unsustainable practices.

Langage Farm is an example of a local business that is making global impact through its circular approach to its whole operation, enabling it to be the UK's first ever zero carbon dairy. By working with Plymouth University Knowledge Exchange students it is harnessing the power of first-class research to further drive its economic, social and environmental sustainability.

ECONOMIC SUSTAINABILITY? LIFESTYLE ENTREPRENEURSHIP WITHIN SURFING BUSINESSES IN DEVON AND CORNWALL, UK

Author: *Dr Emily Beaumont*

Additional authors or affiliations: *Andreas Walmsley (Plymouth University), Eleanor Woodward (Plymouth University) and Laura Wallis (Plymouth University)*

This paper focuses on a Sustainable Earth Institute funded study which explored lifestyle entrepreneurship among surfing business owners within Devon and Cornwall. How we define lifestyle entrepreneurship is considered 'fuzzy' and the purported tendency for lifestyle entrepreneurs to play down elements of growth and profit may lead to issues of precarity in economic sustainability. Definitions of lifestyle entrepreneurship frequently make recourse to the subordination of economic to lifestyle goals and yet this clear-cut distinction is not shared by all. Shaw and Williams (2004) and Lewis (2014), for example, offer another type of business owner, the freestyle entrepreneur, as someone who values a specific lifestyle, is not necessarily growth averse, but considers factors to the way they pursue their personal lifestyle before deciding upon a direction of their business, including economic gain. Conducted within Devon and Cornwall, an area where

surfing generates over £600m per annum (Mills and Cummins, 2013), this study sought responses to a survey consisting of both open and closed questions which were sent electronically to surfing business owners across the two counties (n=101). Results confirmed the dominant presence of the freestyle lifestyle entrepreneur (82%) in comparison to the more traditional purist lifestyle entrepreneur (18%). It was found that freestyle entrepreneurs within surfing set up their business to sustain their lifestyle whilst incorporating their ambition to be a business owner and achieve economic sustainability. However, when these two lifestyle-focused entrepreneurs are faced with challenges, the freestyle entrepreneur is more concerned with economic sustainability than the purist entrepreneur, whose primary concern is sustaining their lifestyle.

Panel experts at the Planet Oil event: Dr Tim Daley (Sustainable Earth Institute), Dr Matthew Watkinson (School of Geography, Earth and Environmental Sciences), Professor Iain Stewart (Sustainable Earth Institute), Professor Camille Parmesan (School of Biological Sciences), Professor Steve Rowland (School of Geography, Earth and Environmental Sciences) and Dr Sabine Pahl (School of Psychology)



NEWS

ACADEMIC HOSTS BBC4 DOCUMENTARY ABOUT OIL PRODUCTION (OCTOBER 2015)

The rise of an industry which has come to dominate the world was explored in a documentary series fronted by a Plymouth University academic.

Planet Oil: The Treasure that Conquered the World is a three-part series presented by Iain Stewart, the University's Professor of Geosciences Communication and Director of the Sustainable Earth Institute.

Aired on BBC4 in October, the three-part series charted the early days of oil production in the mid-19th century, the rise of the oil barons, international battles for global control and the fundamental rewiring of geo-politics in the 20th century.

It also takes the story to the modern day and the technological breakthroughs which have extended the life of existing oilfields as well as the new unconventional and controversial oil and gas supplies, such as shale oil and tar sands.

The Sustainable Earth Institute held a public event at the University at which experts debated the past, present and future impacts of the oil industry on the environment.

Read more: www.plymouth.ac.uk/news/academic-hosts-bbc4-documentary-about-oil-production

NEWS

STUDENTS GO GREEN WITH HOTBOX 500 (SEPTEMBER 2015)

In September 2015, business enterprise and entrepreneurship students took up a unique opportunity to develop their creativity and innovation through Hotbox 500.

Hotbox 500 is a project that tasks students with transforming 500 units of unwanted product into something that could be sold or traded creating impact for the community while also demonstrating a sustainable approach to using physical resources, respecting the natural environment.



Students pitching their business idea at Hot Box 500

The Primary schools Fairtrade tea party, which took place during a series of events organised by the University's sustainability team for Fairtrade Fortnight 2015.



NEWS

FAIRTRADE OFFERINGS ARE SECURED AT PLYMOUTH UNIVERSITY THANKS TO FUTURES' INTERN (AUGUST 2015)

A Plymouth Business School student has helped Plymouth University to renew its Fairtrade status for another two years, enhancing his employability skills in the process.

