

THE NEXUS NETWORK
new connections in food, energy, water and the environment
An ESRC investment

Sustainability in Turbulent Times

Lessons from the Nexus Network for
supporting transdisciplinary research



The Nexus Network

Funded by the ESRC, the Nexus Network brings together researchers, policy makers, business leaders and civil society to develop collaborative projects and improve decision making on food, energy, water and the environment.

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Economic and Social Research Council (ESRC)

The Economic and Social Research Council is the UK's largest organisation for funding research on economic and social issues. The ESRC supports independent, high quality research which has an impact on business, the public sector and civil society.

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Partners

The Nexus Network is a collaboration between SPRU and the Steps Centre at University of Sussex, University of Sheffield, University of Exeter, University of East Anglia, and University of Cambridge's Institute for Sustainability Leadership.



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Foreword



ESRC

Social science has a vital role to play in tackling urgent global challenges, and I want to congratulate all those involved in the Nexus Network for the contribution that they have

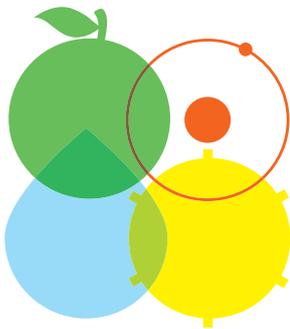
made to understanding and navigating the interconnections between food, energy, water and the environment. Running through the many activities and projects that the network has facilitated is a common theme: the importance of deepening and operationalising links between disciplines and sectors, and of listening to the priorities of research users in government, business and civil society at the design stage.

As we look ahead to the many opportunities being created by UK Research and Innovation, the Global Challenges Research Fund and the Industrial Strategy Challenges Fund, the ESRC is keen to draw lessons from across our portfolio of centres, networks and projects. Creative experiments like the Nexus Network can help to inform how we foster and support future waves of innovative, high-impact research. The external drivers are pressing, the funding system is changing, but the need for robust social science, novel methodologies and interdisciplinary analysis of complex systems has never been greater.

Jane Elliott

Chief Executive, Economic and Social Research Council

The nexus imperative



In September 2015, 193 world leaders agreed seventeen Global Goals for sustainable development, with a set of targets to be achieved by 2030. Ensuring access

for all to food, water, sanitation and affordable, clean energy feature prominently in the list.

But the links, trade-offs and interdependencies between these goals are less well understood. These are now increasingly being debated in terms of the “nexus” – a term which is not new,

but has risen in prominence over the past five years as a way of talking about the connections between food, water, energy and the wider environment.

“ It is a technocratic fallacy that the simple application of science, engineering and technology... will make people happier and improve their lives. This will only happen if the arts, humanities and social sciences are fully integrated with technocratic approaches. ”

Sir Mark Walport, Government Chief Scientific Adviser and incoming Chief Executive, UK Research and Innovation (May 2016)



→ The UN's Global Goals for Sustainable Development, agreed in September 2015.

NEXUS BY NUMBERS

With the global population growing at a rate of approximately 80 million people a year, by 2030 it is estimated that the world will need **30% more water, 50% more energy and 50% more food**, whilst mitigating and adapting to climate change. This threatens to create a 'perfect storm.' (Sir John Beddington)¹

It takes **13,000 to 15,000 litres of water** to produce one kilo of grain-fed beef (International Fund for Agricultural Development)²

In the UK, the electricity sector is the largest water abstractor, accounting for more than **50% of licensed abstraction**, with 95% used by hydroelectricity power plants and the rest by thermal power plants. (Environment Agency)³

In the United States, between 2011 and 2016, a total of **358.4 billion gallons of water** was used for hydraulic fracturing, equivalent to the annual water needs of 200 mid-sized cities. **57% of the 109,665 wells** that were hydraulically fractured in the past five years in the US were located in regions with **high or extremely high water stress**. (Ceres)⁴

The nexus floated to the surface in debates over water; an influential 2011 report by the World Economic Forum described water security as "the gossamer that links together the web of food, energy, climate, economic growth and human security challenges."⁵ The concept gained further currency in the lead up to the Rio+20 Summit in 2012, and continues to draw attention from decision makers in policy, business and civil society.

