

**Imperial College
London**

outlook 2014



Grantham Institute

Climate Change and the Environment

An institute of Imperial College London

FROM THE DEAN

Foreword

SINCE TAKING UP THE ROLE OF DEAN of the Faculty of Natural Sciences in 2008 I have watched the Grantham Institute grow and establish itself as a world class institute on climate change. 2014 has been one of its busiest years to date, with many exciting activities and changes taking place.

Imperial has decided to build on the success of the Institute by broadening the scope of the Grantham to encompass environmental science and engineering research from across the College, whilst still maintaining core strength in climate change research. To reflect this expansion the Institute will now be known as 'The Grantham Institute – Climate Change and the Environment'.

Many of you will also be aware that Professor Sir Brian Hoskins has retired as Director. Brian has led the Institute since early 2008 and it has been a pleasure to work with him over the past six years. He has contributed enormously to the external success of the Grantham Institute, whilst also building a vibrant community of academics and students spread across the College. We are fortunate that Brian will continue to be involved in the Institute and has taken up the position of Chair.

I am very pleased to introduce the two new Co-Directors of the Grantham Institute, Professor Joanna Haigh and Professor Martin Siegert. I am confident that under their leadership the Grantham Institute will continue to flourish and strengthen its reputation in both climate change and environmental research.

Professor Maggie Dallman
Dean of the Faculty of Natural Sciences

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Professor Maggie Dallman delivering the vote of thanks at the 2013 Grantham Annual Lecture

“ We are delighted that Imperial is broadening the scope of the Grantham Institute, whilst maintaining core strength in climate change research. We know that in the lead up to the UN Conference of Parties in Paris next year the Institute will play an important role in informing decision makers, both in the UK and internationally. We are at a crucial stage in the climate negotiations process where work such as that carried out by the Grantham Institute is needed more than ever.”

Jeremy and Hannelore Grantham

From the Co-Directors

WE ARE DELIGHTED TO BE TAKING up our new positions as Co-Directors of the Grantham Institute at such an exciting period in the Institute's development.

As the role of the Grantham Institute develops further it will build on its past successes. Over the last seven years the Grantham Institute has harnessed the tremendous research strengths across all faculties to deliver research which addresses a wide spectrum of climate-related issues, from fundamental understanding of climate processes to climate impacts and mitigation technologies and policies.

Imperial also has strong capabilities in research relating to both the natural and built environment. The expansion of the Grantham Institute will help to increase the impact and reach of environmental research, training and education at Imperial. The Institute will act as a window onto Imperial's environmental research, showcasing and supporting the work carried out by academics and students across the College, as well as developing new projects.

Education at the Grantham Institute is also expanding rapidly, and we are delighted to be involved in training the next generation of environmental experts and leaders. The Institute led the successful bid for a NERC funded Doctoral Training Partnership at Imperial, which will start in October 2014 with an intake of 28 PhD students in the first year. The Science and Solutions for a Changing Planet DTP will cover a wide range of research topics on climate change and the environment. We are also working to develop a Masters course in environmental change which will begin in October 2015.

We are excited to begin developing the Institute to extend its scope and look forward to getting to know our colleagues and collaborators at Imperial and elsewhere. We will be driving new partnerships across academia, policy and industry, and invite people to come forward with new ideas.

Professor Joanna Haigh and Professor Martin Siegert
Co-Directors, Grantham Institute

Meet the Co-Directors



Professor Joanna Haigh has moved to the Grantham Institute from the Department of Physics, where she was Head of Department since 2009. Jo's research focuses on solar radiation and variability and its links with climate. She was recently listed as one of the top 20 women making waves in the climate change debate.



Professor Martin Siegert has joined Imperial from the University of Bristol where he was Director of the Bristol Glaciology Centre. He was previously Head of the School of GeoSciences and Assistant Principal for Energy and Climate Change at the University of Edinburgh. Martin is a glaciologist specialising in the scientific exploration of Antarctica.

A year in the life of the Grantham Institute

MAY

Energy governance

Neil Hirst was invited to speak at the International Energy Forum organised by the Istanbul International Centre for Energy and Climate. Neil spoke on energy governance reform and climate change mitigation as part of a “Thought Leaders” panel which included senior officials from NGOs and business.



JUNE

Ecosystem impacts

Professor Colin Prentice hosted a workshop at Imperial on the impacts and risks of climate variability and change on terrestrial ecosystems, to mark the start of his new position as Chair in Biosphere and Climate Impacts, awarded by the AXA Research Fund. The workshop, held on 24 and 25 June, brought together leading climate scientists and ecosystems researchers to discuss topics ranging from food security to the role of land and ocean feedbacks on atmospheric carbon dioxide.



