Activities with Countries
United Kingdom

UK national interests are integrally connected to complex global systems that impinge on the country, its economy, and its people. Systems analysis is one of the few research tools that has the breadth and depth to explore complex problems across multiple sectors, regions, and timeframes. Current collaborations between IIASA and the UK are enhancing UK expertise in developing and applying systems analysis especially integrated assessment models. Establishing multinational and multidisciplinary teams of researchers is a key building block in IIASA's work and many productive partnerships exist between IIASA and UK researchers as this Info Sheet shows. Prospects for future IIASA-UK collaborations include developing bespoke UK versions of IIASA's global models, conducting international assessments in areas of UK strategic interest, partnering with UK institutions to win international research grants, and contributing to UK science diplomacy. This Info Sheet provides a summary of current interactions between the UK and IIASA since 2008 and the prospects for enhancing joint activities.

Highlights of Interactions Between IIASA and United Kingdom

Former Membership of IIASA	UK membership of IIASA, via the Royal Society but funded by the then Department of Environment, ran from 1972 to 1982
Selected research partners	57 UK organizations have recently collaborated with IIASA including: ■ Centre for Ecology and Hydrology (CEH) ■ Department for International Development (DFID) ■ Government Office for Science ■ Imperial College London ■ London School of Economics and Political Science (LSE) ■ Met Office ■ Office of National Statistics (ONS) ■ Tyndall Centre for Climate Change Research ■ University College London (UCL) ■ University of Oxford
Areas of research collaboration	■ Enhancing UK expertise in developing integrated assessment models ■ Enhancing UK expertise in applying integrated assessment models ■ Working with the UK to analyze and project the future ■ Smarter ways to manage development ■ Feeding a future global population of 9 billion ■ Advancing the research methods of systems analysis
Scientific exchange	■ Over 340 UK nationals have participated in IIASA events; over 150 researchers from the UK have visited IIASA; while IIASA scientists have visited the UK over 400 times ■ On average 20 UK nationals have been employed by IIASA every year
Joint research grants	■ Between 2006 and 2013, IIASA almost doubled its income by winning research grants that amounted to €62.5 million—22% of which funded projects with 27 UK and other research partners
Publication output	■ 186 journal articles and books have resulted from research collaborations between IIASA and UK scientists

Activities with Countries: United Kingdom

IIASA Info Sheets provide succinct summaries of IIASA activities.
They do not necessarily reflect the views of IIASA staff, visitors,
or National Member Organizations.

This Info Sheet summarizes IIASA's recent interactions with the United Kingdom.
It includes highlights with links to further information but is
not meant to be a comprehensive report on all interactions.

Feedback and updates are encouraged and should be sent to Iain Stewart.

Highlights of Recent Research Collaborations

Enhancing UK expertise in developing integrated assessment models

UK national interests are integrally connected to complex global systems that impinge on the country's economy, energy systems, and climate, among others. IIASA's recent collaborations with UK researchers and institutions are improving integrated assessment modeling and thereby contributing to the UK's strategic research base through enhancing modeling knowledge and skills. Integrated assessment models are one of the few research tools that enable researchers to analyze highly complex and interconnected global problems and test the impact, including negative side effects, of different national policies.

Collaborations between IIASA and UK researchers are advancing expertise in the development and application of integrated assessment modeling in the UK

Recent collaborations to improve integrated assessment modeling include:

- The UK is a party to the Convention on Long-Range Transboundary Air Pollution—one of the first international environmental treaties that has helped Europe slash air pollution. At the centre of the treaty is IIASA's GAINS model, an integrated assessment model that identifies the most cost-effective measures to reduce air pollutants and greenhouse gas emissions. The Convention, through its Network for Integrated Assessment Modeling (NIAM), has encouraged parties to collaborate with IIASA and develop their own national integrated assessment models as a means to enhance national activities to cut air pollutants. Imperial College London is part of NIAM and has collaborated with the GAINS team to establish a UK integrated assessment model to analyze measures to tackle air pollution. In addition, the GAINS team regularly consults with Defra to ensure its model uses the best data for the UK.

- The UK's Tyndall Centre, University College London (UCL) and the University of Cambridge are members of the Integrated Assessment Modeling Consortium (IAMC), which is coordinated by IIASA and partners in Japan and the US. IAMC is a consortium of scientific research organizations that facilitates and fosters the development of integrated assessment models. Recent IAMC work for the climate change research community involved in the IPCC's Fifth Assessment Report includes: (1) the Representative Concentration Pathways (RCP) database that provides greenhouse gas emission and other projections (see box: IIASA's global contribution, page 10), and (2) the Shared Socio-economic Pathways that facilitate the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation.

- Similarly, CSERGE at UCL, Cambridge University, London Business School, and Oxford Economic Forecasting are members of the Energy Modeling Forum (EMF) at the University of Stanford, where IIASA is also a leading partner. EMF helps its partners to learn from state of the art developments in energy and integrated assessment modeling.

Some leading UK personalities from government and academia who are associated with IIASA (recent and past)

Recent

Professor **Brian Collins** served as Chief Scientific Advisor to two government Departments (Transport 2006-11; Business Innovation and Skills 2009-11) and is currently Director, Centre of Engineering Policy at University College London. He has recently partnered with IIASA to host the International Symposium for Next Generation Infrastructure at IIASA in September 2014.

Peter Cox, a Professor of Climate System Dynamics at the University of Exeter, has collaborated with IIASA on research ranging from abrupt global change to ozone levels. Until September 2006 he was the Science Director of Climate Change at the Centre for Ecology and Hydrology and prior to that he was at the Hadley Centre.

Lord Deben is Chair of the UK Committee on Climate Change, which recently invited IIASA to present the cost savings and co-benefits of integrating policies to tackle both air pollution and greenhouse gas emissions.