Agreement on the Global Goals in September 2015, followed just weeks later by the Paris Agreement on climate change, increased optimism and galvanised momentum towards challenge-based research (as reflected by the UK government's creation of a £1.5 billion Global Challenges Research Fund). But in recent months, the mood has changed, as Britain's vote to leave the European Union, the election of a more protectionist US administration, and unpredictable waves of political populism

worldwide, seem likely to slow or reverse environmental and social policies. For the UK, where much environmental legislation and regulation has been developed on a pan-European basis, frameworks of governance and collaboration will need to be redesigned, and fresh capacity developed at a national level.

In some ways, recent political turbulence illustrates the nexus argument: that efforts to improve the sustainability of one domain, without considering others, can fail or create vulnerabilities to shocks and feedback loops of various kinds. It is increasingly recognised that more integrated approaches are required, but policies often remain siloed. A recent study, funded by the Nexus Network, highlights the challenge in a UK context: "The UK Energy Act (2013) does not refer to either food or land use, while it only mentions water in a narrow legal context... The UK Water Act (2014) makes no mention of either energy/electricity or land use."⁶

¹ Beddington, J. (2012). Food, energy, water and the climate: A perfect storm of world events? BIS/Go-Science Working Paper.

² www.ifad.org/topic/facts_figures/overview

³ Environment Agency (2013). Water Use and Electricity Generation.

⁴ Ceres (2016). Hydraulic Fracturing and Water Stress: Water Demand by the Numbers (2016 update).

⁵ World Economic Forum (2011). Water Security: The Water-Energy-Food-Climate Nexus.

⁶ Sharmina, M. et al. (2016). A nexus perspective on competing land demands: Wider lessons from a UK policy case study. Environmental Science & Policy. 59 (2016) 74–84

Social science is vital

The language of the nexus highlights the need for interconnected thinking between natural and social sciences, and between the research community and decision makers. This is now an increasing focus of research funding, both in the UK, where ESRC, EPSRC and NERC⁷ have all funded nexus-related projects in the past three years, and internationally, where the European Commission, Belmont Forum and Future Earth have initiated nexus programmes. The US National Science Foundation recently invested \$72 million in its “Nexus of Food, Energy and Water Systems” programme.⁸

Social science has a particular contribution to make to nexus integration. As the 2013 World Social Science Report puts it: “The social sciences must help to fundamentally reframe... global environmental change from a physical into a social problem.”⁹ A great deal of social science research is relevant to this task: from political science; geography; economics; science, technology and innovation studies; and many other disciplines.

In the UK, the social science community has been at the forefront of efforts to support interdisciplinary research on nexus challenges. In 2013, the ESRC held a workshop to engage researchers, government departments, businesses and other stakeholders around the question: “What are the future social science challenges that cut across the energy-environment-food nexus?” This identified a set of priorities, including: sustainable prosperity; resilience; consumption and behaviour change; public policy shaping; governance arrangements for sustainable resource use; and data, methods and skills needs.

In June 2014, to strengthen capacity across these areas, the ESRC launched the £1.8 million Nexus Network, as the first in a series of linked investments, which have since included the Centre for Sustainable Prosperity (CUSP), led by Professor Tim Jackson, and the Centre for the Evaluation of Complexity Across the Nexus (CECAN), led by Professor Nigel Gilbert.

DEFINING THE NEXUS

The ESRC defines ‘the nexus’ as a way of thinking about the interdependencies, tensions and trade-offs between food, water and energy security, in the wider context of environmental change.

Nexus discussions are often dominated by concerns over resource scarcities, and couched in the language of increasing efficiency and enhancing security. But there are many nexuses: in addition to food, energy, water and the environment, we need to understand interactions across other systems, including land, health and cities.

Interdependencies can also be understood at a range of geographical, political and temporal scales. Some are inherently global, such as climate change. Others, such as food security, cut across scales, or are highly localised, such as urban air pollution.

The Nexus Network embraced this plurality, and deliberately avoided a narrow operational definition of the nexus. The concept, in all its fuzziness, has functioned as a helpful convening mechanism for diverse disciplinary and sectoral perspectives.