JULY

Past climates

A Nature Geoscience paper by Grantham student Carys Cook concluded that the East Antarctic ice sheet has been more sensitive to climate change in the past than

previously realised. This research on the level of glacial melting during the Pliocene Epoch may give us insights into how sea levels could rise as a consequence of current global warming.

2013

NOVEMBER

Fast action

The chance to keep global warming below the safe level of a 2°C increase is rapidly disappearing according to the 2013 Grantham Lecturer, Professor Thomas Stocker, co-chair of the Intergovernmental Panel on Climate Change Working Group I. In his talk on ‘Anthropocene: The Closing Doors of Climate Targets’, he presented an overview of how human activities since 1870 have changed the climate system and the need to reduce CO₂ emissions rapidly to limit mean global warming to a safe level.

DECEMBER

Energy markets

Jeremy Leggett, founder of SolarAid, visited Imperial to launch his book on The Energy of Nations. In his talk Leggett argued that major risks are being ignored in energy and financial markets, with bubbles continuing to inflate, but also outlined the road to reform.



JANUARY

Low-carbon solutions

The US Secretary of Energy, Dr Ernest Moniz, delivered a Grantham special lecture to a packed lecture theatre where he outlined current US energy policy and his thoughts on our ‘carbon constrained world’. He also met with energy experts from the Grantham Institute and elsewhere to discuss the challenges of providing sustainable energy.



AUGUST

India visit

Brian Hoskins was invited to India to deliver the Foundation Day Lecture at the Ministry of Earth Sciences in Delhi. Whilst in Delhi he also visited the British High Commission to give a talk on climate science and UK progress on climate change mitigation.



SEPTEMBER

Emission cuts

The Grantham Institute and the Energy Futures Lab at Imperial produced a joint report on the technologies and costs associated with halving global CO₂ emissions by 2050. The report concludes that reaching this target would cost \$2 trillion per year by 2050, which is about one per cent of the world's GDP.



OCTOBER

Climate commentary

In October the Grantham Institute started a blog called 'Climate at Imperial' which features insights from staff and students across Imperial working in climate related areas. Posts cover everything from recently published papers to opinions on the public discussion about climate change.



2014

december

january

february

march

april

FEBRUARY

Future cities

Simon Buckle was invited to participate in a UK-India workshop on Future Cities organised by the British High Commission in Delhi. His scene-setting talk focussed on the myriad challenges facing cities and how research and innovation could help address these. Simon also met with senior Indian academics and officials in Delhi for discussions on a range of climate issues.



MARCH

Arctic warning

Arctic sea ice has almost halved since measurements began in the late 1970. As a keynote speaker at the Economist Arctic Summit, Professor Brian Hoskins set out the scale of the problem and the potential impacts that changes in the Arctic might have on the climate system. He told attendees that the melting of ice in the Arctic was like 'the canary in the coal mines' and should be seen as a warning.



APRIL

Business impacts

In his speech for the 2014 Grantham Annual Lecture, Paul Polman, the CEO of Unilever, called on business leaders to improve their efforts to address climate change. Stating that the cost of inaction is starting to exceed the cost of action he stressed that adaptation would not be enough to protect businesses from the impacts of climate change.





Environment at Imperial

Ecosystems impacts of forest fragmentation

When forests are cleared for commercial purposes, it is usual for small forest fragments to remain behind. Forest edges and fragments have different characteristics from the rest of the forest; they tend to be warmer and dryer, with denser vegetation. Forest fragmentation often has a negative impact on biodiversity, as some species cannot live near to the forest edge. Others can become trapped in small forest fragments, unable to survive in the bright sunlit areas in between.

Researchers from Imperial involved in the SAFE (Stability of Altered Forest Ecosystems) project, led by Dr Rob Ewers of the Department of Life Sciences, are currently investigating forest fragmentation in Malaysian Borneo. The area of forest under study is being legally converted to palm oil plantations, providing an opportunity for scientists to study the effect of forest fragmentation on the biodiversity of the region. This is one of the world's largest ecological experiments, with the study site covering 8,000 hectares. Ewers hopes that the results will help guide the management and conservation of remaining rainforests in tropical Asia.

As well as researching the impacts on biodiversity, the project will also investigate the impact of agricultural development on the ecosystem's ability to absorb carbon dioxide, an important greenhouse gas.

Through links with the Grantham Institute, Ewers has now teamed up with Professor Ralf Toumi from the Department of Physics on a project predicting how microclimates in tropical forests respond to forest fragmentation and global climate change. The ability of a forest to buffer its microclimate from external changes is likely to be a key factor in determining the sensitivity of forest ecosystems to global climate change.