Professor **David Fisk**, Director of the Laing O'Rourke Centre for Systems Engineering and Innovation at Imperial College London and former Chief Scientific Adviser to the Office of the Deputy Prime Minister, recently collaborated with IIASA on the Global Energy Assessment and subsequently urban energy.

Professor **David Fowler** FRS of NERC's Centre for Ecology & Hydrology collaborates with IIASA's air pollution experts on measures to reduce short-lived climate pollutants.

Professor **David Grey** of the School of Geography and the Environment at the University of Oxford is the Project Director for IIASA's new Water Futures and Solutions initiative.

Professor **Jim Hall** is Director of the Environmental Change Institute at the University of Oxford. He is collaborating with and advising upon IIASA's growing water systems program. He also collaborates with analysts at IIASA working on risk analysis and the insurance sector.

Professor **Sarah Harper** of Oxford University and Director of the Oxford Institute of Population Ageing has recently collaborated with IIASA's demographers on a new set of world population projections to be published by Oxford University Press in summer 2014.

Professor **Sir Brian Hoskins** CBE FRS became the first Director of the Grantham Institute for Climate Change (GICC) at Imperial College London in January 2008, and now shares his time between Imperial and the University of Reading, where he is Professor of Meteorology. Most recently, GICC has collaborated with IIASA on the AVOID project (see page 5).

Professor **Sir Chris Llewellyn Smith**, formerly Director General of CERN (European Organization for Nuclear Research) and is currently President SESAME Council (Synchrotron-light for Experimental Science and Applications in the Middle East) is a visitor and supporter of IIASA.

Prof **Julia Slingo** OBE is the Met Office Chief Scientist. She is a former President of the Royal Meteorological Society and Director of Climate Research in NERC's National Centre for Atmospheric Science at the University of Reading, where she is Professor of Meteorology. Current joint studies between IIASA and the Met Office include three EU-funded projects: AMPERE, ECLIPSE and IMPACT2C.

Professor **Jim Watson** of the University of Sussex worked with IIASA on the Global Energy Assessment and is Research Director at the UK Energy Research Centre, where IIASA Program Director, Professor Arnulf Grubler serves on the advisory board.

Past

Professor **Sir John Beddington** CMG, FRS of Imperial College London, was previously the UK Government Chief Scientific Adviser (2008-13). IIASA researchers contributed to several Foresight studies initiated by Beddington (see page 6), who also gave an IIASA Koopmans Lecture in Vienna in 2008.

Professor **Sir Gordon Conway**, former Vice-Chancellor of the University of Sussex and Chief Scientific Advisor to the Department for International Development, is now Professor of International Development at Imperial College. He worked at IIASA in the 1970s on the systems analysis of pest management, work which he then continued as an active collaborator.

Professor **Mike Hulme** is Professor of Climate and Culture at King's College London and collaborated closely with IIASA's risks experts on the EU-funded ADAM project, which he led.

Professor **Martin Parry** of Imperial College London and former Co-Chair of Working Group II of the Intergovernmental Panel on Climate Change (IPCC), led the Climate Change Project at IIASA from 1982 to 1985 and has collaborated with IIASA ever since.

Professor **Iain Colin Prentice**, who chairs the 'AXA Programme in Biosphere and Climate Impacts' at Imperial College London, was a research fellow at IIASA in the late 1980s and early 1990s and is a long-term collaborator with IIASA.

Lord Rees, President of the Royal Society from 2005 to 2010, gave the second lecture in the IIASA and Austrian Academy of Sciences public lecture series in 2013.

Professor **Sir Adrian Smith**, FRS, Vice-Chancellor of the University of London, has been Director General of Science and Research at the UK Government's Department for Business, Innovation and Skills; and head of the mathematics department at Imperial College. He was a regular visitor to IIASA at its inception.

Lord Stern is President of the British Academy and Professor at the London School of Economics. Collaborations with IIASA include input from the Institute's researchers into the Stern Review on the Economics of Climate Change.

Enhancing UK expertise in applying integrated assessment models

Integrated assessment models can identify policies that have benefits on multiple sectors and regions, and avoid policies that lead to negative side effects. For example, the GAINS model explores the synergies and interactions between climate change, air quality and other policy objectives. This was further advanced as part of a six year EU-funded study (EC4MACS), coordinated by IIASA and including UK partners, Ricardo-AEA and MetroEconomica.

Collaborations between IIASA and UK researchers have focused on applying integrated assessment modeling to provide insights and options for policy makers

Other joint studies with the UK using the GAINS model have included:

- Various collaborations with NERC's Centre for Ecology & Hydrology (CEH) on how to reduce emissions of nitrous oxide (N_2O)—now the most significant ozone-depleting substance emission and the third most important greenhouse gas released into the atmosphere. Joint activities included the European Nitrogen Assessment (2013), the EU-funded projects NitroEurope (2006-11) and ECLAIRE (2011-15), and collaboration on the UNEP Synthesis Report "Drawing Down N_2O to Protect Climate and the Ozone Layer (2013)"

- Research with CEH, King's College London, the Stockholm Environment Institute in York, and various US institutions among others identified strategies to reduce short-lived climate pollutants, methane and black carbon, and was published in *Science* (2012).The integrated approach identified measures that would simultaneously increase human wellbeing through reduced local air pollution, increase security of food and energy supply, and lower water demand. In many cases, these measures would also result in more efficient energy use and thereby also reduce emissions of long-lived greenhouse gases.

- This 2012 *Science* study provided the intellectual underpinnings for the then US Secretary of State Hillary Clinton to launch the Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants in 2012. It was the first international effort to treat these pollutants as a collective challenge. By March 2014, it had 35 member countries, including the UK, committed to taking action on short-lived climate pollutants.

- Other collaborations on short-lived climate pollutants include (1) research with the Met Office and the University of Reading as part of the EU-funded ECLIPSE project (2011-14), and (2) a 2010 study published in *Nature Geoscience* with researchers from the University of Edinburgh.