⁷ • www.cecan.ac.uk/ • <https://www.epsrc.ac.uk/newsevents/news/ukwaterenergyfood/> • <http://steppingupnexus.org.uk/> • <http://nercgw4plus.ac.uk/project/role-of-ecosystem-services-in-the-water-energy-food-nexus/>

⁸ www.nsf.gov/news/news_summ.jsp?cntn_id=189898

⁹ www.worldsocialscience.org/activities/world-social-science-report/the-2013-report/

The Nexus Network was set up to foster debate, support research and broker collaborations across food, energy, water and the environment. Coordinated by a team from the University of Sussex, with colleagues from the Universities of Cambridge, East Anglia, Exeter and Sheffield, the network was open to researchers from all disciplines and institutions, and to decision

makers across government, business and civil society.

This report summarises what the network has achieved and some of the lessons we learned along the way. We hope it is useful to others seeking to understand, navigate and develop solutions at the nexus.

WHAT DO WE MEAN BY MULTI, INTER & TRANSDISCIPLINARY RESEARCH?

It is increasingly recognised that narrow single disciplinary approaches are ill equipped to address complex, interconnected challenges. But there are various approaches to the involvement of multiple disciplines within research:

A **multidisciplinary** approach draws upon the strengths or expertise of different disciplines, and more effectively joins up their findings, but leaves disciplinary boundaries (and sometimes hierarchies) intact.

An **interdisciplinary** approach involves the fuller integration of disciplines, to develop potentially novel ways of approaching research questions, recognising that there is a diversity of ways to understand and address particular problems.

Transdisciplinary research not only integrates expertise from across academic disciplines, but also involves societal stakeholders in the design stage, and throughout the research process. In transdisciplinary research, knowledge can come from beyond formal academic disciplines, and insights are often provided through other kinds of tacit knowledge – as held by local communities, businesses, social movements or practitioners.

Nexus Network activities and projects have included all three of these types of cross-disciplinary collaboration, with a particular emphasis on transdisciplinary processes.

The Water-Energy-Food Nexus



The term nexus describes the key interactions between parts of a system or systems. This POSTnote summarises current understanding of the interactions between water, energy and

Overview

- A nexus assessment seeks to describe the interactions of water, food, energy, environmental and social systems to identify the interdependencies and trade-offs between these systems.
- Failure to take account of interactions and trade-offs creates vulnerabilities to shocks, such as extreme weather events, which can have cascading impacts across systems.
- There are no set methods for undertaking nexus assessments, but key aspects involve understanding the interactions between systems and people.
- Awareness of interactions and trade-offs is

← In December 2016, the Parliamentary Office of Science And Technology published one of its 'POSTnotes' on the water-energy-food nexus, which drew on work carried out through the Nexus Network.

→ Part of the Nexus Network core team (L-R) Dr Rose Cairns, Professor James Wilsdon and Professor Andy Stirling.



Nexus Network

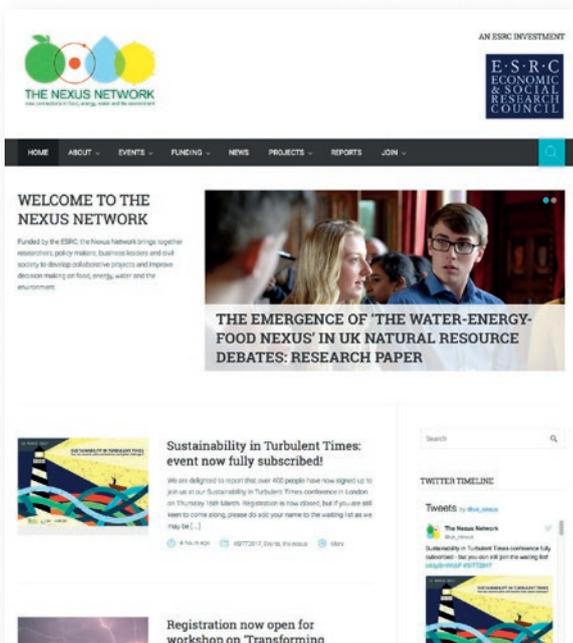
The Nexus Network approach

Since its launch in June 2014, the Nexus Network has worked to support transdisciplinary research at the food-water-energy-environment nexus, and to create meaningful links between communities of researchers, policymakers, business leaders and practitioners. Over three years, the network has:

- Hosted and facilitated numerous events, providing spaces for engagement and discussion about nexus challenges;
- Fostered online awareness and debate, through our website and social media;
- Developed insights into tools and methodologies for nexus thinking and practice;
- Pump-primed and supported nexus-related research through a flexible small grants programme and fellowship scheme;
- Worked with businesses and policymakers to support them to address nexus interdependencies, opportunities and impacts;
- Built capacity in the UK research system for future investments in nexus-related economic, environmental and sustainability research;
- Provided strategic advice to ESRC, RCUK and other funding bodies.

