Priestley International Centre for Climate

UNIVERSITY OF LEEDS

DELIVERING RESEARCH TO UNDERPIN ROBUST AND TIMELY CLIMATE SOLUTIONS

RESEARCH

PRIESTLEY CENTRE PEOPLE

187 MEMBERS

8 FACULTIES REPRESENTED

3 CHAIRS

7 PHD STUDENTS

22 UNIVERSITY ACADEMIC FELLOWS

13 MANAGEMENT COMMITTEE

3 CORE TEAM

7 DISCIPLINES
covered by dedicated Priestley PhD cohort (Geography, Earth & Environment, Biological Sciences, Politics & International Studies; Engineering; Food Science & Nutrition; Business

6 FACULTIES
covered by Priestley UAF cohorts (Environment; Engineering; Education, Social Sciences & Law; Biological Sciences; Mathematics & Physical Sciences; Business)

UNIVERSITY OF LEEDS ACADEMICS

171 ACTIVELY INVOLVED IN CLIMATE RESEARCH

36% ON IMPROVING PREDICTIONS OF FUTURE CLIMATE

24% ON UNDERSTANDING RISK TO DEVELOP A MORE RESILIENT WORLD

22% ON ENABLING LOW CARBON TRANSITIONS

6% ON SOCIAL, POLITICAL AND ECONOMIC DIMENSIONS OF CLIMATE CHANGE

12% ON MULTIPLE SOLUTION SPACES

FUNDING

£65M GRANT INCOME

197 ACTIVE CLIMATE RESEARCH AWARDS

Contents

The Priestley International Centre for Climate launched on 14 June 2016 – and what a year it's been. We now have 187 members and I've met many new colleagues, witnessed new collaborations and have been impressed by the stream of high quality publications flowing out from all corners of campus. The Centre is making a difference. We have three new Priestley professors, our own interdisciplinary doctoral scholarships, developed exciting new international research projects and seen collaboration across a wide range of disciplines, from biology to business and from the arts to the natural sciences. Outreach events included a 24-hour Climathon, where teams designed energy efficiency solutions for housing in Leeds. A big thank you to all that have helped in getting us off to a great start - you can see what we've done to date from the infographics on the inside front and back covers of this, our revised and updated collection of research briefs highlighting the breadth and scope of climate related work the Centre is involved with. We welcome your input into our plans to make our second year even better.

Piers Forster
Director, Priestley International Centre for Climate

Global climate solutions

Our focus is on delivering research to underpin robust and timely climate solutions

There are over 171 academics at the University of Leeds using world-class expertise and interdisciplinary capability to deliver climate research with global reach.

The Priestley International Centre for Climate is dedicated to improving our understanding of fundamental climate science, developing strategies to reduce and mitigate climate change and its impacts, and supporting society, ecosystems and infrastructure in adapting to our changing climate. Using our combination of expertise, scale, track record and relevance, the Centre is able to deliver excellent research to underpin robust and timely climate solutions with a specific focus on the four key areas set out in the following sections: (1) Improving prediction of future climate; (2) Understanding risk to develop a resilient world; (3) Enabling low carbon transitions; (4) Addressing the social, political and economic dimensions of climate change.

Over 171

academics involved in climate research at the University of Leeds

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IMPROVING PREDICTION OF FUTURE CLIMATE

Priestley Centre researchers are leading international efforts to better understand the climate of the past, present and future. By bringing together palaeontologists, geochemists, volcanologists and climate modellers we can better understand the past in a way that helps us to predict future climate. In partnership with the Met Office and National Centre for Atmospheric Science (NCAS), we use our expertise in atmospheric science and biogeochemistry to couple laboratory studies, fieldwork, remote sensing and computer modelling to improve global and regional predictions of climate change, extreme weather, air quality and carbon budgets. Our team involves experts in behavioural decision research, environmental social science and risk communication, enabling us to better understand how different stakeholders use and engage with climate predictions.

How do we make our models more accurate?

Delivering a new generation of climate solutions

At the University of Leeds we have world-leading expertise and state of the art capability to perform end-to-end climate research. This research has improved understanding of the fundamental physical, chemical and biological processes that drive climate and weather. We are testing and delivering a new generation of climate simulations that give a better understanding of future climate change and its impact on society.

For 20 years Leeds researchers have undertaken field measurements, performed laboratory studies and provided theoretical insights that have fundamentally improved our understanding of the Earth system.

Our expeditions have collected data across the globe, from the jungles of Borneo to the Pine Island Glacier in Antarctica. Since the year 2000, we have established a systematic framework for long-term monitoring of the Amazon region, working with international partners to create a unique long term record of biodiversity, carbon and water availability for the region. Painstaking laboratory work has enabled us to understand how water clouds and ice clouds form and the intricacies of reactions that drive chemical processing in the atmosphere. We have made key theoretical insights into understanding how rainfall will be affected under future climate change.

Our research doesn't just gather dust in academic journals - we use it to improve our climate models, allowing us to make better predictions of future temperatures, air quality, extreme weather, sea-level rise and crop yields. Working with our partners at the Met Office and National Centre for Atmospheric Science, we have helped to build a new generation climate model, the UK Earth System Model (UKESM).