- Working with the Royal Society to author its report on "Ground-level ozone in the 21st century: Future trends, impacts and policy implications." (2008)

- In 2014, a new collaboration with King's College London, among other partners, has begun to explore the socio-economic implications of individual responses to air pollution policies in the EU as part of the EU-funded SEFIRA project.

Other collaborations in applying integrated assessment models have used IIASA's MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) model which aids medium- to long-term energy system planning, energy policy analysis, and scenario development. These include:

- In 2011, IIASA and the Imperial College London's Grantham Institute for Climate Change jointly studied low-carbon transition technologies and policies for China to 2050 as part of the AVOID research program. This provides advice to the UK Government (DECC and Defra) on avoiding dangerous climate change. The collaboration has been renewed in 2014 to research the feasibility of global and regional mitigation pathways as part of the second phase of AVOID to inform international policy discussions, leading up to the UN Climate Change conference in Paris in 2015.

- IIASA's energy experts are working with the London School of Economics' Grantham Research Institute on Climate Change and other global partners to carry out a rigorous assessment of what a stringent climate policy entails, and what is needed to overcome major impediments as part of the EU-funded project, LIMITS (2011-14).

- Another EU-funded project, AMPERE, (which finishes in 2014), explored mitigation pathways and associated mitigation costs under real-world limitations and offered insights into the differences across models and the relation to historical trends. IIASA, the UK's Met Office and 19 other international partners are part of the project's consortium.

- University College London is working with IIASA in the EU-funded project, ADVANCE. This started in 2013 and aims to develop a new generation of integrated assessment models for the analysis of climate change mitigation policies.
- Collaborations with multiple UK researchers also took place via the Intergovernmental Panel on Climate Change with IIASA and UK researchers working closely together in the Working Group III of the Fifth Assessment Report on Chapter 7 on energy systems and the summary for policy makers.

Example publications resulting from IIASA-UK collaborations

IIASA's work is underpinned by high-quality science, which is regularly published in high impact publications. Some examples of current publications are presented here and a full list can be found in appendix 5:

Fowler D, Coyle M, Skiba U, Sutton MA, Cape JN, Reis S, Sheppard LJ, Jenkins A, Grizzetti B, Galloway JN, Vitousek P, Leach A, Bouwman AF, Butterbach-Bahl K, Dentener F, Stevenson D, Amann M, Voss M. (2013). The global nitrogen cycle in the twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences* 368 (1621).

Feng K, Davis SJ, Sun L, Li X, Guan D, Liu W, Liu Z, Hubacek K. (2013). Outsourcing CO_2 within China. *Proceedings of the National Academy of Sciences of the United States of America* 110 (28) pp, 11654-11659.

Mechler R, Bouwer LM, Linnerooth-Bayer J, Hochrainer-Stigler S, Aerts JC, Surminski S, Williges K. (2014). Managing unnatural disaster risk from climate extremes. *Nature Climate Change* 4 (4) pp, 235-237.

Reichstein M, Bahn M, Ciais P, Frank D, Mahecha MD, Seneviratne SI, Zscheischler J, Beer C, Buchmann N, Frank DC, Papale D, Rammig A, Smith P, Thonicke K, Van Der Velde M, Vicca S, Walz A, Wattenbach M. (2013). Climate extremes and the carbon cycle. *Nature* 500 (7462) pp, 287-295.

Shindell D, Kuylenstierna JCI, Vignati E, Van Dingenen R, Amann M, Klimont Z, Anenberg SC, Muller N, Janssens-Maenhout G, Raes F, Schwartz J, Faluvegi G, Pozzoli L, Kupiainen K, Höglund-Isaksson L, Emberson L, Streets D, Ramanathan V, Hicks K, Oanh NTK, Milly G, Williams M, Demkine V, Fowler D. (2012). Simultaneously mitigating near-term climate change and improving human health and food security. *Science* 335 (6065) pp, 183-189.

Working with the UK to analyze and project the future

IIASA researchers have helped the UK analyze its future through contributions to multiple UK Government's Foresight projects and by providing independent projections of the UK's future population

The UK's Government Office for Science has regularly conducted foresight studies into complex and pressing issues to provide strategic input to UK policies. IIASA researchers have often been asked to contribute their expertise due to the increasing global and interconnected nature of these challenges. Ten IIASA researchers have contributed to the following foresight studies:

- Future of Cities (current project)
- Reducing Risks of Future Disasters: Priorities for decision makers (2012)
- Migration and Global Environmental Change: Future challenges and opportunities (2011)
- The Future of Food and Farming: Challenges and choices for global sustainability (2011)

Foresight methods were also used in a Scottish Government funded study by IIASA researchers to explore the vulnerability of Scotland to sudden changes in complex socio-economic systems.

Understanding a country's changing population and analyzing its future size and composition provides crucial input to government policy. IIASA's demographers do precisely this and produce one of the few independent alternatives to the demographic projections of the UN Population Division. As a testament to the quality of IIASA's demography, the UK's Office of National Statistics has been using IIASA's methods to redefine the assumptions that sit behind its UK population projections and to produce the first probabilistic population projections for the UK.

IIASA was established in 1972 to use scientific cooperation to build bridges across the Cold War divide and research growing global problems on a truly international scale. Today the soft power of science diplomacy continues to help IIASA's member countries through using scientific cooperation to improve international relations, and through international teams jointly researching controversial issues to find consensus such as through integrative assessments of the future for the Arctic or of economic integration of Eurasia.

For example, a new IIASA project has brought together economists, mathematicians and modelers to analyze the challenges and potential benefits of economic cooperation and integration "from Lisbon to Vladivostok." Despite the current tense political situation between Europe, Russia, Ukraine and the US, researchers from all these countries, including the UK, have come together at IIASA to conduct a comprehensive, independent analysis of the prospects for Eurasian integration.