ENVIRONMENTAL RESEARCH AT IMPERIAL stretches across many departments, and covers everything from studying human health impacts of the environment to developing novel technologies for monitoring biodiversity.

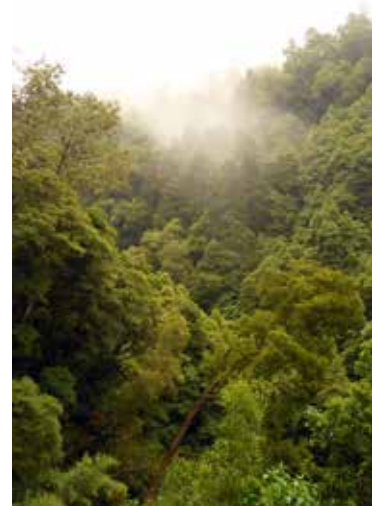
Research groups at Imperial are leading major international projects which are helping to significantly advance our knowledge on key environmental challenges, some of which are highlighted on these pages. Part of this research is already supported by the Grantham Institute. The Institute will continue to support these existing activities, whilst also engaging more widely with environmental research at Imperial and fostering new collaborations.

The Grantham Institute's strong cross-faculty network will help to develop new cross-disciplinary partnerships in environmental research.

Translating and communicating research findings is of great importance, and the Institute will work with academics to help them increase the impact of their research. The Grantham briefing paper series continues to be a successful way of translating research into outputs that are policy relevant and the series will expand to include more environmental topics, whilst still covering important climate science, impacts and mitigation issues.

Monitoring tropical forests with micro-robots

Forest microclimates are also the focus of a unique collaboration between the Department of Aeronautics, the Department of Life Sciences and the Natural History Museum, in which Imperial researchers are using robotic drones to monitor changes in the environment. Grantham PhD student Thomas Creedy is researching how impacts of climate change on tropical forest canopies might in turn impact the invertebrate communities living in this environment.



There is currently little knowledge about the microclimate conditions in the canopy and its effects on biodiversity, as methods for monitoring are difficult and time consuming. Creedy is working to develop new methods for placing sensors in the environment using flying micro-robots that are able to move freely through the canopy. He is also working on developing next-generation genomic identification techniques for large invertebrate samples to greatly reduce the time, effort and expertise barriers that currently limit such research.



Environment and human health

The Environment and Global Health research group, led by Professor Majid Ezzati, is researching the health effects of environmental risk factors, such as air pollution. The research group has conducted a number of large field studies on household fuel use, air pollution and health in Kenya, Ghana, The Gambia, and China. Recent and ongoing research has focused on testing alternative fuel-stove interventions for household air pollution under actual conditions of use; on the variations and sources of air pollution in urban neighbourhoods; and on modelling the future health benefits of air pollution interventions for infectious and non-communicable diseases.

Ezzati's group are also investigating how the number of heat and cold related deaths in the UK might change as a result of climate change. Warmer temperatures are expected to lead to an increase in the amount of heat-related illnesses and deaths due to increases in extreme high temperatures, as well as increases in the average temperature. The group are trying to understand how much these effects vary between communities, such as different districts in England and Wales, and what the reasons for this variation are. The hope is that this knowledge will help to identify vulnerable communities, and to develop ways of minimising the health impacts of heat extremes, both currently and in the future.

Environmental impact of wave and tidal renewable energy farms

As the wave and tidal renewable energy sector expands, large arrays of marine energy devices are likely to extend along many parts of the UK coastline. The impacts that such arrays might have on marine ecosystems and sediments on the sea floor have to be understood and predicted, with negative impacts mitigated as part of the array design.

Imperial researchers are part of a project which has received funding of £1 million from the Engineering and Physical Sciences Research Council to develop and exploit different (including open-source) numerical modelling approaches to investigate these potential impacts. In particular, 2D and 3D wave and tidal current models are being used to link the hydrodynamic changes caused by the installation of arrays with ecological models. This will allow the prediction of the impacts that installation may have on sea-bed habitats, plankton growth and fish communities. Dr Matt Piggott, a Grantham Reader in Ocean Modelling, is leading the hydrodynamics work package for this project.