Global expeditions

Our expeditions have collected data from across the globe

Leeds activity has focussed on two key areas of model development:
1) incorporation of aerosol chemistry, giving improved prediction of cloud changes and future air quality;
2) high-resolution forecasting, that is leading directly to improved forecasts over Africa and other tropical regions.

- **Leeds researchers have delivered high-resolution climate forecasts for Africa and across the tropics.**
- **Leeds end-to-end climate research contributed substantially to national capability in climate modelling and delivery of a world-leading model, UK Earth System Model, in June 2016.**

Photo: Hogg/CPOM/iSTAR

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www.jwcrp.org.uk/research-activity/ukesm-cmip6.asp

How can expert knowledge help assess future risk?

Producing regional climate narratives to make better predictions of future climate

An interdisciplinary team of social scientists, physical climate scientists, statisticians and communication experts have developed a new method of uncertainty quantification for regional climate information that combines expert judgement with climate observations and simulations.

The Indian summer monsoon impacts the societal resilience of a large population in Southern India. However, many important processes are poorly reproduced by global climate models. To address this, a combination of expert-derived climate narratives with climate observations and simulations was used to understand and project how regional climate in Southern India could change in the future.

In July 2015, experts on the Indian summer monsoon from the UK and India were brought together to determine how the climate in Southern India could change in the near to mid-term future (2030s and 2050s). With a focus on the Cauvery River Basin and the mountain range of the Western Ghats (as its source), experts agreed that the most important climatic processes determining river flow were moisture availability over the Arabian Sea and strength of air flow perpendicular to the Western Ghats. From this, a number of narratives were developed with the experts describing possible future evolutions of the Indian summer monsoon and underlying plausible processes.

The relationship between these two key processes (moisture availability and flow) and rainfall and river flow in the catchment were verified using data from observations and climate simulations. Using these relationships, time series of future regional climate information were created for each expert-based climate narrative.

Expert-derived climate narratives can be combined into time series of regional future climate change that can be used as part of a climate risk assessment to inform long-term adaptation decision-making.

Moisture availability and flow can project 2050s climate

River Kaveri, Southern India (photo: vbel71, iStock)

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Cathryn Birch, University Academic Fellow in dynamical meteorology and high-resolution modelling of weather and climate

John Paul Gosling, Associate Professor of Statistics

How can chemistry help our understanding of the atmosphere?

Unravelling the reactions controlling greenhouse gases

The removal of many greenhouse gases is controlled by chemical oxidation reactions. We have the knowledge, capability and facilities to improve our understanding of the chemistry of oxidation using a combination of fieldwork, laboratory studies and numerical computer modelling.

A key underpinning component of climate models is a detailed description of the chemistry responsible for the removal and formation of greenhouse gases such as methane and ozone.

For over 20 years Leeds researchers have applied fundamental techniques developed in the laboratory to study the chemistry of our atmosphere. The concentration of the hydroxyl radical, OH (sometimes referred to as nature's detergent) has been measured in many parts of the world, from the Arctic to Antarctica, and from the Borneo rainforest to the Tropical Atlantic Ocean on the ground and on-board aircraft and ships. OH is short-lived (<1 sec) and only controlled by the local chemistry, so is an ideal target to test the predictive capabilities of computational models.

A comprehensive determination of the composition of the surrounding air must be undertaken in order to constrain the models, requiring a highly interdisciplinary and collaborative approach involving many instruments from Universities across the UK which make up the national capability as part of the National Centre for Atmospheric Sciences (NCAS, headquartered at Leeds).

Laboratory studies of chemical reactions provide fundamental data for processes at the molecular level required by computational models. Leeds operates a large atmospheric simulation chamber (HIRAC), which can mimic the conditions in many parts of the atmosphere. We target our studies to answer pressing questions such as the impact of any escape of chemicals added to the exhaust stacks of power stations to capture carbon dioxide.

Our laboratory research is not just applied to processes at the surface of the planet but also right to the edge of space, and studies of comparative planetary atmospheres are also being undertaken. Neither is our laboratory research limited to the gas-phase; we also study chemistry of particulate matter i.e. aerosol particles.

- **Leeds contributes substantially to national capability in the field measurement of atmospheric composition**
- **At Leeds, and through NCAS, we adopt an interdisciplinary approach involving field measurements, laboratory studies and numerical computer modelling to tackle difficult challenges associated with understanding the chemistry of greenhouse gases.**

Our laboratory studies are applied to the edge of space!

Cape Verde, location of an atmospheric observatory.
Photo: Peter Edwards.

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How far can we rely on tropical forests to act as a carbon sink?

The role of tropical forests in offsetting human carbon emissions

One of the greatest uncertainties surrounding future climate is the ability of tropical forests to serve as an offset to anthropogenic carbon emissions. Researchers at Leeds are using a combination of field observations, experiments and modelling to study the tropical carbon cycle and the impacts of nutrient availability on the ability of plants to absorb carbon dioxide.

Leeds is experimenting with ecosystems in Panama

In order to determine how much of the carbon dioxide that humans produce can be offset (or absorbed) by tropical forests, we need to better understand the size of the tropical carbon sink and the role of nutrient availability in limiting carbon uptake by plants.