Today IIASA also maintains its original bridge-building objective through attracting member countries that represent a range of geo-political interests. For instance, both Russia and the US are members; as are Brazil, China, India, and South Africa. The future of the Arctic is of great interest to Finland, Norway, Russia, and Sweden which are all member countries. The growing economic significance of the countries bordering the Pacific is reflected through IIASA members: Australia, China, Indonesia, Japan, Malaysia, Russia, South Korea, United States, and Vietnam. Several key factors also unite all IIASA member countries: their interest in systems analysis, scientific and academic infrastructure, economic stability and the geopolitical role in future global transitions. With this in mind, IIASA is also negotiating membership with countries in the Middle East (Qatar, Saudi Arabia, Turkey) and has discussed with IIASA Council the opening of negotiations with Iran and Israel.

Research to support science diplomacy

The Institute's interdisciplinary setting has encouraged its demographers to research beyond the traditional boundaries of demography and to explore how changes in society, economy, and the natural environment influence the health and mortality, migratory patterns, and reproductive behavior of human society.

A recent innovative example of this broader approach has been the development of research methods, in collaboration with researchers from the University of Oxford, to project population by level of education. This equips researchers with the tools to explore the implications of different education policies on a country's future fertility, life expectancy, migration, and population level as well as economic growth and ability to adapt to climate change. In 2014 IIASA will publish the first projections of educational attainment by age and sex for 195 countries with *Oxford University Press*. Findings for the UK show how different policies over the next few decades could lead to the country's 2010 population of 62 million rising to 81.7 million by 2060 or remaining close to 62 million.

Other population studies related to the UK include:

- A joint project between IIASA and the University of Oxford explored very long range global population scenarios to 2300. In 2013, they found that in contrast to Malthusian disaster scenarios, there is a distinct possibility of significant population shrinking associated with increasing life expectancy and human well-being.

- A six-year study (2009-15) funded by the EU is using demographic techniques to project changes to people's skills, productivity, attitudes and beliefs in Europe over the coming decades. Another EU-funded project (2013-18) is developing new demographic tools to study aging and its impact on European pension and health systems.

- IIASA demographers have regularly contributed to a range of UK events including: a workshop of leading statisticians discussed establishing a world statistical agency at the Oxford Martin School in 2014; a high-level population workshop in 2013 at St John's College, Oxford; the annual conference of the Royal Statistical Society in 2008; and a Royal Society discussion on population and the planet in 2012.

■ In 2011, IIASA's demographers assembled a global panel of experts, including Partha DasGupta of Cambridge University, and David King of the University of Oxford. Together, they issued the Laxenburg Declaration which outlined the demographic challenges for sustainable development and was subsequently published in *Science.*

IIASA working with business

Business can benefit from science through the analysis and knowledge it provides. In turn, science can benefit from business through its experience on the ground and in implementation. IIASA also recognizes that closer collaboration between business and its researchers can increase the impact of the Institute's work. Not surprisingly, IIASA is seeing a growing number of contracts with commercial partners, including:

■ The global insurer, **Zurich Insurance Group**, began working with IIASA in 2013 to identify and address research gaps on flood resilience and community based disaster risk reduction, demonstrate the benefits of pre-event risk reduction over post-event disaster relief and to improve public dialogue around disaster resilience. Partners include Practical Action, UK.

■ The UK office of the multinational consumer goods company, **Unilever**, funded IIASA's agricultural experts from 2008-10 to analyze yields and land suitability of key agricultural crops under a changing climate.

■ The German carmaker, **Daimler AG,** is collaborating with IIASA researchers to assess biofuel potential from marginal and degraded lands in India and Brazil.

■ The Brazilian energy company, **Petrolero Brasileiro**, was one of nineteen sponsors of IIASA's Global Energy Assessment.

■ The research institute of the Japanese carmaker, **Toyota**, has an ongoing collaboration with IIASA to research measures to reduce ozone emissions in Asia.

Other interactions with business include analyzing risk culture and modeling risk in the insurance industry; researching on the regulation of the financial sector with the Pension Insurance Corporation; and researching with UK National Grid and other partners how to expand the European electricity grid to integrate a growing share of electricity from renewable sources as part of the EU-funded BESTGRID project (2013-15). In addition, IIASA is exploring ways that it can work more closely with multinational corporations, including Anglo-Dutch corporations Unilever and Shell, particularly through input to the development of their global sustainable business plans.

Smarter ways to manage development

Findings from collaborations between IIASA and UK researchers are improving disaster risk management

Studies have assessed ways to improve proactive disaster risk management through:

■ Improving financial disaster risk management via the development of IIASA's CATSIM model, which has helped countries, including Madagascar and Mexico, to prepare public finances to fund rescue, recovery and re-building in case of major natural disaster. Recently CATSIM was used as part of a DFID review of government insurance schemes in the Caribbean (2012-13), and in the EU-funded MEDIATION project (2011-15) which involved IIASA and nine research partners including the Oxford office of the Stockholm Environment Institute.

■ Developing, applying and evaluating pro-active disaster risk management strategies in disaster prone developing countries (India, Nepal and Pakistan) as part of the DFID-funded From Risk to Resilience project (2006-09).

■ Improving landslide risk assessment and management tools as part of the EU-funded Safelands project (2009-12) which included King's College London and TRL Ltd as research partners.

■ Enhancing society's resilience to catastrophic natural hazards through developing new multi-sector partnerships to reduce or redistribute risk as part of the EU-funded ENHANCE project (2012-16) and including UK partners at London School of Economics and the University of Oxford.

- Developing methods to economically appraise different climate change adaptation actions, including the management of extreme weather events, as part of the EU-funded ECONADAPT project (2013-16) with the University of Bath, University of East Anglia and Paul Watkiss Associates among other partners.
- Researchers from IIASA and the Overseas Development Institute also collaborated on the IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2012).