Made possible through an internship with the University's sustainability team, the first project Kasimierz (Kasi) Jankowski, first year BA (Hons) Business Studies undergraduate, took on during his eight month term included putting an application pack together in support of the University's Fairtrade status renewal.

Under the direction of Dr Samantha Price, Sustainability Manager at Plymouth University, Kasi set about researching the evidence required. Dr Price said:

"Every two years, we have to recertify our Fairtrade accreditation. This includes reviewing the criteria and making sure we meet each of the standards before producing and presenting an application pack. This is a key event in our calendar which requires a dedicated pair of eyes and attention to detail. Kasi has proved to be an asset to our team and committed to his work."

The University's Futures Entrepreneurship Centre, in partnership with local organisations and internal departments, provides these opportunities to Plymouth Business School students and Kasi applied for the role specific to Fairtrade.

Read more: www.plymouth.ac.uk/news/fairtrade-offerings-are-secured-at-plymouth-university-thanks-to-futures-intern

Undergraduate engineering students have the chance to visit a local manufacturing and production company.



CLIMATE CHANGE

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Professor Camille Parmesan

National Marine Aquarium Chair in Public Understanding of Marine Science and Human Health, Plymouth University

Climate change is but the latest in a series of ever-increasing anthropogenic pressures on natural systems, yet there are fundamental differences between this relatively new threat and traditional anthropogenic stressors that have challenged ecological research over the past century. With greenhouse gas emissions continuing to rise, earth is rapidly approaching a climate regime that has not been experienced for millions of years. The “big picture” trends that have emerged show that wild species around the world are already being affected by the relatively small levels of global warming to date. About half of plants and animals have shifted their ranges towards the poles and up mountainsides, and about 2/3 have advanced their timing of spring events, attempting to track the shifting climate in both space and time. Detailed ecological and evolutionary research on wild plants and animals, such as that conducted by multiple scientists at Plymouth University, shows a complexity of responses. This is in part due to basic differences among species, but is also due to the complexity of changes in weather and climate patterns caused by anthropogenic global warming. While most parts of the globe are indeed warming, this is causing complex changes in ocean currents, increases in the frequencies and intensities of storms, more floods, more droughts, more heat waves, more fires and less snow and ice.

Research on how the natural world has already responded to warming of the past century (0.6° to 0.8°C) has helped to shape the international declaration to keep anthropogenic warming below a 2°C limit (by 2100) in order to prevent “dangerous” climate change (as per the Copenhagen Accord of 2009). However, even if emissions reductions are successful, preservation of biodiversity in the face of anthropogenic climate change will require a much deeper understanding of how wild species will respond not only to the myriad of changes in “climate” and extreme weather events expected in future, but also how these effects interact with other changes driven by human activities, such as increased fertilization of lands and oceans, and a landscape increasingly dominated by farms and urban areas.

Further Reading:

Parmesan, C and M Hanley (2015). *Plants and climate change: Complexities and surprises* Annals Botany 116(6):849-864.

Parmesan, C and M Attrill (in press). Human health (disease) and ocean warming. Ch. 5.7 in *Explaining Ocean Warming: Causes, Scale, Effects and Consequences*, Ed by J Baxter and D Laffoley, IUCN, Gland, Switzerland. (slated for publication Sept. 2016)

PUBLIC ENGAGEMENT IN SUSTAINABILITY THROUGH MUSIC AND SOUND ART

Author: Miss Nuria Bonet

Additional authors or affiliations: None

My research looks at music and sound art as ways to engage audiences with topics of sustainability and climate change. In particular, I work with sonification which is the transmission of data through audio rather than visually. When sonifying data related to climate change for example, the audience can effectively listen to climate change. Interpreting data aurally can have advantages as we can understand different more complex aspects of information through our ears than our eyes. Furthermore, music evokes an emotional reaction in a listener which can further the empirical perception of scientific concepts. As a composer and researcher, I look for data to sound mappings which can result in the most powerful but also scientifically correct sonification. These result

in music pieces and installations aimed at a non-specialist audience. A recent example includes a work based on climate change data taking the temperature and salinity values from the British Coast over the last century. It was presented at the Eden Project as part of NUS’ launch of the Students Organizing for Sustainability Network (SOS) in October. The audience response was overwhelmingly positive as they felt that they had gained an understanding of the scale of the climate change occurring in the Atlantic Ocean while also engaging emotionally with the subject matter. This paper discusses methods available to composers and sound artists to further the sustainability cause as sonification can be a powerful tool to catch listeners’ attentions. This is bolstered by examples of my own work as a composer and other related practitioners.