Understanding climate change

THE LATEST REPORT ON THE PHYSICAL SCIENCE basis for climate change from the UN Intergovernmental Panel on Climate Change (IPCC) Working Group 1 (WG1) updates our knowledge of the broad field of climate change science. It concludes that limiting climate change will require “substantial and sustained” reductions of greenhouse gas emissions. “We are now more confident of the models’ ability to reproduce previous temperatures, which increases our confidence in the panel’s latest projections,” says Dr Flora MacTavish, of the Grantham Institute. Flora’s work as a science communication research analyst has involved taking detailed scientific information from the report and translating it into briefing notes for a policy and business audience. The topics covered by these Grantham notes include the carbon budget, sea level rise and the changing water cycle.

“This report significantly strengthens the consistent message from the four previous IPCC assessment reports: climate change is happening and we are conducting a dangerous experiment with our planet,” says the Institute’s Chair, Professor Sir Brian Hoskins.

The report’s new estimate is that the long-term increase in surface temperature, in response to a doubling of CO₂, is likely to be between 1.5 and 4.5°C. It has expressed these relationships in a way intended to be useful for policy makers: as a carbon dioxide budget.



Carbon dioxide budget

The report estimates that one trillion tonnes of carbon dioxide is the total amount that can be emitted if we are to have a good (66 per cent) chance of avoiding global warming of more than 2°C, relative to the period 1861-1880. About half of this amount had been emitted by 2011 and if we continue at current emissions rates, we will probably face warming of over 2°C around the middle of this century.

“Staying within the 2°C limit is a policy goal, and the half-trillion figure should provide a basis for discussion between different countries,” says MacTavish. “It will be challenging,” she adds.



Sea level rise

Published in 2013, the contribution of Working Group 1 to the Fifth Assessment Report contains other updates as well. Its projection of the probable rise in sea levels is more realistic than previous estimates because, for the first time, it includes the melting of ice sheets in Greenland and the Antarctic. These ice masses have been melting at a dramatically faster rate over the period 2002-2011 relative to 1992-2001.

The report gives various estimates of how much sea levels will rise during the period 2081-2100 compared to 1986-2005, depending on emissions levels. With no reduction in emissions the estimated mean rise is 62cm. The equivalent rise for the lowest feasible emissions scenario is 40cm.

“The lowest emissions scenario would require very strong mitigation, and would be a considerable challenge,” comments MacTavish.

The science report predicts that surface melting of the Greenland ice sheet is projected to exceed accumulation of ice for sufficiently large increases in global mean surface temperature, leading to ongoing decay of the ice sheet. Sustained warming would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea level rise of up to 7 metres. It is virtually certain that global mean sea level rise will continue for many centuries beyond 2100. Instability in the West Antarctic ice sheet is also a significant concern for future sea-level rise.



Energy budget

Since 1970, more energy has entered the Earth's system than has left it due to the effect of greenhouse gases in the atmosphere from human activity. Nearly all of the excess energy – 93 per cent - has gone into warming the sea. The rest has melted ice and warmed the continents and the atmosphere.

The energy budget is also influenced by volcanic eruptions, which cool the atmosphere, and by the natural variability of solar radiation. The energy imbalance has increased during the period 1993-2010 compared with 1971-2010.

Water cycle

The report also looks at the changes to the water cycle that will happen as a result of climate change. Globally, there is likely to be more intense rainstorms in mid latitudes, and also more intense precipitation over wet tropical regions, by the end of the century. There is an increasing risk of drought in dry places, for example the Mediterranean, Southern Africa and south-western USA, on the same time scale.



Surface temperature hiatus

Professor Sir Brian Hoskins is Chair of the Grantham Institute. One of the questions he is asked most often is why, in an era of climate change, is the Earth no warmer than it was in 1998?

“We knew 1998 would be a warm year because there was a big El Niño in the Pacific in 1997,” he says. This would normally be followed by a warm year in terms of global temperatures, and some cooler years would typically follow it.

There is always variation in the climate. “Volcanoes can emit reflective particles that cool the Earth, and the Sun's output can vary slightly over time. More importantly, there is natural variability which is internal to the atmosphere and the ocean, of which El Niño is an example,” he says.

On a short timescale, a pause like this is no surprise. “But if you look at a 50-year timescale,” Hoskins adds, “it is clear that the surface of the planet is warming steadily.” In the past decade there have been many localised weather extremes, including floods, record tropical cyclones, heat waves and even some very cold spells. The potential for more extreme weather will be a very important aspect of future climate change.

Global carbon cycle

Heather Graven has recently joined Imperial as a Grantham Lecturer in Climate Physics and Earth Observation. Her research examines the processes that put carbon dioxide into the atmosphere, and those that remove it.

She says, “Estimates of the amount of carbon going into the atmosphere come from economic sources such as oil consumption data.” Uncertainties in data on fossil fuel emissions add up to hundreds of millions of tonnes per year, and there is little independent data to verify the figures.