“ As the international community moves towards implementation of the UN’s Global Goals, the provision of evidence and analysis across the food-water-energy nexus is vital. In the past three years, the Nexus Network has invested over £700,000 in a series of pilot projects, which together demonstrate the huge contribution that UK social science has to offer to these agendas. By prioritising work that spans disciplinary and sectoral boundaries, I hope that we’ve helped researchers, policymakers, businesses and civil society to navigate the nexus more intelligently. ”

Professor James Wilsdon, Director, The Nexus Network



← In addition to events, projects and fellowships, the Nexus Network has built interest and engagement in nexus debates through its website, Twitter feed and regular newsletters.



← To accompany the launch of the network in June 2014, the Guardian ran a series of nexus-themed articles on its 'Political Science' blog.

→ Participants at the sustainable cities workshop.



Nexus Network

Creating spaces for transdisciplinary engagement

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The rhythms and routines of different professional worlds can limit opportunities for interaction between individuals from varied disciplines and sectors. Providing spaces and networking opportunities for this kind of engagement is crucial if transdisciplinarity is to flourish.

This is why the Nexus Network has organised and facilitated an extensive programme of events over the past three years. Over 1000 people have

participated in everything from small, interactive workshops and countryside “walkshops”, to policy focused seminars and larger conferences in Westminster and Whitehall. A core group of around 250 people have attended multiple events as the network has grown.

Highlights from the events programme include:

Improving decisions at the food, water, energy and environment nexus: values and valuation (Defra, November 2014)

Led by Professor Ian Bateman from the University of East Anglia, this workshop brought together fifty people from government, business, research and civil society to explore practical solutions

“There’s a paradox inherent in transdisciplinary research, as its strength lies in gathering a diverse group of perspectives and players, but these must then be aligned towards common goals and research outcomes.”

Dr. Frances Harris, senior lecturer, University of Hertfordshire and author of a Nexus Network thinkpiece

to the challenges of decision-making across the nexus. Discussion focused on the strengths and limitations of economic valuation techniques to support nexus decision making, and speakers included Dr. Ulrike Hotopp (then Chief Economist at Defra) on 'Economic Appraisal: What we value and how'. The workshop identified research gaps needed to improve the frameworks for bringing non-monetary evidence into policy and decision-making.

Scales, levels and spaces of the nexus (London, November 2015)

The second Nexus Network annual conference brought together 140 people to explore the ways in which questions of scale are crucial in understanding nexus challenges. Although nexus challenges are often framed in terms of energy, food or water security at a global level, the discussion focused on how important it is to recognise interactions and trade-offs at all levels, from the household, to regional, national and international scales. Participants debated how the scale at which nexus interactions are examined affects choices over methodology and the scope for participation.



← Participants at the sustainable cities 'workshop'.

Nexus Network

Water, energy and food provision for sustainable cities

(Sussex University, May 2016)

This workshop explored social science perspectives on the provision of food, water and energy for those living in cities. Dunu Roy, director of the Hazards Centre in Delhi, India gave a keynote address on urban nexuses of social injustice, in which he highlighted the unsustainability and injustices of present patterns of resource use, and argued that the use of more efficient technologies is likely to "sharpen the social conflicts born out of inequality, as long as social relations remain the same."



“ In the places and the spaces where I walk and work, infrastructure for water, energy, food, waste – as well as land – are highly political, politicised and contested... They may necessarily benefit from a more critical and socio-political understanding and framing. ”

Anni Beukes, Stellenbosch University, reflecting on the Urban Nexus workshop

Meena Kadri on Flickr

Methodologies for nexus thinking and practice

There is no such thing as a “nexus method.” Just as these challenges span disciplinary boundaries and institutional settings, so they demand methodological pluralism. Transforming global systems for food, water and energy in integrated ways requires us to harness a range of techniques, and to interrogate and interpret evidence and data in diverse ways.