EUROPEAN DEFORESTATION AND PREHISTORIC LAND HUMAN USE

Author: Dr Jessie Woodbridge

Additional authors or affiliations: Neil Roberts and Ralph Fyfe

When was Europe transformed from a land of forests to its current land-cover mosaic? The answer to this question requires a long-term perspective, for which fossil pollen analysis is well suited. Understanding past human land use change is important for future sustainable land use and valuable to climate modelling. Fossil pollen preserved in peat and lake sediments provides a record of vegetation change; the ‘pseudobiomization’ approach turns pollen data into anthropogenic land cover classes. This approach

has been applied to over 800 fossil pollen records from the European Pollen Database through two Leverhulme Trust funded projects. Europe-wide land cover maps have been generated at 200-year time steps, from the time of the first farming communities 9000 years ago to the present-day, which have been used to identify when human land use intensified and where impacts were most significant.



NEWS

CLIMATE CHANGE SCIENTIST SAYS MORE MUST BE DONE TO MEET 2-DEGREE TARGET (NOVEMBER 2015)

Ahead of the UN Climate Change Conference in Paris, one of the most influential scientists in the field warned that international commitments to reduce carbon emissions will not be sufficient to meet the key 2-degree centigrade figure by the end of the century.

Professor Camille Parmesan has said that, while agreement at the COP21 conference will represent 'some form of success', she fears that the pace of change is insufficient to counter the threat of global warming.

Professor Parmesan, the National Marine Aquarium Chair in Public Understanding of Oceans and Human Health within Plymouth University's Marine Institute and the National Marine Aquarium, and an Adjunct Professor at the University of Texas, adds that complacency cannot be allowed to creep in.

Professor Parmesan is renowned for her research on the impact of climate change on wildlife, and was the first to demonstrate that species are shifting their natural ranges in response to changes in temperature. Indeed, her 2003 research paper, 'A globally coherent fingerprint of climate change impacts across natural systems', is the most cited research paper in the field of climate change.

Read more: <https://www.plymouth.ac.uk/news/climate-change-scientist-says-more-must-be-done-to-meet-2-degree-target>

THE CO₂ CONUNDRUM

Jason Hall-Spencer

Professor of Marine Biology at Plymouth University and the University of Tsukuba

The past 60 years have without doubt seen the most profound transformation of our relationship with the natural world in the history of mankind, leading to a great acceleration in our use of the earth's resources. We have now entered unknown territory, as the excess CO₂ in the atmosphere is acidifying the oceans.

Monitoring off Hawaii and on both sides of the North Atlantic clearly shows that seawater CO₂ levels are rising and tracking atmospheric increases. The amount of carbon taken up by the oceans at present equates to every person on earth throwing carbon of the weight of a bowling ball into the sea every day.

This ocean acidification is clearly not acting in isolation. Rising CO₂ levels are also causing ocean warming, which is damaging tropical coral reefs, melting Arctic ice, thawing tundra and shifting the distributions of many marine species towards the poles.

Not all organisms loose out, however; higher CO₂ levels stimulate the growth of certain diatoms, macro-algae and sea grasses. If temperatures remain low enough, the symbiotic algae of corals and anemones do well, as do numerous invasive species of seaweed.

As evidence about the effects of ocean acidification has started to build up, it seems highly likely that iconic coral reefs will be a shadow of their former glory, with fewer coral species and a much lower diversity of many other organisms, from noisy nocturnal shrimps to colourful shoals of fish.

As individuals, we can reduce our carbon footprint and buy products that support sustainable fisheries and aquaculture. And societies can harness knowledge about marine biology to help improve the political, legal and institutional frameworks to showcase success stories in better marine governance.

To stand a chance of protecting coral reefs and marine habitats, we need to integrate better the challenges associated with climate change and at the same time rein in the most obviously damaging activities, like the extermination of large marine organisms, fuel-thirsty trawling or mining of the seabed and the pollution of coastal habitats.