Graven takes a direct approach to this problem by measuring radioactive carbon (¹⁴C) in the air. As fossil fuels do not contain this isotope of the carbon atom, its abundance in atmospheric carbon is diluted by their use. Measurements of radioactive carbon in the atmosphere can therefore tell us how much carbon has been recently added by fossil fuel combustion.

Her work has also revealed changes in the saw-tooth shape of the graph of carbon dioxide in the atmosphere. While the concentration rises year on year, it falls a little in the northern hemisphere summer and rises again in winter. This is because plants are active in summer and decompose in winter. In recent decades, the dip has become about 50 per cent deeper, indicating that plants are exchanging more carbon as a result of rising carbon dioxide levels, warming temperatures and other environmental changes.





Avoiding dangerous climate change

The Institute provides the UK government with scientifically robust, policy-relevant evidence to inform the international policy discussions through the AVOID programme, which runs to early 2016. This is led by the Hadley Centre at the Met Office and funded by the UK Department of Energy & Climate Change. The programme explores issues such as: What levels of climate change are potentially dangerous? What emissions pathways will avoid “dangerous” climate change? And what is the feasibility of such pathways?

Buckle says: “The Grantham Institute is responsible for delivering the mitigation component of this programme. The work is led by Ajay Gambhir, drawing on energy modelling by Dr Adam Hawkes and Dr Tamaryn Napp and input from a range of experts from Imperial and elsewhere. The team will be using state-of-the-art energy system modelling to understand the feasibility and costs of different levels of emissions reduction.

“The Institute is also running the communications (led by Dr Simon Bailey) and external engagement for the entire programme, ensuring that we provide UK stakeholders with regular updates tailored to user needs and engage with officials and other organisations in key countries overseas on the scientific evidence,” concludes Buckle.



Responding to climate change

“WE ARE AT AN IMPORTANT JUNCTURE IN EFFORTS TO TACKLE CLIMATE CHANGE,” says Dr Simon Buckle, Director for Climate Policy at the Grantham Institute. “The Intergovernmental Panel on Climate Change launched three reports between September 2013 and April 2014. These make clear that a substantial and sustained decrease in greenhouse gas emissions will be necessary if we are to limit climate risks. They also show that the risk of serious impacts will increase the longer we delay that action, and that there are feasible ways to make a transition to a low-carbon, resilient economy at an affordable cost.

Following the 2008 financial crisis, shorter-term economic problems diverted leaders’ attention from the longer-term and potentially more serious risks from climate change. Nearly five years on, political attention is now refocusing on climate. “A positive development was the recent announcement by the United States Environment Protection Agency that it would introduce its clean power plan, which could cut carbon dioxide emissions from the power sector by 30 per cent below 2005 levels by 2030,” Buckle continues. “Similarly, China seems to be pressing ahead with concerted action, including several pilots of emissions-trading schemes.”

For its part, the European Commission has proposed - but Member States have yet to agree - a target of reducing greenhouse gas emissions by 40 per cent by 2030. The decision is likely to be taken in October and, Buckle notes, “The UK Government’s recent decision not to amend the Fourth Carbon Budget, covering UK emissions from 2023-27, is broadly in line with this level of ambition.” However, the UK and others face challenges in delivering on their commitments. Fossil-fuel related carbon dioxide emissions in some of the major European economies (for example Germany and France) have actually increased slightly in the last year or two, and globally carbon dioxide emissions continue to grow strongly.

International climate negotiations

The United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties to be held in Paris at the end of 2015 aims to reach a new agreement on global emissions reductions as well as host of other issues including adaptation, technology and finance.

The current process is for countries to make “bottom-up” contributions to emissions reductions in 2015, but there is no apparent mechanism to ensure that these would in aggregate be consistent with the long-term climate targets that governments are signed up to. “This”, says Buckle, “is a pretty fundamental problem. The negotiators tend to talk about an aspiration to achieve a carbon-neutral world in the second half of the century. While this is indeed a necessary condition for limiting climate risks, a more immediate problem is to control emissions over the next 10-20 years or so. Achieving a global peak in long-lived carbon dioxide emissions is an essential first step towards a long-term goal and could be achieved while still allowing emissions in parts of the developing world to grow for some time to come.”

“I would suggest that this is the moment at which political leaders need to give a clear commitment to achieving a peak in global carbon dioxide emissions, ideally before 2030,” he says.



Response from business

THE BUSINESS WORLD IS TAKING CLIMATE CHANGE SERIOUSLY.