Building upon our findings that trees with the ability to acquire nitrogen fertilizer via nitrogen fixation enhance carbon uptake in young tropical forests recovering from land use (Batterman et al., 2013, Nature; Levy et al. in prep), we are now studying the evolution of nitrogen-fixing trees to disentangle their function in the past, present and future. Using a combination of field observations, experimentation and modelling that cuts across disciplines, we are testing how nitrogen-fixing trees function in tropical forests and other biomes worldwide.

As part of this project, we have established a large-scale ecosystem manipulation experiment at the Smithsonian Tropical Research Institute in Panama to directly test whether nutrients limit tropical forest carbon uptake. This experiment will provide first evidence for whether tropical forests can respond to changing climate and carbon dioxide or if there are not enough nutrients or nitrogen fixation to support forest growth and significantly offset human carbon emissions.

- **Recovering tropical forests have the potential to offset significant human carbon dioxide emissions but require the presence of diverse nitrogen-fixing tree species to maximize the carbon sink.**
- **Research at Leeds is testing nutrient limitation on tropical carbon uptake with a large-scale experiment in Panama.**
- **These findings will help us to make more accurate predictions of future climate and quantify the role of tropical forests in mitigating climate change.**

Field technician spreading nitrogen fertilizer on a recent pasture that is being allowed to regenerate into a tropical forest. PVC tubes and yellow rope delineate the location of the plot, which is part of an experiment in Panama that tests how nutrients limit tropical forest recovery from land use and the ability of tropical forests to serve as a carbon sink.
(Photo: Sarah Batterman)

Want to Know More?

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Batterman, S. A., Hedin, L. O., van Breugel, M., Ransijn, J., Craven, D. J., and Hall, J. S. 2013. Key role of symbiotic dinitrogen fixation in tropical forest secondary succession. Nature 502, 224–227. DOI: 10.1038/nature12525

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UNDERSTANDING RISK TO DEVELOP A RESILIENT WORLD

Priestley Centre research is improving understanding of climate related risks at local, regional and global scales. We evaluate climate impacts such as changes in rainfall, crop yield, sea level rise and land degradation, along with impacts on people and socio-economic systems. This broad understanding of climate risks provides the knowledge base to drive future development pathways that are both climate resilient and practical. By coupling sustainable development research with expertise in physical climate change, we are implementing a more rigorous approach to climate solutions to tackle issues including global food security, flood adaptation, biodiversity, ecosystem service protection, urban development and resilient infrastructure.

How do we ensure crops are matched to future climates?

Reforming crop breeding systems to keep pace with climate change

Climate change is projected to pose considerable challenges for agriculture and food security around the world. In work published in 2016, world leading plant scientists, plant breeders, crop modellers and climate modellers came together to determine how crop breeding can contribute to global food security in the face of increasing demand and future climate change.

It takes around 10 - 30 years to breed a new crop variety and have it adopted by farmers in Africa. The rate at which temperatures are increasing across the tropics means that by the time the crop is in the field it is being grown above the temperatures that it was developed in. Unless immediate action is taken to improve crop breeding systems, yields will begin to fall within the next decade. Leeds research has focussed on maize in Africa, but the underlying processes affect crops across the tropics.

Options for ensuring that crops can be developed and delivered to the field more quickly range from hi-tech solutions such as biochemical screening techniques to more socially-centred measures such as improving government policy on breeding trials and farmers' access to markets. The efficacy of these options is limited by resources and by social and political structures. The research team is already involved in active testing of new agricultural technologies around the globe (see photo).

By looking at a range of data on farming, regulatory policy, markets and technologies the team developed average, best and worst case scenarios for reform of breeding systems.

Only the most optimistic assessment showed crops staying matched to future temperatures and even that scenario fails to keep up if greenhouse gas emissions continue at current rates. One interesting avenue for future research is the use of global climate models to determine target temperatures for use in greenhouses. Crops are then bred in these greenhouses at the temperatures expected to occur when they reach the farmers. The challenge here is in knowing what future emissions will be and ensuring that climate models can produce accurate enough information on future temperatures based on those emissions.

- **The process of breeding new varieties and getting them into farmers' fields needs to speed up in order to keep up with climate change.**
- **The social and political structures involved in seed development and delivery are an important bottleneck requiring urgent attention.**
- **Climate models can be used to target breeding strategies.**

10-30 years

to develop new crop varieties

Ms. Lampai, head of Women's Union and leader of the food processing group in Pailom Village in Savannakhet Province, Laos, in the community garden, where she helps test different agricultural interventions as part of a climate-smart village. Photo by CUSO international via CCAFS

Want to Know More?

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Current warming will reduced yields unless maize breeding and seed systems adapt immediately, Nature Climate Change, 2016, doi:10.1038/nclimate3061

What can we do to protect land and people in a warming world?

Triple win adaptations tackle climate change, land degradation and biodiversity loss

Much is known about the processes and effects of land degradation and climate change; little is understood about the links and feedbacks between them. Less still is known about how these processes interact in different social and ecological settings around the world. Research at Leeds tackles these knowledge gaps, offering solutions in adapting to the dual challenge of climate change and land degradation.