This article has been adapted from the Save Our Seas magazine. See the original at

www.saveourseasmagazine.com/the-co2-conundrum



RESOURCES

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Professor Kristín Vala Ragnarsdóttir
University of Iceland

One of humankind's biggest challenges over the next century is to provide adequate resources for civilisation. The future of our civilisation depends on their wise use for ensuring adequate supplies and for minimising the risk of poisoning ourselves.

The main focus is on the most important metals and on phosphorus in addition to fossil fuels. The sobering common aspect for all of these resources is, that available data suggests that their production has either peaked already or will peak within the next 50 years. Throughout history, the major part of the economy of the world's nations has been driven directly or indirectly by access to and use of natural resources, and this still remains so.

The main findings are that the world is heading towards a restricted access to the key resources that are used by humanity today and these restrictions will have a profound impact on the world economies and life styles of future generations. The challenge is to accept this knowledge, and to find the necessary solutions and adaptations for the future while we still have time and possibility to so. History will judge how well we responded to current resource challenges.

SUSTAINABLE MINING AND RARE EARTH ELEMENT RESOURCES THE POTENTIAL OF THE FEN COMPLEX, NORWAY

Author: *Dr Colin Wilkins*

Additional authors or affiliations: *Dr. Arjan Dijkstra and Christian Marien*

The principles of sustainable mining can be stated in two different ways: 1) Developing mines in a sustainable manner that preserves the local environment, respects and protects indigenous cultures, cares for the local community and aims to fully rehabilitate the land after mining has finished. Or, 2) Extracting minerals from the Earth in such a way that exploitation can continue indefinitely. Hence mineral resources can be thought of as effectively infinite. In this presentation we will consider the second definition of sustainable mining and discuss it in relation to the exploitation and use of REE (Rare Earth Elements) – a critical commodity in our increasingly technological society. If this question was considered for relatively well known commodities such as copper, nickel, chrome, tin, tungsten, etc. then mining must be (ultimately) unsustainable as reserves would eventually be exhausted and, of course, we live on a finite planet. However, the geological community would take a different position on this issue as consideration of known reserves and future resources, together with improvements in recycling, substitution and efficient extraction and use of commodities indicates that depletion, scarcity and exhaustion are not likely in the foreseeable future. But what about REE? They are required in increasing amounts to sustain a wide range of devices such as hybrid and electrical vehicles, catalytic converters, wind power generators, LEDs, computer hard discs, flat panel

display screens, portable electronics and more. REE have been identified as critical commodities needed for our technological future but are considered to have a supply risk due to the current scarcity of economically recoverable resources as growth in demand has been rapid over the last 20 years. They are also difficult to process (separation of ore from waste), have significant environmental impacts when mined (e.g. associated with Th), and have potential for export restrictions from producer states. The current scarcity of REE mining operations has led to worldwide exploration initiatives that require basic research into understanding the geological processes that concentrate REE into potential ore bodies. The Fen Complex in Norway, a c. 580 Ma igneous complex containing REE-bearing carbonatites, has the potential to become a REE mine, but high Th concentrations are an impediment to exploitation at present. Carbonatite containing primary REE-minerals and REE fluorocarbonates (e.g. Bastnäsite) is progressively hydrothermally altered to hematite-rich rødbergite. The transformation of carbonatite to rødbergite causes Th-bearing REE fluorocarbonates to be replaced by hematite in conjunction with precipitation of monazite – a REE-phosphate, but with low-Th concentrations. It is hoped that future work on the separation of REE-bearing phases from Th-bearing phases during hydrothermal alteration will identify areas with potential exploitable concentrations of REE within the Fen Complex.

Professor Iain Stewart (Sustainable Earth Institute), James McFarlane (Wolf Minerals Senior Mine Geologist) and Jeff Harrison (Wolf Minerals' Operations Manager).



NEWS

STUDENTS USE NEW MINE FOR GEOLOGICAL RESEARCH (MARCH 2016)

Students from Plymouth University are using a recently opened tungsten mine on the edge of the city to develop a greater understanding of the South West's rich and fascinating geology.

The £140 million Drakelands Mine project opened in September 2015, making it Britain's first new metal mine in 45 years and putting the UK back on the world map as a metals exporter.

Now the mine's owner, Wolf Minerals, is working with leading institutions including the University, Camborne School of Mines and the British Geological Survey on geological and mineralogical studies of the Hemerdon tungsten and tin deposit, on which the mine is located, and which will feed into broader research of the South West's geology.