“It is remarkable that, during the economic recession, the main area of global growth has been in green technology,” says Professor Richard Templer, Director of the Climate Knowledge Innovation Community UK. Climate-KIC, which the Grantham Institute helped to create, is Europe’s largest public-private innovation partnership focused on climate change.

“Our UK start-ups have been very successful in raising seed capital,” continues Templer. The Open Access Catastrophe Model (OASIS) brings to market state-of-the-art extreme weather event models so that insurers can price climate insurance accurately.

More companies are thinking about the risks climate change could pose to their businesses. Simon Buckle cites Unilever CEO Paul Polman’s call to action in the Institute’s 2014 Annual Lecture: ‘Left unchecked, climate change has the potential to become a significant barrier to our growth strategy, and that of just about every other company.’

“In February 2014, the Grantham Institute held a workshop in Atlanta, Georgia with colleagues from Georgia Tech, at which business, government, and research communities met to explore how climate science can inform adaptation decisions,” Buckle explains. Participants from organisations as different as Coca Cola, the UK Department for International Development, the World Bank, the United Nations, Swiss Re and the US National Institutes of Health outlined the complex challenges they faced.

“Improved climate models will help businesses think through complex risks and opportunities,” Buckle continues. “However, even the most advanced models are not yet able to forecast detailed information on patterns of regional variability with significant confidence. This means that other approaches to support decision making will be needed. For example, scenarios that capture a wide range of drivers of environmental change, and not just greenhouse gases; and more effective use of historical data about climate variability. Researchers will also need to make smarter use of climate models of different levels of complexity to identify what can be said robustly on the shorter timescales relevant to businesses.”



“ It is remarkable that, during the economic recession, the main area of global growth has been in green technology.”



Paul Polman, CEO of Unilever, speaking at the 2014 Grantham Annual Lecture

Building a low-carbon future

Pathways to a low-carbon future

GOVERNMENTS AND BUSINESSES ARE REALISING that climate change requires new approaches to industry and the economy. The Grantham Institute works with them to develop low-carbon technologies that are profitable as well as technically feasible.

This work is supported by Nilay Shah, a Professor of Process Systems Engineering at Imperial who cooperates closely with the Institute. He says: “Our work with businesses and governments is often concerned with the viability of certain technologies. When might they come on stream? At what cost? And what needs to be done to make them happen?” One example is a road map for the implementation of carbon capture and storage which Shah and colleagues helped to draw up for the UK Department of Energy and Climate Change.

It is possible, Shah says, to create energy systems that suck carbon dioxide out of the atmosphere rather than emitting it. One approach is to use bioenergy crops. They consume carbon dioxide as they grow, and the carbon dioxide emitted as they burn can be captured. Another is to turn carbon from biofuels into biochar, a solid form of carbon that can be added to poor soils to improve their productivity.

Shah adds: “The problem of climate change is so big that we shall need every approach to solving it, including nuclear power, biomass, renewables and carbon capture, as well as smarter buildings and vehicles. Carbon capture and storage is a good example of one solution. All the pieces needed for it to succeed already exist, but it will cost money to join them up.”

He says: “Everyone knows that we need these technologies, but the international negotiations on implementing are progressing slowly. That is why it is important for us to develop approaches that reduce emissions but which also save money, so they are attractive commercially as well as environmentally.”



Disruptive technologies

The New Climate Economy is the flagship project of the Global Commission on the Economy and Climate. It aims to provide evidence on the low-carbon technologies which can both strengthen economic performance and reduce the risk of dangerous climate change. Grantham’s involvement has led to six of our PhD students spending time at Stanford University working on widely differing projects. Here are just two examples.

Philip Sandwell has focused on Concentrating Photovoltaics (CPV). CPV arrays track the Sun across the sky and concentrate its light on a small area of photovoltaic material that generates electricity. If it works, efficiencies could be higher than for familiar flat-plate systems.

The flat-plate solar panels are made in huge volumes and their prices have fallen fast. But CPV already works more efficiently than flat-plate systems. If there are more installations, the optical and mechanical equipment involved will fall in price and improve in performance.

Sandwell says: “CPV tends to work best with bright, direct sunlight. One early use might be in mining projects in places such as Chile and Australia. Those sites are not on the power grid, but need a lot of electricity.”

His colleague Clementine Chambon explores ways in which the carbon dioxide produced by burning fossil fuels might be turned into an asset.

She explains: “Carbon dioxide can be used as raw material for fuels and plastics, or to grow algae which can be turned into biofuel.” This may lead to fuels whose use absorbs carbon dioxide instead of emitting it. Carbon dioxide can be used as raw material for the production of polyurethane, cutting out a step in the present process that involves highly toxic chemicals.