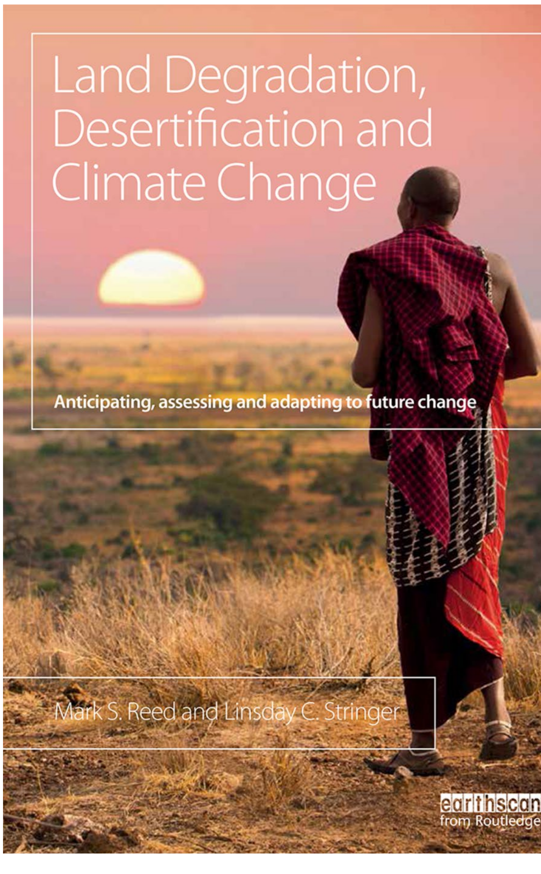
As climate changes, weather events are expected to become more extreme and more variable, with droughts and human mismanagement of land causing vegetation die-off and soils left exposed to erosive forces leading to accelerated land degradation. At the same time, land degradation contributes to climate change when organic carbon is released from soils and vegetation and land-atmosphere gas fluxes are disrupted. Impacts resulting from the combination of climate change and land degradation will vary with location. However, the poorest groups and societies lose out the most, experiencing damage to their livelihoods and food security.

Policies offer useful starting points in tackling land degradation and climate change challenges across scales. Improved cooperation and knowledge exchange is needed so that researchers from across disciplines, land users and policymakers can work together more effectively. We have identified key vulnerabilities to the combined effects of climate change and land degradation, drawing on examples from around the world. The research recommends methods for monitoring and evaluating the combined effects of climate change and land degradation. Importantly, we have identified interventions that benefit both climate change and land degradation, whilst supporting biodiversity and ecosystem services, and we call these triple-win adaptations.

Weather events

are expected to become more extreme and more variable

- **Recommendations for monitoring and evaluating the impacts of the combined challenges of climate change and land degradation have been made.**
- **Triple-win adaptations that tackle climate change and land degradation whilst protecting biodiversity and ecosystem services have been identified, including climate-smart agriculture and water harvesting methods that rely on local and indigenous knowledge.**



Want to Know More?

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Land degradation, desertification and climate change: Anticipating, assessing and adapting to future change. Routledge, ISBN 978-1-84971-271-2.

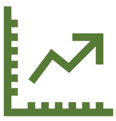
How can we keep track of changes in Arctic ice sheets?

Safeguarding the Arctic using near-real satellite measurements

The Centre for Polar Observation and Modelling (CPOM) is a Natural Environment Research Council (NERC) national centre of excellence with its directorate based at the University of Leeds. CPOM is now generating information on Arctic sea ice thickness in near-real time, using satellite data from the European Space Agency's CryoSat-2 mission. This is not only helping scientists to understand rapid changes in the Arctic but also providing valuable information for users of the region.

CPOM studies Earth's sea ice, ice sheets, glaciers, and polar oceans using satellite observations and numerical models, providing UK National Capability in Earth observation and modelling of the cryosphere – the frozen parts of our planet – using cutting edge techniques. Monitoring the polar regions from around 700 km above the Earth, CryoSat provides radar measurements of ice that CPOM processes rapidly to give up-to-date information on Arctic sea ice thickness and volume. CPOM's techniques ensure that information on the whole Arctic, an ocean basin or point location is available within two days of the satellite passing over the ice.

Although other sea ice data services are available, none of them provide the same information, level of detail, or timeliness as CPOM's freely-accessible web portal. With economic growth in the Arctic estimated to be worth $100bn over the next two decades, CPOM's timely and routine information ensures that users of the Arctic (such as shipping companies, search and rescue operations and tourism) can effectively plan and carry out their operations safely and with care. The CPOM data portal is also now providing information on ice sheet velocity for key outlet glaciers of the Antarctic and Greenland ice sheets, and measurements of Earth's ice caps and glaciers will be available shortly.



$100bn

estimated economic growth in the Arctic over the next two decades

The data CPOM freely provides demonstrates CryoSat's potential as an operational service as well as a purely scientific mission.

- **The Centre for Polar Observation and Modelling is now providing data on Arctic sea ice thickness and volume in near real-time through a freely accessible web portal.**
- **These data have important applications for anyone who needs to navigate through the sea ice, with potential to benefit a wide range of Arctic users and those researching the impacts of climate change in the Arctic.**
- **A new app, SeaIce for IOS and Android, has been created based on CPOM data.**

Photo: ESA/AOES Medialab

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www.cpom.ucl.ac.uk/csopr/seaice.html

How can we balance regional and national conservation strategies?