International assessments at IIASA
Case study: Global Energy Assessment

The UK was a significant contributor to the Global Energy Assessment (GEA) from 2006-12, and subsequent IIASA-UK collaborations have developed in the areas of urban energy and energy technology innovation. The GEA, published in 2012, defined a new global energy policy agenda—one that transforms the way society thinks about, uses, and delivers energy. Coordinated by IIASA and involving over 500 specialists from a range of disciplines, industry groups, and policy areas, GEA research aims to facilitate equitable and sustainable energy services for all, in particular for around three billion people who currently lack access to clean, modern energy. Forty-three of the 500 GEA authors and reviewers were from the UK, and the assessment was launched in London in 2012 at Chatham House.

- Building on the collaboration developed through the GEA chapter on urban energy systems, researchers from IIASA and Imperial College London published the book, *Energizing Sustainable Cities* with *Routledge* in 2012. The book produced the first comprehensive global overview of urban energy use and of the specifics of urban energy demand and supply. It also uniquely embedded energy issues into the broader sustainability agenda of cities: including housing for the poor, functional transport systems, as well as environmental quality, in addition to the challenges imposed by climate change.
- IIASA and Tyndall Centre researchers worked together on the GEA chapter on energy technology innovation. This research collaboration has subsequently resulted in a book, published by *Cambridge University Press* in 2014, exploring what can be learned from past successes and failures in energy technology innovation.
- Outcomes from the GEA include the adoption of GEA's findings as the three key objectives of the UN Secretary-General's Sustainable Energy For All (SE4ALL) initiative on energy access, energy efficiency, and renewable energy.

Feeding a future global population of 9 billion

A key challenge for humanity is how a future global population of 9 billion can be fed healthily and sustainably. Achieving this goal involves finding a balance between the competing pressures for land from the agriculture, forestry, energy and conservation sectors. IIASA and partners from around the globe have been researching these issues since the 1980s.

Joint studies between IIASA and UK researchers are analyzing the main sectors that use land and how this may impact sustainable food production in the future

Recent collaborations with UK researchers include:

- Researchers from IIASA and Imperial College London explored the modelling studies on this issue in an article in the *Philosophical Transactions of the Royal Society B*.
- Forests are the focus of multiple IIASA studies with partners in the UK, including the London School of Economics, the Global Canopy Programme in Oxford, and the World Conservation Monitoring Centre in Cambridge. Current projects include analyzing incentives to protect global forests in the future via REDD (reducing emissions from deforestation and forest degradation) schemes, and developing technical know-how and capacity in designing efficient, effective and environmentally relevant policy strategies for REDD.
- Other collaborations with UK researchers at Imperial College London and the University of Bristol have explored the emerging bioenergy sector. In particular, the research showed how land-use modelling tools can help distinguish the bioenergy options that can address energy security and greenhouse gas mitigation from those that cannot.

- Global warming of 2°C will impact agriculture, forests, and tourism among many other land uses. IIASA is contributing to the EU-funded project IMPACT2C (2011-15) with its biophysical crop and forestry models to quantify such impacts and is developing its economic land use model GLOBIOM to help in the costing of different adaptation options. UK partners on this project include the Met Office, Paul Watkiss Associates, University of Southampton, and the Stockholm Environment Institute in Oxford.

- The different land-use sectors play key roles in the global carbon cycle, and IIASA, the University of Aberdeen, CEH, Cranfield University, and the Met Office are working on the EU-funded CARBO-Extreme project (2009-15). Together they are improving our understanding of how extreme weather events impact the Earth's ability to absorb carbon and published early findings in *Nature* in 2013.

Seafood is the primary source of animal protein for more than one billion people. Many developing nations and coastal communities depend on fisheries. However, expanding food production from fisheries is hindered by rampant overfishing and changes in marine habitats. By combining fields of expertise as diverse as population genetics, evolutionary theory, and fisheries science, IIASA's researchers have been analyzing the consequences of commercial fishing practices on the evolution of fish. Collaborations with the UK include:

- Various case studies since 2007 with the Fisheries Research Services in Pitlochry into the impact of selective fishing practices on Irish and Scottish Atlantic salmon. Findings indicate evolutionary changes to the fish which can be reversed but only over long periods of time.

- Research with Marine Scotland (2007-12) examined the rates of evolution in exploited fish stocks and argued that the costs of ignoring trait evolution are high.

IIASA's water experts joined hydrologists, climate change specialists, agricultural scholars among other disciplines to contributed to the EU-funded WATCH project (2007-2011) to assess the vulnerability of global water resources. UK partners in the project were CEH, the Met

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IIASA's global contribution

Many of today's most pressing challenges do not stop at international borders. IIASA's research areas such as climate change, water scarcity, and poverty are affected by multiple factors across the globe. In turn these global problems have impacts on nations, regions, and continents. Finding long-lasting solutions to these challenges requires scientific expertise that is free from the interests of a single nation. IIASA's National Member Organizations recognize this need and that their investment in IIASA is a contribution to a global public good. Furthermore the benefit of this contribution is paid back to global researchers, policymakers, and citizens in multiple ways, here are two recent examples:

1. IIASA supports the climate change research community by hosting the Representative Concentration Pathways (RCP) database. The database provides data on greenhouse gas emissions for four different future scenarios that underpin the analysis of thousands of climate change researchers. IIASA also calculated the data for one of the scenarios, all of which have been developed for the world's most comprehensive analysis of climate change—the IPCC's (Intergovernmental Panel on Climate Change) Fifth Assessment Report.