The Sustainable Earth Institute held the first public talk since the reopening of the Drakelands Mine. The talk was delivered by a Senior Mine Geologist and Operations Manager, where they discussed how and why tungsten is extracted, the world's tungsten supply and mining in the South West.

Find out more:

www.plymouth.ac.uk/research/institutes/sustainable-earth/tungsten-mining-at-plymouth-drakelands

NEWS

OPINIONS ON FRACKING LINKED TO POLITICAL PERSUASION – STUDY (MAY 2016)

New research by a team from Plymouth University and Ryerson University in Canada indicates how important a person's political affinity is to their opinion about hydraulic fracking.

Professor Yaniv Hanoch, Professor of Decision Science in Plymouth University's School of Psychology, co-authored the study alongside Dr Becky Choma and Shannon Currie from Ryerson University. The researchers examined the role of people's political ideology in people's attitude, knowledge, and perceptions about hydraulic fracking.

For this study, 412 American adults were asked a series of questions to assess their attitude, knowledge and perceptions about fracking, such as: how close to a fracking site, coal power plant, nuclear power plant and wind turbine site they would be willing to live; the agencies – such as government, environmental, and trade – they trusted when forming an opinion about fracking; their risk perceptions about fracking; and what they perceived to be its economic benefits.

Find out more at: www.plymouth.ac.uk/news/opinions-on-fracking-linked-to-political-persuasion-study





EDUCATION

THE LOCAL, NATIONAL AND GLOBAL CONTEXT

Professor Stephen Sterling

*Professor of Sustainability Education,
Plymouth University*

How far is the education we are providing appropriate to, and sufficient for, the kind of world condition graduates will face in the near to distant future? An informed answer to this question depends on an appreciation of the global context, such as the work of Stockholm Resilience Centre, which suggests nine planetary boundaries defining a 'safe operating space for humanity', and the associated notion of a 'Great Transition' towards a future which is socially equitable, economically sustainable, and ecologically resilient. The 17 Sustainable Development Goals (SDGs) and their 169 targets present a milestone on this journey, and whilst as an entirety they present a comprehensive challenge to mainstream educational policy and practice, the specific Education Goal 4 falls short in addressing sustainability issues. More pointedly, UNESCO'S Global Action Programme (GAP) for sustainability education seeks a bold response from education in the light of contemporary issues.

Beyond the rhetoric, the UNESCO-Japan Prize for ESD, is eliciting submissions from all over the world which demonstrate innovative and effective sustainability education projects both

in the formal and non-formal sectors. Such work, and the urgent global sustainability context, are spurring a growing international debate on what competencies should be developed through education. Partly, this comes down a key question of what we collectively think Higher Education is for. Clearly, the usual agendas of employability, internationalisation, enterprise etc are important, but so too are the ability to manage and flourish in socio-economic and environmental conditions of increasing uncertainty, flux and complexity. At Plymouth, we are launching the 'Plymouth Compass' framework of 'future-facing' attributes, intended to help students the qualities and skills that can guide and enhance their academic, professional, civic, and personal lives. Meanwhile, SEI's sister research institute PedRIO is supporting a range of sustainability related pedagogical research, whilst SEI is increasingly interested in how sustainability research can infuse and inform teaching and learning. There is much to celebrate, but also a real opportunity for Plymouth to go to another level in terms of innovation, energy and leadership in meeting the very real global conditions that will influence graduates' lives.

STUDENTS' ENERGY LITERACY IN UK UNIVERSITIES

Author: Prof Debby Cotton

Additional authors or affiliations: Jennie Winter, Wendy Miller and Reema Muneer

Energy-saving forms an important part of efforts to enhance sustainability on campus, yet little is known about levels of energy literacy amongst HE students. Previous research suggest that students' understanding of energy is often patchy, with high concern but lower knowledge and skills (DeWaters & Powers, 2011). Where energy issues do appear in HE, this is mainly in the context of campus greening or energy-reduction schemes, particularly in student residences where the focus is predominantly behaviour change, an emphasis that may have important implications for the longer-term impact of changes. This paper reports on research which explored energy literacy in the student population at five UK universities which sat at different positions in the UK Green League. The research utilised an online questionnaire to explore similarities and differences between the institutions, exploring the extent to

which differences in the universities' commitment to sustainability was reflected in students' energy literacy. Early findings suggest that there were a number of similarities in student responses between the different institutions, including widespread enthusiasm for sustainability and energy issues, but patchy experience in the curriculum. Gaps in knowledge mean that behavioural choices are not always the most effective, and energy-saving initiatives on campus are often unseen by students or undermined by 'mixed messages'. Most differences between universities could be attributed to discipline mix or gender rather than position in the Green League. However, universities with higher Green League positions were seen as doing more to save energy, and providing more information to students about energy-saving.