Integrating climate goals into biodiversity conservation decisions

Climate change threatens biodiversity in often unpredictable ways. Coral reef ecosystems are "canaries in the coal mine" being among the first ecosystems to be severely threatened by climate change. Integrating regional reef conservation goals into national decision making, addresses multifaceted challenges in biodiversity management such as national sovereignty, connectivity, people and climate change.

Coral reefs

are amongst the first ecosystems to be severely threatened by climate change

Our limited understanding and predictive capability for the responses of reef organisms and their users to climate change is a major hurdle to smart management and governance decisions for coral reefs. Yet, climate is only one of the multiple factors informing sustainable development and biodiversity conservation for tropical marine ecosystems.

The six countries of Malaysia, Philippines, Indonesia, East Timor, Papua New Guinea, and Solomon Islands formed a regional initiative to better conserve the world's centre of marine biodiversity, the Coral Triangle, home to over 500 coral species, 2500 reef fishes and the world's largest area of mangroves. Together, their regional goals are to sustain coral reef biodiversity, improve food security through sustainable fisheries, and enhance climate change adaptation. With these regional goals in mind, places were identified where it would be beneficial to establish marine protected areas.

There are two main strategies for countries to take. The first is to protect locations where the potential benefit is good for several or all of these goals. There are also places where exceptional conservation benefits can be achieved for a single or few goals, and they are spread across countries.

The second national strategy to meet their regional obligations is therefore to collaborate and together protect complementary locations with single high benefits. For example, Papua New Guinea has a key turtle rookery and important turtle pathways they can protect, while the Philippines can prioritise the protection of reefs that are likely to experience lower rates of warming.

- **Coral reefs are amongst the first ecosystems to be severely threatened by climate change.**
- **Protect reefs that are less affected by climate change, or that are still important for management objectives despite shifting species distributions and reduced overall health.**
- **Preserve each country's decision making sovereignty: regional goals can be met nationally by either protecting places where several regional goals can be met, or protecting places that are crucial for single goals and complementary to achieve regional goals.**

Photo: Dani Ceccarelli

Want to Know More?

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Integrating regional conservation priorities for multiple objectives into national policy. Nature Communications, 2015, 6, 8208.
DOI: 10.1038/ncomms9208

3

ENABLING LOW CARBON TRANSITIONS

The ability to meet future climate commitments depends on how we meet our global energy demand. Priestley Centre researchers are addressing energy challenges through interdisciplinary research, working towards a low-carbon future. Engineers, physical and social scientists work together to understand and develop the potential from bioenergy, renewables, carbon capture and storage, energy efficiency and demand reduction, sustainable transport and sustainable cities. Through our work with the Centre for Climate Change Economics and Policy (CCCEP) and Centre for Industrial Energy Materials and Products (CIE-MAP) we are ensuring that our research has policy relevance and a real impact on future energy pathways.

What are the solutions for industry to meet climate targets?

Policy recommendations for energy demand reduction

The Research Council's Energy Programme funds the Centre for Industrial Energy, Materials and Products (CIE-MAP), which is one of the Energy Use Demand Centres (EUED), as well as the UK Energy Research Centre (UKERC). The centres take a whole-systems perspective to understand how to transform the energy system to be low carbon, affordable and secure.

Our research links every point in the supply chain

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CIE-MAP identifies opportunities along the product supply chain that deliver a reduction in industrial energy use:
http://ciemap.ac.uk

UKERC carries out world-class research into sustainable future energy systems:
http://www.ukerc.ac.uk

End Use Energy Demand Centres address the technical, social and economic challenges of reducing energy demand:
http://www.eueduk.com

Meeting our climate targets requires an almost complete transformation of the energy system to low carbon technologies combined with substantial reductions in our demand for energy. There is considerable evidence to support the claim that energy demand reduction provides an immediate and effective low risk response to climate mitigation while also improving energy security, reducing fuel poverty and raising economic activity.

The Centre for Industrial Energy, Materials and Products (CIE-MAP), with its directorate at Leeds, brings together engineers, designers, environmental scientists, economists and other social scientists to identify the solutions needed to deliver a substantial reduction in industrial energy demand. With many of the efficiency gains already made in some sectors, reducing industrial energy requires a wider investigation considering the key drivers of industrial energy demand.

CIE-MAP takes into account the UK's global energy requirement to meet its demand for products and explores how to change our use of materials and products, increase efficiency and explore material substitution options to deliver a reduction in industrial energy demand.

Our approach of including every point in the supply chain in our research helps to determine the most effective energy demand reduction strategies. Using these strategies, industry could make a substantial contribution towards climate mitigation goals while also improving productivity and creating employment opportunities.

Current drivers for industry to pursue material productivity strategies are weak. CIE-MAP is working closely with the Department for Business, Energy and Industrial Strategy on a plan to ensure that Government works in partnership with industry to support materiaL productivity gains in key sectors. This involves:

- **Supporting the measurement of material productivity to establish metrics, monitoring and management structures for whole life carbon emissions of key products.**
- **Supporting the demonstration and dissemination of innovative products and business models.**
- **Focusing on sharing sector learning and regulating sectors where insufficient performance improvements are achieved.**

Container ship (Photo: EvrenKalinbacak, iStock)

Why are district heat networks key to comfort and carbon savings?