Any nexus-related problem or solution is partly in the eye of the beholder. Nexus-related interactions include the complex dynamics of large-scale interacting **objective** systems:

energy, water and food infrastructures (and the social, ecological and physical systems in which these are embedded). But equally complex are the **subjective** processes through which these systems are framed and understood. Any discussion of “the nexus” must pay attention to both these subjective and objective dimensions.

There can sometimes be political pressures for research to close down options and favour particular methods; for example, cost-benefit analysis, or risk assessment. Professor Andy Stirling, who led the Nexus Network’s methodologies strand, argues that two qualities should be prioritised in designing a mix of methods:

The first is **broadening out** the inputs taken into account when designing methods to address nexus-related questions. Methods need to address a comprehensive range of relevant *issues*; explore the entire field of *uncertainties* associated with these issues; pay attention to a full set of strategic, policy or technology *options*; and do all this by engaging in fair and balanced ways with the knowledge, values and *perspectives* of all interested parties.

The second is **opening up** the outputs of research and appraisal, particularly in how results are communicated into wider policy debates. This means rigorously documenting uncertainties, exploring ambiguities and

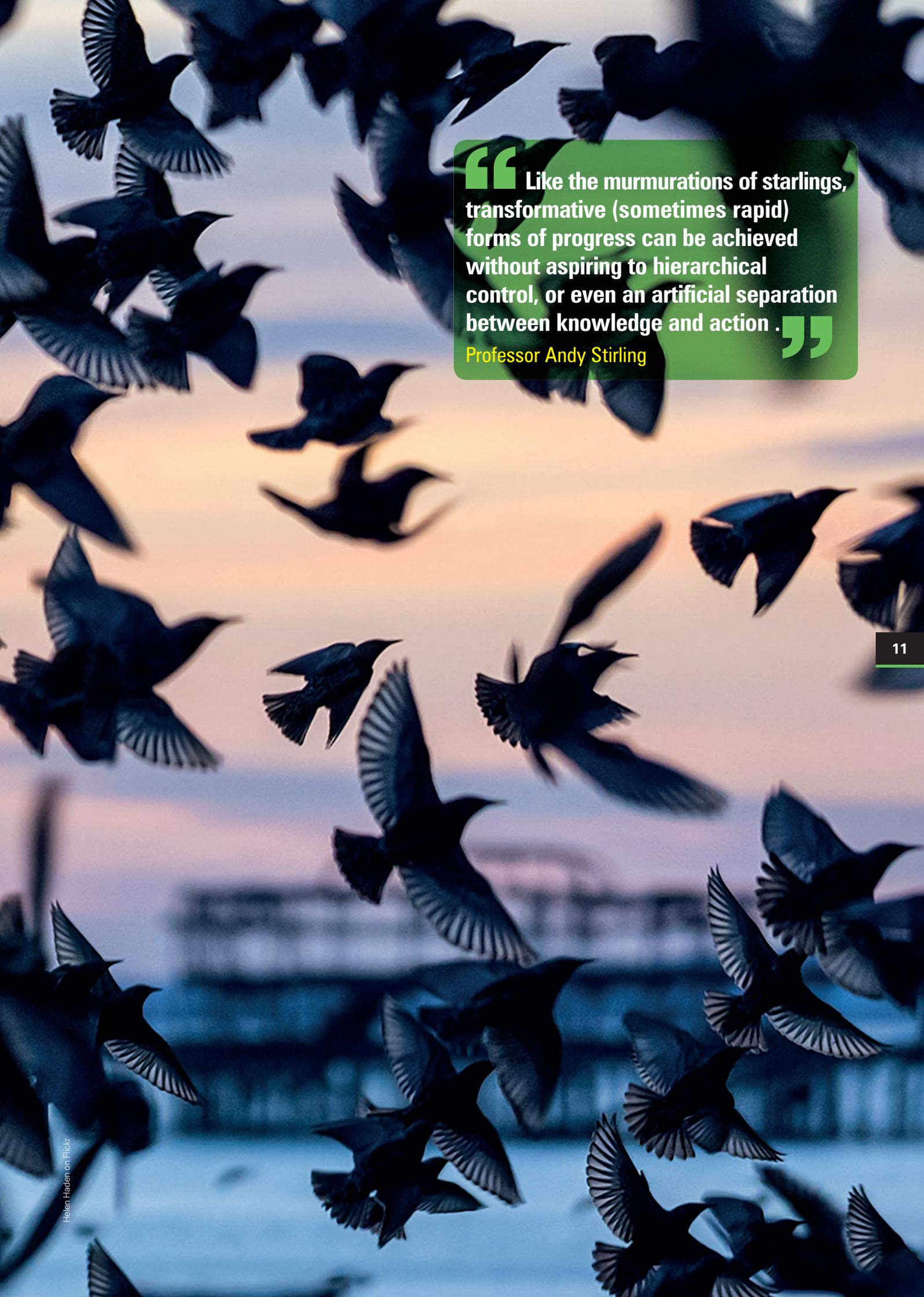
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↓ Andy Stirling presenting at the trans-disciplinary nexus methods workshop.