USING GAME-BASED LEARNING TO ENGAGE STUDENTS WITH THE SUSTAINABILITY OF WASTE MANAGEMENT

Author: Dr John Maskall

Additional authors or affiliations: School of Geography, Earth and Environmental Science, Plymouth University

Key questions focussing on the sustainability of waste management include the following:

- What types of wastes are generated by human activities?
- How does unregulated disposal of wastes create pollution?
- How does this pollution affect environmental quality and the health of animals and humans?
- Is it acceptable for industrialised countries to export their waste to developing countries?
- What should we do (as individuals and nations) to eliminate or reduce the negative impacts of waste?

To explore these questions, delegates are invited to play Waste Connections, a card game designed to introduce students to wastes and their management. Based on the popular card game ‘Concentration’ (aka ‘Memory’ or ‘Pairs’), players aim to collect pairs of cards. Each pair comprises a product and its possible impact on environmental quality or human health if disposed of improperly. Students are introduced therefore to a wide variety of wastes which range in size from bottle tops to ships, from the everyday to the specialised and from hazardous to inert. The game

tests therefore not only memory but also the ability to identify links of varying complexity. Participants can choose to play solo or in groups of two, the latter option providing a choice of either a competitive or a cooperative game. Waste Connections is followed up with a series of slides which provide contextual information, quantitative data and management strategies for each waste. These slides act as a launching pad for discussion on the wider issues of sustainable waste management.

THE SUSTAINABLE UNIVERSITY CREATING NEW LEARNING SPACES THAT ARE FIT FOR PURPOSE

Author: Dr Paul Warwick

Additional authors or affiliations: Professor Stephen Sterling (Plymouth University)

This workshop combines research findings on the apt design of learning spaces for sustainability education with a presentation of plans to create a new Sustainability Hub on campus for staff and students. This workshop begins by outlining the international call for interdisciplinary, collaborative, and active learning approaches to Sustainability Education. From this starting point we move on to consider the design of physical spaces conducive to such teaching and learning approaches in Higher Education. We present a research informed perspective that draws specifically from a small scale mixed-methods research project. This sought to develop an understanding of the complexity of learning spaces inhabited by HE students in the 21st century and resulted in a theoretical model for future sustainability learning spaces that places an emphasis on dynamic, engaging, ecological and participatory

(DEEP) dimensions. How we might creative such DEEP learning spaces with our students and staff here at Plymouth provides the final interactive element of this workshop. Participants will be able to see plans for a new Sustainability Hub on campus and share their perspectives on its design and the range of potential activities it will need to host. This Hub is in direct response to the University’s sustainability strategy and will be based at Kirkby Lodge. It is hoped that the design of the Sustainability Hub will further enhance the University’s integrated ‘whole institutional approach to sustainability’ and will provide a range of flexible spaces for staff and students to utilise in pursuit of sustainability as it relates to curriculum, research and operations.