Decarbonising city heat using the Leeds Heat Planning Tool

In the UK we spend around £32 billion a year heating our homes and businesses and produce around a third of our greenhouse gases in doing so. Over 90% of our heating systems are fuelled by conventional gas boilers. In research at Leeds, we have developed methods to facilitate local authorities to provide low carbon and affordable heat to homes and commercial properties.

Heat networks can provide a low carbon, affordable alternative to conventional heating systems by using a diverse range of heat sources including waste heat from industrial processes, efficient generation through combined heat and power and fuels such as biomass. Retrofitting our existing housing stock and developing new networks presents a complex and enormous infrastructure challenge, but it is one that is key to meeting climate targets.

Through a number of projects and by working with key stakeholders we have identified policy interventions that may unlock development of heat networks in the UK. These include:

1) National energy policy must align with the objectives of local authorities, accounting for non-economic motivations for delivering energy infrastructure such as environmental and social benefits.
2) Heat network infrastructure needs to be valued differently to allow over-sizing in the initial stage of development. This will allow phased expansion to district-scale systems that are more economically and environmentally beneficial.
3) A more systemic approach to policy support for heat networks that recognises that a range of actors' capabilities and decision stages must be addressed is more likely to be successful.

Our research has led to the development of the Leeds Heat Planning Tool for England and Wales, which offers planners an additional evidence base to support business cases for potential schemes and opens up discussions with stakeholders. The free-to-use tool gives users an initial indication of locations that have the potential to offer viable heat networks and incorporates social benefits such as alleviating fuel poverty.

We have delivered Leeds Heat Planning Tool, a free-to-use service that offers energy planners a simple way to include social factors from the early stages of developing low carbon and affordable district heating in UK cities in England and Wales.

Over 90%

of our heating systems are fuelled by conventional gas boilers

Leeds Heat Planning Tool

Want to Know More?

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4

ADDRESSING THE SOCIAL, POLITICAL AND ECONOMIC DIMENSIONS OF CLIMATE CHANGE

The Priestley Centre brings together specialists in humanities, arts and social science with physical scientists to develop solutions that are informed by cultural, historical, and societal perspectives. By drawing on expertise in sociology, psychology, business, economics and politics, we ensure global climate solutions serve the needs of individual consumers and society while communicating the latest research to allow people to make informed decisions about their impact on future climate.

What can cities do to reduce emissions and cut costs?

Low carbon action plans for climate smart cities

Cities are responsible for 75% of global energy use and greenhouse gas emissions from cities and their populations are growing rapidly. Decisions are being taken now that will lock cities into carbon emissions for decades to come. Pioneering research at the University of Leeds has explored the potential for low carbon cities and highlights the economic case for ambitious levels of action.

Our research for the Global Commission on Economy and Climate has shown that economics need not be a barrier to ambitious climate action in cities. Such action in all of the world's cities would require approximately $1.0 trillion to be invested each year between 2015 and 2050. Critically, these investments would unlock a stream of net savings between 2015 and 2050 with a current value of $16.6 trillion. The wider co-benefits of urban climate action – relating, for example, to reduced air pollution and congestion and improved public health – could be more significant still, and we are currently working to evaluate these.

Through our Climate Smart Cities programme, we have translated the global case for climate action into detailed and specific low carbon plans for cities around the world (so far including China, India, Indonesia, Malaysia, Brazil, Peru, Rwanda, Canada and UK). Our work has provided city decision makers with an evidence base and a menu of options to develop fundable, deliverable low carbon action plans. We have explored the potential for new forms of governance such as the creation of city-scale Committees on Climate Change to share responsibility for climate action out across a city. We have also evaluated the contribution of new forms of finance and business models for delivering low carbon transitions, illustrating that revolving funds can radically reduce the cost and improve carbon effectiveness of different forms of investment.

- **Global investments in urban climate action of ~$1.0 trillion per year between 2015 and 2050 would unlock net savings with a current value of ~£16.6 trillion along with co-benefits such as improved air quality and public health.**
- **The Climate Smart Cities programme has provided city decision makers across the globe with an evidence base and a menu of options to develop fundable, deliverable low carbon action plans.**

Want to Know More?

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Exploring the economic case for climate action in cities, Global Environmental Change, 35, 93 – 105, 2015. http://eprints.whiterose.ac.uk/89495/

Low Carbon Cities: Is Ambitious Action Affordable?, Climatic Change, 138, 681 – 688, 2016. http://eprints.whiterose.ac.uk/104625/

75%

Amount of global energy use and greenhouse gas emissions cities are responsible for

Aerial view of Hong Kong (Photo: Cozyta, iStock)

How does local weather affect responses to climate change?

Communicating climate and weather risk

Combining expertise in behavioural decision making and climate change adaptation, Leeds researchers have determined the implications of different types of local weather on people's beliefs about climate change and their decisions about risk. This research is informing best practice in communicating climate change and weather risks to UK audiences.

Research conducted in the USA has found that higher than average local temperatures tend to correspond with greater concern about climate change. However, in temperate regions such as the UK people often have positive feelings towards hot weather. This raises questions as to whether (a) different types of weather inform beliefs about climate change and (b) positive feelings towards hot weather reduce concerns about its negative impacts.