Nathan Oxley

Continues on page 12 →



“ Like the murmurations of starlings, transformative (sometimes rapid) forms of progress can be achieved without aspiring to hierarchical control, or even an artificial separation between knowledge and action . ”

Professor Andy Stirling

acknowledging ignorance. When nexus research and appraisal are opened up, results are produced in a plural and conditional form (“*if condition X holds, then action A is favoured; but if condition Y holds, then action B is favoured*”). Choosing between these is then acknowledged as an irreducibly political process, beyond the scope of expert analysis alone.

To assist researchers in selecting a portfolio of methods for nexus-related challenges, Andy

Stirling mapped over 100 methods according to their properties of disciplinary practice (analytic or interactive); their epistemic cultures (quantitative or qualitative); and their reasoning processes (deductive, inductive or abductive). Full details can be found in the Nexus Network paper on transdisciplinary methods:

<http://www.thenexusnetwork.org/wp-content/uploads/2015/06/Stirling-2015-Nexus-Methods-Discussion-Paper.pdf>

TRANSDISCIPLINARY NEXUS METHODS WORKSHOP, UNIVERSITY OF SUSSEX, 29–30 JUNE 2015



This workshop for around sixty participants focused on what combinations of method might form the basis for transformative action to address nexus challenges. It also considered the skills, training and capabilities needed to develop these methodologies among researchers, and their partners in government, business and civil society. Speakers included: Professor Guy Poppy, Chief Scientific Advisor to the Food Standards Agency; Professor Dame Henrietta Moore, Director of the UCL Institute for Global Prosperity; Dr. Gary Kass, Deputy Chief Scientist at Natural England; and Professor Sue Hartley, director of the York Environmental Sustainability Institute.

Many at the workshop felt that more capacity needs to be built for transdisciplinary research. This means broadening undergraduate education and the PhD experience, and enabling more established researchers to develop boundary-crossing skills. Working in this way may be inherently uncomfortable for researchers who have come through a single-discipline background, and support mechanisms need to be improved. This is partly a matter of funding but also of mentoring, personal support, and building career routes for transdisciplinary researchers. A full report of the workshop, by science writer Martin Ince, is available here:

www.thenexusnetwork.org/wp-content/uploads/2015/09/Transdisciplinary-Nexus-Methods-Workshop-final-Report-2015.pdf