She says: “There is already a start-up business in Alabama making fuel from algae fed on waste carbon dioxide. Another in Texas produces high-value carbonates from carbon dioxide captured from a cement plant. Approaches such as this could potentially absorb billions of tonnes of carbon dioxide.”

Technology opportunities and barriers

Paul Fennell is Reader in Clean Energy at Imperial College London and a specialist in carbon capture and storage (CCS), the underground sequestration of carbon dioxide from the burning of fossil fuels.

His work with the Institute involves exploring the policy and economic reasons for the slow take up of CCS. As he sees it, “The pilot projects so far give us confidence that the technology works. And because the storage of carbon in the UK would mainly take place offshore, public objection is likely to be limited.”

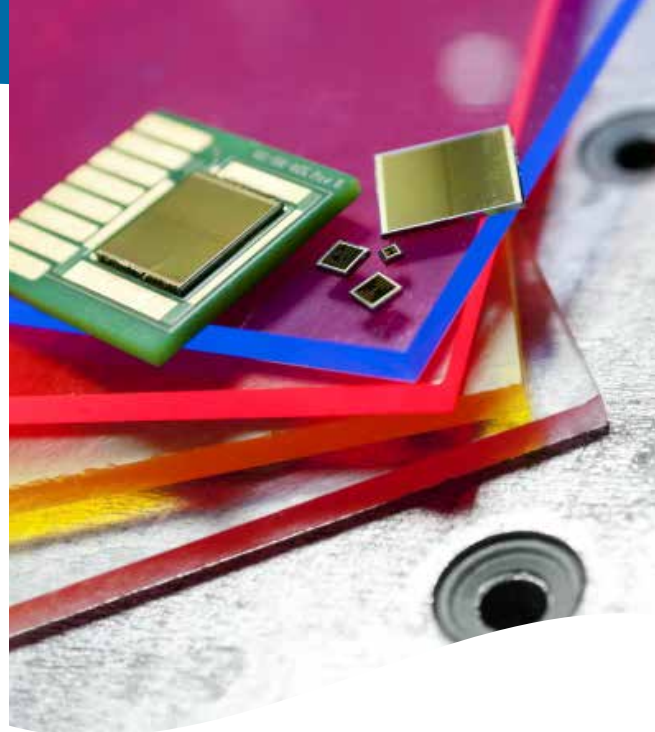
But he adds that the real importance of CCS has not yet been appreciated. “If you have dependable, low-carbon fossil fuel generation, it increases the amount of renewables you can have in the system.” This makes low-carbon electricity networks more feasible.

Jenny Nelson is looking at ways to reduce carbon emissions by replacing carbon-intensive electricity sources. As Professor of Physics at Imperial College London, she works with new materials for solar power. Today’s silicon cells for generating photovoltaic electricity have fallen rapidly in price, and solar power has become the fastest-growing electricity technology.



New materials could help to push the price even lower. But there are other green reasons for thinking beyond silicon. Nelson says: “Photovoltaic electricity generation has been growing worldwide at 30-40 per cent each year. But making the cells takes energy, which leads to carbon emissions. The panels have to run for some years before they produce more energy than they took to make. New types of panel, such as thin film PV modules, cost less energy to make and result in fewer carbon emissions per unit of solar electricity they generate.”

She says that it should be possible to supply about 20 per cent of grid electricity from renewable sources unproblematically. There have already been days on which up to half of Germany’s electricity has been generated by wind and solar power.



“ If you have dependable, low-carbon fossil fuel generation, it increases the amount of renewables you can have in the system.”





Training the next generation of researchers

AN AIM OF THE GRANTHAM INSTITUTE has always been to develop graduate students who have the depth of knowledge that comes from being associated with a strong academic department, but also have a wide breadth of knowledge on climate change and related issues as a result of their association with the Institute. Our recent success in winning funding from the Natural Environment Research Council (NERC), and additional private funding, has enabled us to extend our student training to encompass a wider appreciation of environmental challenges.

“ The SSCP’s five-year programme encapsulates much of what makes an Imperial education so great. Students will undertake cutting-edge research, engage with government and industry, and apply the fruits of their work for the benefit of our environment and society.”

Professor James Stirling
Provost of Imperial College London

In 2013, the Institute led a successful Imperial bid to host a NERC Doctoral Training Partnership on Science and Solutions for a Changing Planet (SSCP). This partnership of almost 30 public and private sector organisations will offer a new research and training experience to students. It will provide training and secondment opportunities that will address key skills shortages identified by NERC and increase students’ employability. Students will receive unique skills coaching in policy, regulation, and entrepreneurship from partners with business and government experience. Participating in secondment opportunities and cohort challenge teams will allow students to apply their research and skills to real-world situations.