2. IIASA's research provides scientific guidance to the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe. This international environmental treaty between 33 countries has slashed air pollution in Europe, improving people's health and countries' crop production. IIASA's GAINS model guided negotiators and policymakers as they worked on the treaty to identify the most cost-effective approach to cleaning Europe's air. The negotiators chose the GAINS model not only because of its accuracy and usability but also because it had been developed by an international team with funding from multiple countries, which assured them that the model was nationally unbiased. This work has subsequently been reflected in UK legislation.

Office and the University of Oxford. CEH also worked with IIASA and the UK's Institute for European Environmental Policy on the EU-funded SCENES project (2006-10) to produce a set of comprehensive scenarios of Europe's freshwater futures up to 2025.

Accurate data is key to all these studies and over the past 5 years, IIASA researchers on the Geo-Wiki project have been leading a team of citizen scientists who examine satellite data to categorize land cover or identify places where people live and farm. The rise of citizen scientists provides potential to radically improve the accuracy of maps and subsequently the quality of the research and policy recommendations that are based on mapping data. Researchers from IIASA and the University of Nottingham are leading the ICT COST Action TD1202 (2012-16) project to explore and enhance the role that citizen scientists play in mapping.

One question the research teams always get is whether the analysis from lay people is as good as that from experts. In other words, can they rely on non-experts to provide accurate data analysis? Together with a researcher from the University of Leicester, IIASA researchers showed in the journal *PLOS ONE* (2013) data gathered and analyzed by non-experts can rival the quality of data from experts. IIASA's crowd sourcing experts also collaborate with researchers from Aston University, UCL, the University of Leeds, and the University of St Andrews.

Advancing the research methods of systems analysis

IIASA brings its expertise in modeling complex systems including characteristics such as thresholds, feedback loops, avalanche effects, and irreversibility, to the EU-funded project, COMPLEX (2012-16), which is coordinated by the University of Newcastle upon Tyne. The researchers are developing a suite of modeling tools and decision-support systems to inform national and supra-national policy and support communities across Europe working to make the transition to a low-carbon economy.

Developing new research methods and tools ensure both IIASA and UK system analysis remains at the cutting edge

Developing new methods and pioneering their applications, IIASA analyzes and forecasts how ecological and evolutionary dynamics shape populations, communities, and ecosystems, and how behavioral dynamics and adaptations determine the fate of groups of interacting agents. Recent collaborations with UK researchers include:

- Researchers from IIASA and the University of Sheffield, among others, analyzed the impacts that hybridization has on the process of speciation.
- The development of a theory to explain why a predator switches between different species of prey with a biologist from Royal Holloway, University of London.
- An exploration of the evolution of body size with a researcher from the University of Oxford.

IIASA's models, tools, and data

Through intense data gathering, computer modeling, and other advanced research methods, IIASA provides a country's researchers and their policymakers with the essential numbers and tools to select the most effective policies. Here is an example of one such piece of work done by IIASA for IIASA member country India:

- The air pollutant, fine particulate matter ($PM_{2.5}$), can travel far down into the lungs contributing to illnesses such as cardiovascular diseases, asthma, and lung cancer. Current levels of $PM_{2.5}$ in most of India exceed the World Health Organization guideline of 10μg/m3 by more than a factor of four. And if the level of consumption of energy in India grows as expected, without additional air pollution controls, concentrations of $PM_{2.5}$ in many parts of India will more than triple by 2030. However, if India implements advanced air pollution measures by 2030, life expectancy would increase by 2.8 years, and 2.5 million premature deaths per year would be saved. The costs of these new

measures would also pay for themselves through the resulting health improvements which reduce lost work days and increase productivity. (Source: IIASA's GAINS model. Research published: Sanderson W, Striessnig E, Schoepp W & Amann M (2013). Effects on Well-Being of Investing in Cleaner Air in India. *Environmental Science and Technology.* 47:13222-13229).

Many of the research projects summarized in this Info Sheet draw on analyses from IIASA's models, tools, and data including:

- Reducing air pollutants and greenhouse gas emissions simultaneously (GAINS model).
- Financial disaster risk management (CATSIM model).
- Projecting future population (Demographic multistate modeling).
- Planning a sustainable energy system (MESSAGE model, Global Energy Assessment Scenario Database).
- Improving agricultural productivity through identifying yield gaps (GAEZ model) and assessing competition for land use between agriculture, bioenergy, and forestry (GLOBIOM model).
- Reducing energy poverty (Energy Access Interactive Tool [ENACT]).

Capacity Building

Young Scientists Summer Program

Since 2006, six students based at UK universities have developed research skills and networks by taking part in IIASA's Young Scientists Summer Program

The Young Scientists Summer Program (YSSP) develops the research skills and networks of talented PhD students. Program participants conduct independent research within the Institute's research programs under the guidance of IIASA scientific staff. The young scientists gain international and interdisciplinary research expertise and start to develop a system analytical approach to solving complex problems. Funding is provided mainly through IIASA's National Member Organizations and selection of participants is based on merit, with priority given to doctoral students from member countries. For instance since 2008, 47 and 68 young scientists from IIASA member countries, China and the US respectively, took part.

These benefits of taking part in IIASA's programs for young scientists even led Nobel Prize winner, Thomas Schelling to say: "The YSSP program alone would be worth the cost of US membership." Recognizing this benefit, South Africa has teamed up with IIASA to create a regional version of YSSP in South Africa, which has recently completed its second successful year. The Southern African Young Scientists Summer Program is organized jointly by the South African National Research Foundation, the South African Department of Science and Technology, the University of the Free State in Bloemfontein, South Africa, and IIASA.