Leeds research has shown that UK residents perceive wet weather to have become more common and hot weather to have become less common. When we examined changes in beliefs over 2013-2014, we found evidence for experiential reasoning, such that perceiving increases in wet weather over time, leads to stronger climate change belief. We also found evidence for motivated reasoning, such that UK residents with stronger climate change beliefs are more likely to perceive increases in both hot weather and wet weather.

UK residents' positive feelings about hot weather undermine their willingness to implement recommended heat protection behaviours such as avoiding the midday sun and drinking lots of liquids. Heat protection warnings have limited effect on heat protection behaviours because they evoke pleasant feelings about impending heat. Reminding UK residents of unpleasant aspects of hot weather (which most have experienced but do not think about when hot weather is expected) increases their willingness to implement the recommended heat protection behaviours.

- **Climate change communications that target UK audiences should not focus exclusively on changes in temperature, but also consider other impacts that are locally relevant (e.g. rainfall and flooding).**
- **When encouraging people to take steps to protect against weather risks that evoke positive feelings, stressing their unpleasant aspects may increase the likelihood of behaviour change.**

In the UK, rain leads to stronger beliefs about climate change

Brighton beach, South England (photo: William87, iStock)

Want to Know More?

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Climate Change Beliefs and Perceptions of Weather-Related Changes in the United Kingdom, Risk Analysis, 34, 1995 – 2004, 2014. http://eprints.whiterose.ac.uk/79820/

How do we decouple human wants and needs from energy?

Living Well Within Limits

What is the energy use required for universal human well-being? If climate change mitigation means significant decreases in energy use, how could this best be employed to enhance and preserve well-being? The Living Well Within Limits (LiLi) project combines approaches from environmental, engineering, economic and social sciences to seek empirical answers to these urgent questions.

The energy required for human satisfaction is not well understood

The connection between economic activity and energy / material use is well understood, whereas very little research has been carried out on the natural resource requirements of human well-being within those economies.

The LiLi project, funded by the Leverhulme Trust, views well-being through the lens of human need satisfaction, meaning that a finite of well-defined human needs can be satisfied in different ways, depending diverse social, cultural and technical arrangements. In turn, energy supply chains can be understood to contribute to need satisfaction through the energy services they deliver, allowing large efficiency potential to be explored.

Rather than assuming simple increasing relations between resource use and well-being, LiLi will connect human needs with different ways they can be satisfied, depending on infrastructure and technology. This allows for maximum decoupling of human needs from energy use to be explored, highlighting how well-being can be achieved within a climate-constrained economy.

The LiLi project focuses on:
(1) biophysical resource use (energy in particular);
(2) the social (e.g. markets, communities, culture) and physical (e.g. technology, infrastructure) provisioning systems which draw up on these resources as inputs; and
(3) the social outcomes which depend upon them in order to:

- **Estimate the energy service "baskets" required for human need satisfaction.**
- **Study the technological and social circumstances under which reducing energy use to mitigate climate change would be consistent with universal well-being.**

Want to Know More?

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Brand Correa, L. and J. K. Steinberger (2017). "A framework for decoupling human need satisfaction from energy use." Ecological Economics.

Photo: Hendrick van Leeuwen (CC)

How can literature inform a human-shaped future?

Understanding the relationship between culture and climate change

Climate change is not only experienced through weather, but also through different forms of representation such as art, nature writing, poetry, and fiction. Environmental humanities scholars at the University of Leeds have developed new insights into how culture can help us to understand climate change.

We are living in an epoch that many are calling the Anthropocene: a period of unprecedented human impacts on earth systems. Paradoxically, our developing awareness of humanity's power as a geological agent exists alongside a growing sense of our vulnerability to natural phenomena which our activities affect but which we cannot control. Research conducted at Leeds has revealed the cultural and political significance of the idea of the Anthropocene and the role of art, nature writing, poetry, and fiction in understanding how human beings shape and are shaped by a rapidly changing world.

The current environmental crisis is unprecedented, but we can still learn from historical experience. The AHRC-funded project British Romantic Writing and Environmental Catastrophe investigates how writers of the early nineteenth century responded to environmental change, and particularly to the weather disruption and the drop in global temperatures following the eruption of the Indonesian volcano Mount Tambora in 1815.

Romantic-period writers moved beyond conventional religious narratives of apocalypse to develop more complex engagements with climate change, ranging from bleak visions of human extinction to utopian fantasies of geoengineering. With remarkable prescience, their works investigate the entanglements of nature and culture that characterise the Anthropocene. This research has led to collaborations with the Wordsworth Trust and the Poetry Society that have given young people an opportunity to produce their own creative responses to climate change.

- **Climate change affects all spheres of human activity, including the creation of art and literature.**
- **Cultural forms play a vital role in showing how climate change affects and will affect our daily lives, as well as imagining new ways in which human agency might interact with environmental forces.**

Climate change

affects the creation of art and literature along with all spheres of human activity

Want to Know More?