The Institute has also supported the Department of Mathematics to win funding from EPSRC for a Centre for Doctoral Training (CDT), in association with the University of Reading. This CDT on ‘Mathematics of Planet Earth’ will train students in mathematical sciences for weather, oceans and climate research.

The Institute has also been fortunate to receive funding from the Kristian Gerhard Jebsen Foundation, which has supported the creation of five new PhD scholarships in the field of ocean research. Recipients of the scholarships will study the melting of the Antarctic ice sheet, ocean-atmosphere interactions, and marine ecology, all with a focus on oceans in the Polar Regions, with potential to generate societal, business and policy impacts. Researchers at Imperial are already working in many of areas of ocean research, and the scholarships will accelerate this work and forge new multidisciplinary relationships between academics in the departments of Earth Sciences and Engineering, Life Sciences, and Physics.

Our innovative PhD programmes will train and inspire a new generation of environmental experts and leaders who will tackle some of the toughest challenges of our time. Students will be provided with the skillsets and experiences required to become future scientific leaders in academia, business and policy.



Congratulations

We would like to congratulate all our students who have completed their studies in the last year, successfully gaining their doctorates and moving on:

Dr Sadia Ahmed: Postdoctoral researcher at the Microsoft Computational Sciences lab

Dr James McNamara: Research Fellow at the Centre of Excellence for Environmental Decisions, University of Queensland

Dr Juan Duan: Working in hydrology and flood risk assessment at CH2M HILL

Outreach

GRANTHAM PHD STUDENTS ARE ACTIVE IN INFORMING UK CLIMATE POLICY, and in communicating their knowledge to the public.



SCIENCE ON A SPHERE

Most people in London regard the desert dust storms that periodically spread a brown layer of murk across cars and buildings as a nuisance. But they fascinate Sian Williams, whose PhD in atmospheric physics concerns airborne dust and its role in climate change.

She and fellow PhD student Christina Newinger showcased the importance of dust at Science Museum Lates, a series of evening sessions for an adult audience. The Museum has a large floating globe on which data about the environment, such as atmospheric storms and ocean temperatures, can be projected, making for a spectacular show.

Williams says: “We know that atmospheric dust is a factor in climate change, affecting how much heat reaches the Earth’s surface and how much is returned back into space. It is also involved in cloud formation and is an important fertilizer. There could be more dust in future if there are more dry areas of the Earth and if vegetation patterns change.”

INFORMING PARLIAMENT

Grantham Institute PhD student Christoph Mazur has been inside the political machine with a three-month fellowship at POST, the Parliamentary Office of Science and Technology.

His task was to research and write a “POST Note” on demand-side approaches to electricity use. This involved interviewing some 25 experts from industry, academia, NGOs and the policy world about the potential for shifting the timing of electricity demand through the day.

This field is topical because of concern about “keeping the lights on” and about how much renewable electricity the UK grid can accommodate. Demand-side approaches might defer £1 billion in electricity system investment, save 10 per cent of running costs, and allow more renewables to be used.

Producing a POST Note is a rigorous process as the 25 interviewees, plus additional experts, all get to review it. As Mazur says, “This is more refereeing than any scientific paper would get.”



Dr Áine Ní Bhreasail: Working as a geotechnical engineer at Arup

Dr Carys Cook: Postdoctoral researcher at University of Florida, Gainesville

Dr Clemens Lorf: Specialist consultant on product development at McKinsey

Dr Isabel Rosa: Biostatistician for Bio3, a biodiversity consultancy

Dr Nicolo Daina: Postdoctoral researcher at Imperial College London



Grantham Institute – Climate Change and the Environment

The Grantham Institute is committed to driving research on climate and the environment, translating this into impacts and communicating our knowledge to help shape decision-making. The Institute is integrating researchers and capabilities from all areas of the College necessary to tackle the challenges of climate change and the environment, through which we will work to offer practical scientific and technical knowledge of the highest quality.

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About Imperial College London

As the only UK university to focus entirely on science, technology, engineering, medicine and business, Imperial College London offers a critical mass of international research expertise and a vibrant home for innovation and enterprise. Imperial is committed to making sure that its research improves quality of life and the environment.

Sustained support for Imperial's climate change research is a sound investment in environmental improvement, and in developing the next generation of climate change pioneers, researchers, innovators and entrepreneurs.

Climate change and the environment regularly feature on Imperial's home page at www.imperial.ac.uk, which is visited by over 1 million people each month.