NEWS

PLYMOUTH COMPASS – NAVIGATING THE WHOLE UNIVERSITY EXPERIENCE

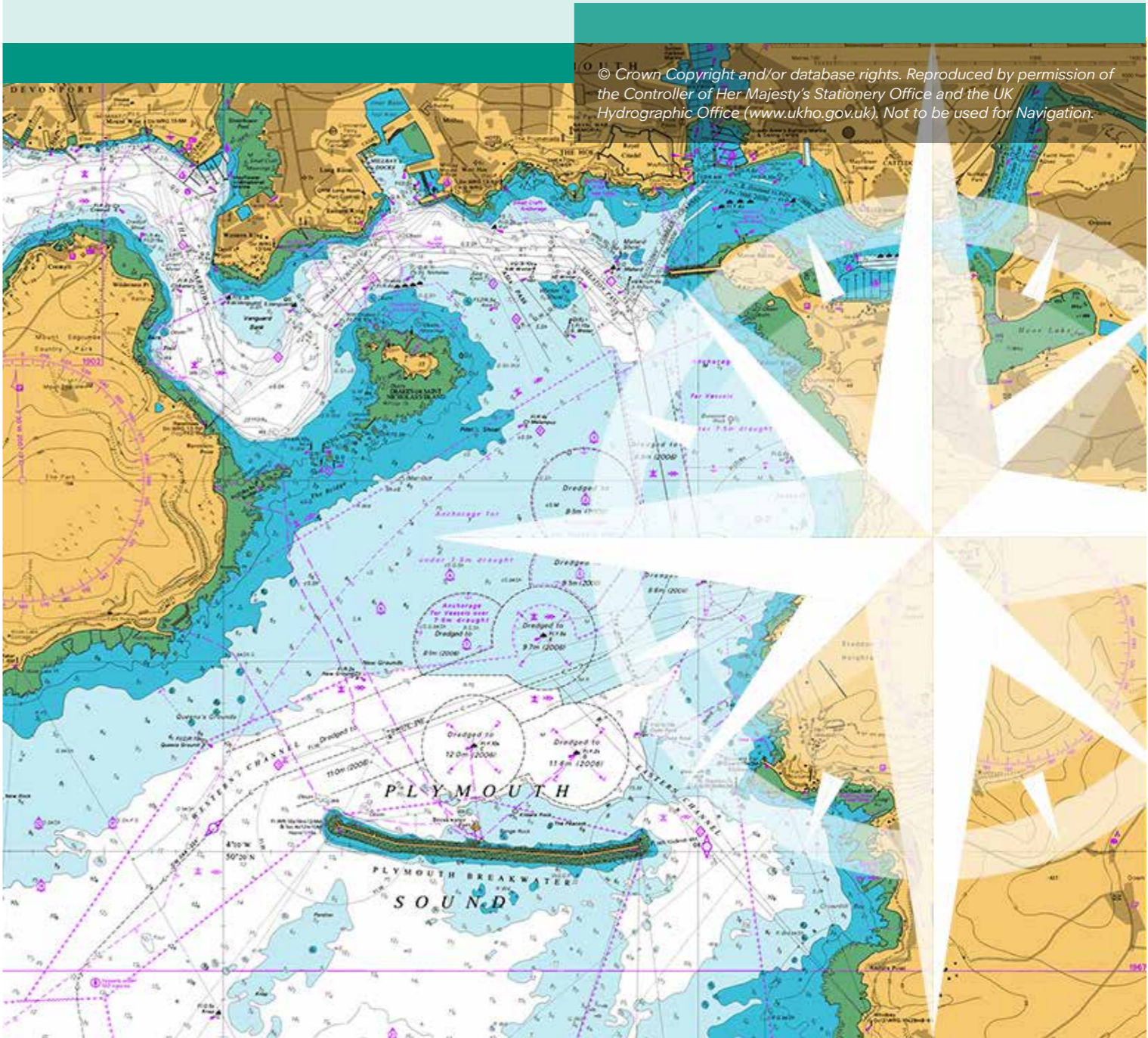
In collaboration with students, academics, and professional services staff across the University, the Teaching and Learning Support team at Plymouth University has developed the Plymouth Compass, which helps students throughout their university journey, in both the taught curriculum and extra-curricular activities.

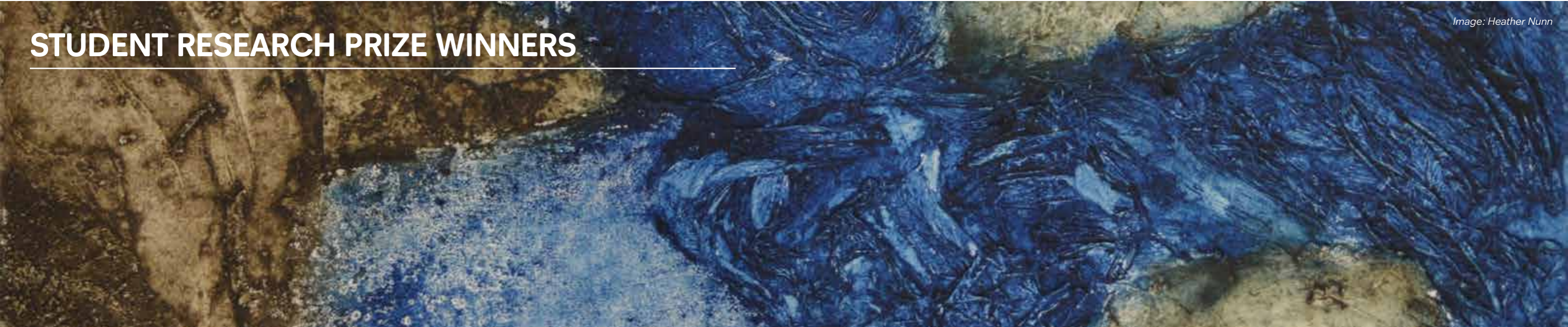
What students learn at university prepares them for more than a career, so the Compass identifies key attributes in four broad areas of life - academic, civic, professional, and personal. The Compass themes include: The Critical and Creative Learner; The Resilient and Thriving Individual; The Competent and