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ENVIRONMENT

7 CLIMATE EXCHANGE SEMINARS

204 PEOPLE ATTENDED

2 GUEST SEMINARS

2 OTHER INTERNAL EVENTS

4 WORKSHOPS

10 E-BULLETINS

1 HACKATHON

REPUTATION

MEDIA COVERAGE

13 RADIO INTERVIEWS

10 PRESS RELEASES

270+ NEWS STORIES

PUBLICATIONS

2 VOLUMES RESEARCH BRIEFS

3 BOOKS

ONLINE – WEBSITE

91 NEWS STORIES

16 BLOGS

3,111 AVERAGE MONTHLY PAGE VIEWS

ONLINE - TWITTER

2,650 TWEETS

830 FOLLOWERS

8.3% PEAK MONTHLY ENGAGEMENT RATE

EXTERNAL EVENTS

5 LARGE SCALE EVENTS (100+)

1 EDUCATION WORKSHOP

2 CONFERENCES SPONSORED

PUBLIC OUTREACH

4 EVENTS

2 FILMS

POLICY

1 EUROPEAN POLICYMAKERS POLICY BRIEFING

13 ATTENDED UNFCCC CONFERENCES

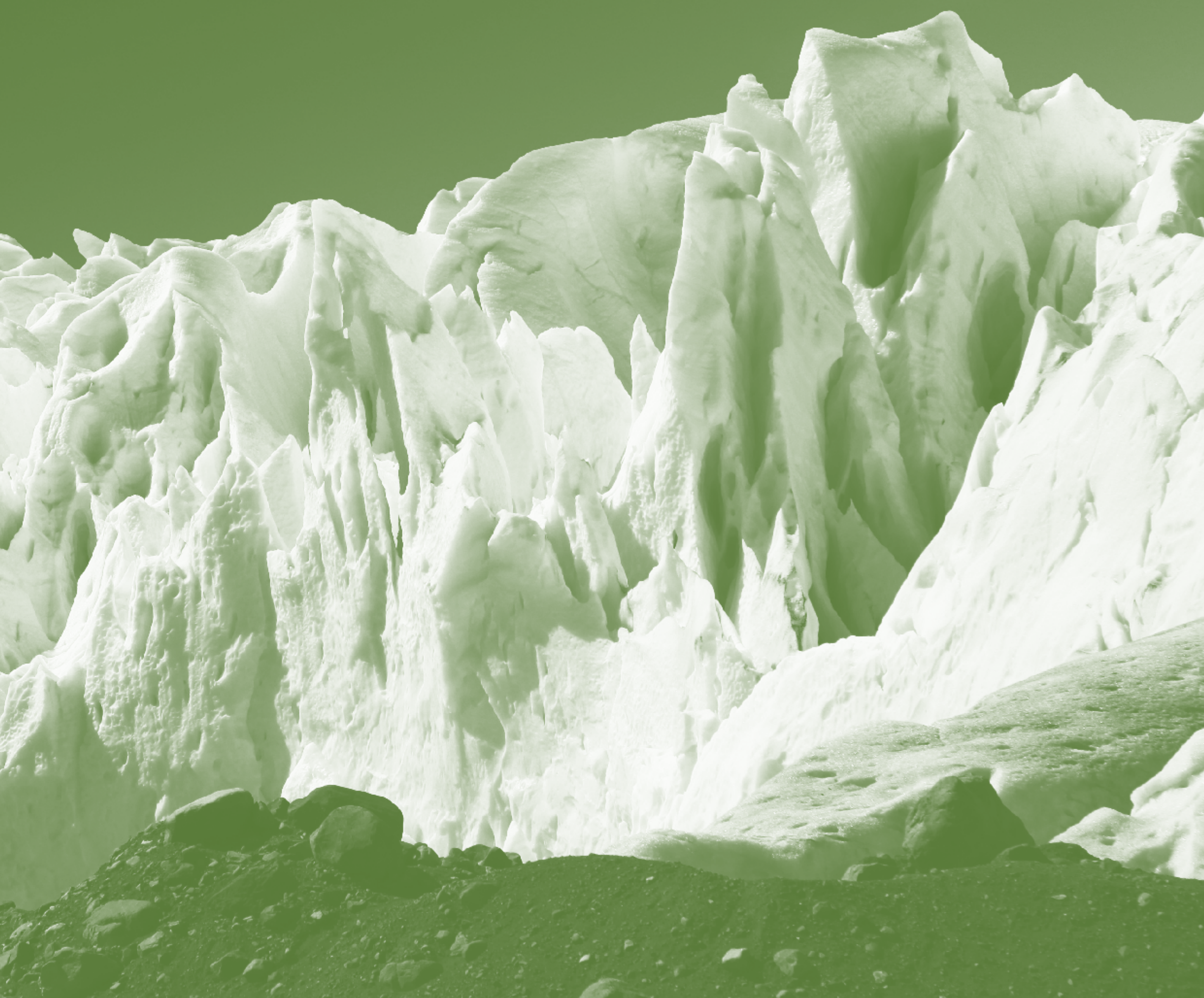
IPCC

2 LEAD AUTHORS IPCC SPECIAL REPORT 1.5 DEGREES

1 LEAD AUTHOR UK GOVERNMENT REPORT 2017

EXTERNAL COLLABORATIONS

LEEDS CITY COUNCIL / ODI LEEDS / MILL HILL CHAPEL, LEEDS / THE CLIMATE COALITION / FRIENDS OF THE EARTH / FUTURE EARTH / TYNDALL CENTRE / BBC LOOK NORTH WEATHER / CLIMATE-KIC / CICERO- OSLO / NCAS / MET OFFICE



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