Since 2006 the following seven students from UK institutions won places on the program:

Stephan Alberth (YSSP '06 & University of Cambridge) worked on developing a stochastic dynamic integrated assessment model of climate change with unfolding uncertainty. (Self-funded)

Edoardo Borgomeo (YSSP '14 & University of Oxford) will research the water resources system vulnerability to hydrological variability and climate change in the Thames river basin. (Co-funded by IIASA and University of Oxford)

Lan Ngoc Hoang (YSSP '12 & Leeds University) used various methods to simulate and analyze different water management options for North Sussex in order to identify the most robust and resilience water policies in the face of climate change. (Funded by the Petr Aven Fellowship—a former YSSP participant, Petr Aven, donated a fellowship fund to IIASA to sponsor one YSSP participant every year)

William Lamb (YSSP '14 & Tyndall Centre for Climate Change Research) aims to identify the consequences of delayed mitigation of climate change in the global North for adequate developmental opportunity for the global South by exploring the link between emissions, energy

and human well-being, and modelling scenarios of delayed mitigation action. (Partial IIASA funding)

Koichi Mikami (YSSP '08 & University of Oxford) analyzed how cultural differences in the perception of risk and accountability affect the development of new technologies such as tissue engineering and regenerative medicine. (Self-funded)

Dominique Thronicker (YSSP '13 & University of Stirling) researched the spatial and temporal diffusion of a range of chemical industry production processes (e.g. for ammonia, ethylene, benzene, chlorine, caustic soda) to see what insights were revealed for patterns, drivers and constraints of future technological change. (Funded by the German NMO)

Charlie Wilson (YSSP '08 & University of British Columbia), who is a UK national and was studying in Canada, analyzed the constraints to scaling up low carbon technologies.

Postdoctoral Program

Postdoctoral researchers at IIASA work in a rich international scientific environment alongside scientists from many different countries and disciplines. The Institute's research community helps its postdoctoral researchers to develop their research from fresh angles, to publish widely in journal articles, and to establish their own global network of collaborators. The following postdoctoral fellow from the UK participated in the program since it began in 2006:

One postdoctoral fellow from the UK has developed his research and published widely at IIASA

Christopher Doll (2007-2009) carried out research on the production of socioeconomic datasets from night-time light satellite imagery and how they could be combined with other data to help answer fundamental questions concerning sustainable development and the human dimensions of global change (PhD in Remote Sensing from University College London).

IIASA-UK scientific exchange through people

Several IIASA researchers hold positions at universities and research centers in the UK. These include David Grey (University of Oxford), Arnulf Grubler (member of advisory board of UK Energy Research Centre, member of scientific advisory board of BP - Imperial College Urban Energy Research Initiative), Wolfgang Lutz (Associate Member of Nuffield College and Visiting Fellow of St. John's College, both at the University of Oxford), Laixiang Sun (SOAS, University of London), and Charlie Wilson (Tyndall Centre for Climate Change Research).

IIASA researchers have also made numerous presentations in the UK, a selection follows:

Valeria Bordone on "Intergenerational Relationships: Does Grandparental Childcare Pay off?" at the Department of Sociology in the University of Oxford in 2013.

Arnulf Grubler on "The Future of Urban Energy Systems – A Global Energy Assessment" at the inaugural Laing O'Rourke Distinguished Lecture series at Imperial College, London in 2013.

Wolfgang Lutz on "Demographic Aspects of Climate Change Mitigation and Adaptation: Comparing Micro- and Macro-perspectives" at a high-level population workshop in St. John's College, University of Oxford in 2013.

Pavel Kabat on "IIASA Systems Analysis Approaches to Global Challenges" at the Royal Society Symposium on "Global Integrated Assessments: Making Sense of Complexity in an Interdependent World" in London in 2013.

Nadejda Komendantova on "Are the European natural hazard governance systems ready for multi-risk mitigation and management?" at the Royal Geographic Society Annual International Conference in London in 2013.

Johan A J Metz on "The interplay of infectivity that decreases with virulence and limited cross-immunity: (toy) models for respiratory disease divergence" at a conference on "Modelling Biological Evolution 2013 – Recent Progress, Current Challenges and Future Directions" at the University of Leicester in 2013.

Nebojsa Nakicenovic on "Challenges: Earth League" at a London Earth League Meeting in 2013.

David McCollum on "Policies to Protect the Global Climate Offer: An Effective Entry Point for Achieving Society's Multiple Objectives for Energy Sustainability" at the Planet Under Pressure event in London in 2012 (12 IIASA researchers presented at this event).

Nebojsa Nakicenovic on "Global Energy Assessment: Goals, Progress and Key Findings" at Chatham House, London in 2012.

Other examples of scientific exchange include:

- Over 340 UK nationals have participated in IIASA events since 2006.
- 186 publications have resulted from collaborations between IIASA and UK nationals since 2006.
- On average 20 UK nationals have been employed by IIASA every year since 2006.
- Over 150 researchers, advisors, and diplomats from the UK have visited IIASA since 2006, while IIASA scientists have visited the UK over 400 times.

Appendices

The details behind the above facts can be found in the following appendices to the country sheet. The appendices are either attached or available on request from Sanja Drinkovic (drinkovs@iiasa.ac.at):

1. Employees from the UK at IIASA (2003-2014)
2. Visitors from the UK to IIASA (2006-2013)
3. Conference participants from the UK attending an event organized or co-organized by IIASA (2006-2013)
4. Travel by IIASA scientists to the UK (2006-2014)
5. Publications relevant to IIASA-UK collaborations (2006-2014)
6. Research Partners in the UK (2006-2014)

Prospects for Future IIASA-UK Activities

Enhancing the IIASA-UK relationship offers benefits for UK research, government policy, and international relations

This Info Sheet summarizes recent research collaborations between IIASA and the UK. Significant potential remains to enhance the IIASA-UK relationship through developing a range of new joint activities including:

- **Enhancing UK expertise in applying system analysis to national problems:** Developing bespoke UK versions of IIASA's global models would allow researchers and policymakers to look at complex global problems and their impact on the UK in a holistic and integrated way. For example, the Dutch government worked with IIASA to develop a Dutch version of the IIASA GAINS model. The new model helps ministries to identify cost-effective measures to improve air quality and reduce greenhouse gas emissions in the Netherlands at the same time as complying with the country's obligations under European air quality agreements.