Confident Individual; and The Sustainable and Global Citizen, which helps graduates contribute to a more sustainable future as an informed, responsible, and active citizen, both locally and globally.

The Compass is available now for students and staff to start using in whatever way they see fit – but there is a formal pilot programme starting in September with a small group of tutors and their first-year students across the institution to explore how the Compass can be used with PebblePad in their tutorials. Guidance for academic and professional staff will follow in mid-2017.

Read more at: www.plymouth.ac.uk/your-university/teaching-and-learning/plymouth-university-compass





STUDENT RESEARCH PRIZE WINNERS

Image: Heather Nunn

The Sustainable Earth Institute student research prize aims to acknowledge sustainability research carried out by undergraduate students, and to nurture and develop the researchers of tomorrow.

The winners of the prize are:

- BSc (Hons) Environmental Science**
Oliver Slaughter
Designing and implementing public participation workshops to influence behaviour towards climate change within an Action research framework
- MEng (Hons) Civil and Coastal Engineering, Faculty of Science and Engineering**
Christopher Ackland
An investigation into the effects of rising sea levels on bridge pier scour at the inter-tidal River Clyst and Exe Estuary coastal interface
- MSc Sustainable Environmental Management, Faculty of Science and Engineering**
Helen Gowans
A critical evaluation of communication strategies used by aquariums to increase public awareness of marine conservation efforts

- BSc (Hons) Biological Sciences, Faculty of Science and Engineering**
Jemma Louise Hearn
The relationship between life-history and risk of extinction for Canadian mammals
- BA (Hons) Architecture, Faculty of Arts and Humanities**
Katelin Thomas
Uneven development - analysing hierarchies within shanty towns
- BA (Hons) English, Faculty of Arts and Humanities**
Mark Hicks
The Nature and Logic of Capitalism in Margaret Atwood’s Maddaddam Trilogy
- BA (Hons) 3D Design – spatial and interior designer, Faculty of Arts and Humanities**
Andrei Dan Carausu
Access

- BSc (Hons) Building Surveying and the Environment, Faculty of Arts and Humanities**
Charles Murphy
Critical Evaluation of the Understanding of Responsible Sourcing by Procurement Teams
- BA (Hons) Photography**
Amie Townshend
Images of Wistman’s Wood, Dartmoor
- BA (Hons) Fine Art, Faculty of Arts and Humanities**
Heather Nunn
Re(f)use
- BA (Hons) Business, Faculty of Business**
Daniel Beattie
Millennials’ Perceptions of Sustainability in UK Retail
- BA (Hons) Marketing, Faculty of Business**
Michael Lovell
A value-action gap: The study of male university students, materialism and sustainably sourced jeans

- BSc (Hons) Psychology, Faculty of Health and Human Sciences**
Claudia Trotter
‘It’s in the bag!’: Testing the effect of Functional Imagery Training on reducing plastic use
- BSc (Hons) Psychology, Faculty of Health and Human Sciences**
Aneta Nastaj
The Effects of Environment on Motivation to Exercise and Commitment to Environmental Sustainability
- BSc (Hons) Nursing, Faculty of Health and Human Sciences**
Louise Watts
An exploration into nurses’ knowledge and views on environmental issues in healthcare
- BSc (Hons) Dietetics, Faculty of Health and Human Sciences**
Megan McGregor-Shenton
The Role of a ‘Less but Better’ approach to Meat Consumption for Public Health Nutrition and the Environment

SUSTAINABILITY WITH PLYMOUTH UNIVERSITY

The University is committed to providing information in accessible formats. If you require information from this guide in an alternative format, please contact: Sustainable Earth Institute (SEI).

Plymouth University

Drake Circus
Plymouth
PL4 8AA
United Kingdom

Tel: +44 (0)1752 585 816

Email: sei@plymouth.ac.uk

www.plymouth.ac.uk/sustainable-earth