- **Conducting international assessments in areas of UK strategic interest:** The UK was a significant contributor to IIASA's Global Energy Assessment which brought together over 500 specialists to transform the way society thinks about, uses, and delivers energy. IIASA is embarking on three new assessments, at the request of its member countries that will focus on issues of strategic interest to the UK. These are holistic, integrative assessments of plausible futures for the Arctic, global water challenges, and tropical forests.

■ **New partnerships between IIASA and UK institutions to win grants from international research funders:** IIASA's high-quality research and international research network makes it highly competitive in its applications for international research funds. Between 2006 and 2013, IIASA almost doubled its income by winning research grants that amounted to €62.5 million—22% of which funded projects with 27 UK and other research partners. These grants were part of a total funding portfolio of €290 million of the external projects in which IIASA was and is involved. Among these are six large grants from the European Research Council which only funds the top European researchers to carry out frontier research. More recently, IIASA is coordinating or a partner on 22 proposals to the new EU research funding program, Horizon 2020, of which six include UK institutions.

■ **Using international scientific cooperation to support diplomacy:** IIASA was established in 1972 to use scientific cooperation to build bridges across the Cold War divide and research growing global problems on a truly international scale. Today the soft power of science diplomacy continues to help IIASA's member countries through using scientific cooperation to improve international relations, and through international teams jointly researching controversial issues to find consensus free from the constraints of national self-interest (see box: Research to support science diplomacy: page 7).

■ **Academic training opportunities for young UK scientists:** There is significant potential to enhance participation by young UK scientists in IIASA's programs to develop international and interdisciplinary research skills (see page 12: Capacity Building). For example since 2008, 47 doctoral students from IIASA member country China have won places in IIASA's Young Scientists Summer Program (YSSP) compared to five from the UK.
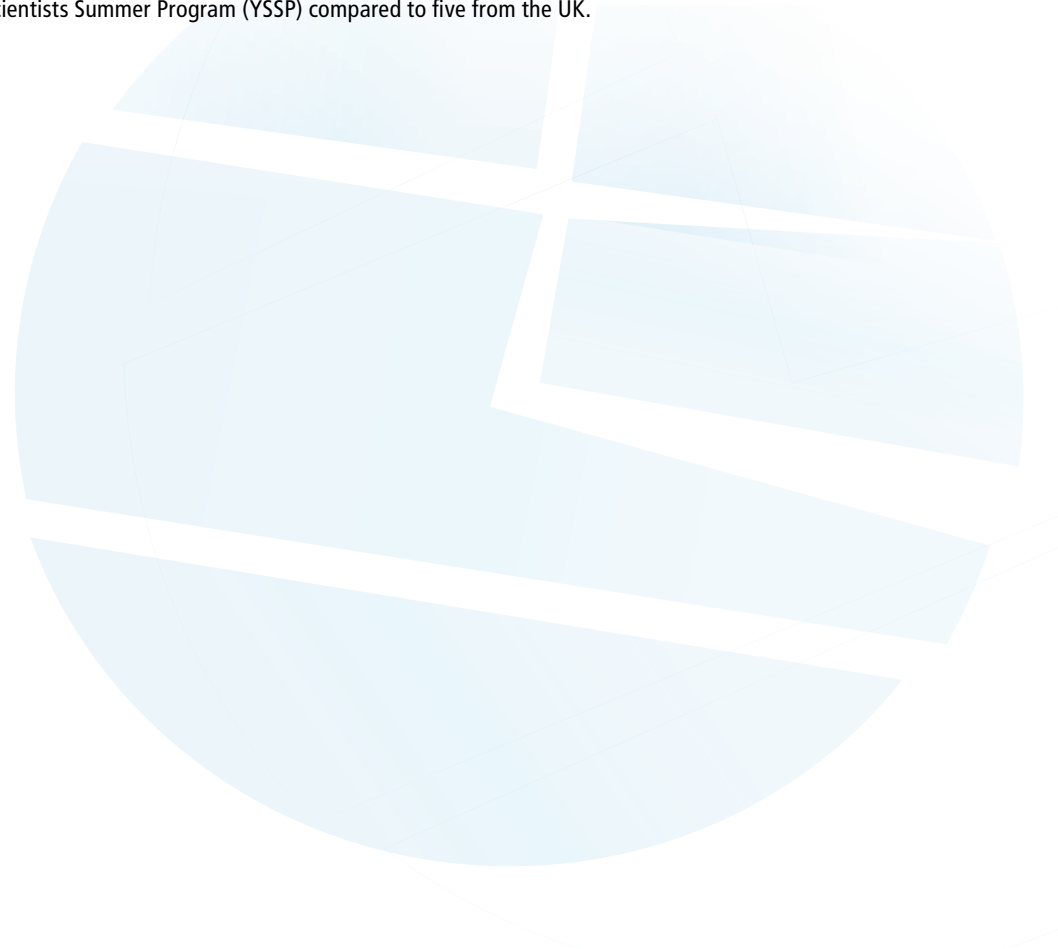
About IIASA

Founded in 1972, the International Institute for Applied Systems Analysis (IIASA) conducts policy-oriented research into problems of a global nature that are too large or too complex to be solved by a single country or academic discipline. IIASA's research areas are energy & climate change; food & water; and poverty & equity.

IIASA is at the center of a global research network of around 2,050 scholars and almost 300 partner institutions in over 45 countries. It is funded and supported by its National Member Organizations which represent the scholarly community in the following countries:

Australia, Austria, Brazil, China, Egypt, Finland, Germany, India, Indonesia, Malaysia, Japan, Netherlands, Norway, Pakistan, Republic of Korea, Russia, South Africa, Sweden, Ukraine, United States of America, Vietnam.

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