Supporting transdisciplinary research: the Nexus Network small grants programme

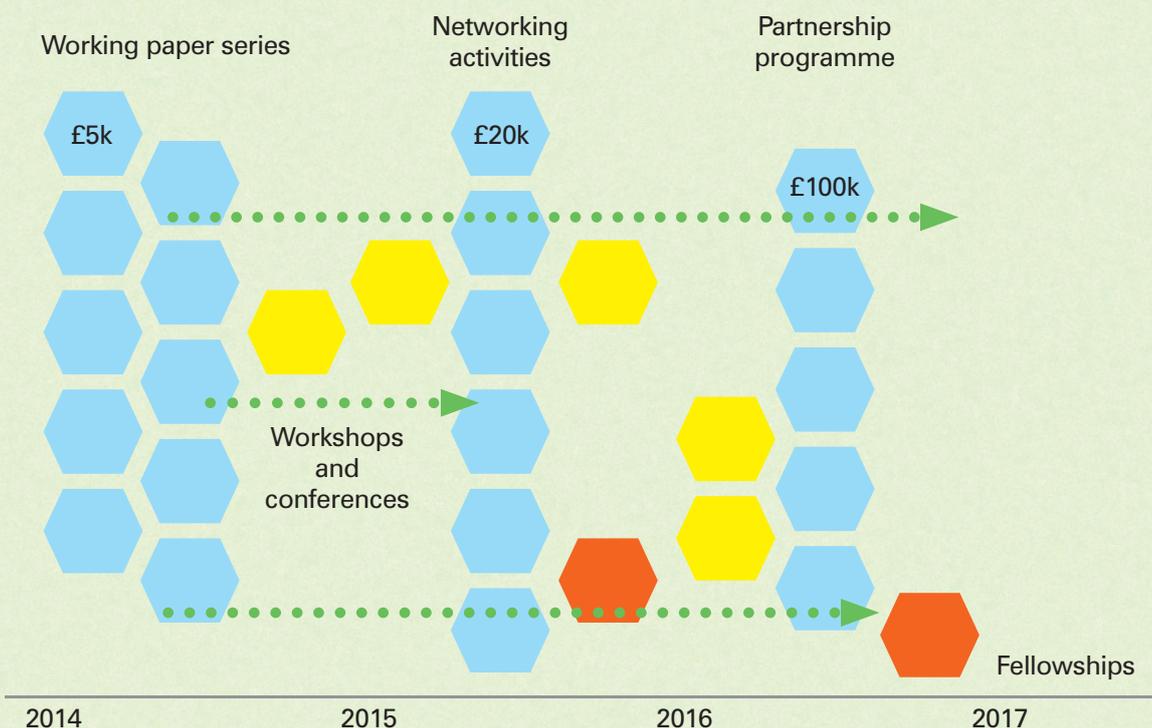
A core strand of efforts to build capacity for transdisciplinary nexus research was our small grants programme. Over three years, the Nexus Network awarded grants totalling more than £700,000 to twenty-seven project teams across the UK. These ranged in size from £5,000 to £150,000. The programme awarded progressively larger grants in three waves.

- Our first call – which made twelve micro-awards of up to £5,000 – was for individuals and teams to produce think-pieces that scoped and defined nexus challenges and opportunities.
- Our second call – which made six awards of up to £20,000 – supported teams to develop networks and co-design nexus research agendas.

- Our final call – which provided five awards of between £50,000 and £150,000 – was to support pilot research projects.
- In addition, we were able to fund two nexus fellowships for outstanding early career researchers.

The methodological and conceptual diversity of the work funded through the small grants programme highlights that the nexus is a fertile framework for stimulating cross-disciplinary collaborations. It also suggests that “nexus approaches”, which focus on connections and synergies between systems, sectors and resources, may have value beyond a focus on food, energy and water.

Figure 1 Schematic diagram of the Nexus Network grants programme 2014 to 2017



Some of our small grant highlights

(Full list of grants in appendix)

The politics of the nexus

Joe Williams, Professor Stefan Bouzarovski and Professor Erik Swyngedouw (University of Manchester) wrote a thinkpiece on the need to politicise the nexus, focused particularly on nexus technologies, urban circulation and the coproduction of water-energy. They argue that much nexus discourse has been

overly technocratic, and dispute the claim that integrated management of water and energy will necessarily lead to more sustainable management of both. If the nexus is to be meaningful, the authors argue, it must be about more than “purely efficiency-based solutions to tensions and trade-offs between energy and water”.

“The concept of “integration” has become a panacea for the negative aspects of the nexus... This assumed logic ultimately implies that the serious challenges posed by the nexus framework do not in fact require real political change.”

Joe Williams

Nexus Shocks Network

Dr. Candice Howarth of the University of Surrey received a networking grant in 2015 to set up the Nexus Shocks Network, which now comprises 300 stakeholders. The network focuses on the idea that failure to take account of nexus interactions can result in greater system vulnerabilities to shocks – high impact,

low probability events – which cut across water, energy and food systems. Through a series of events, the network has explored how different sectors can contribute to resilience and preparedness for such shocks. Subsequently, Dr. Howarth has received a one-year Nexus Network fellowship grant to extend this work.

“It is only by learning from others outside academia and adopting transdisciplinary approaches that we can get a clear sense of the real world applicability of our work.”

Dr. Candice Howarth

The domestic nexus

Dr. Matt Watson of the University of Sheffield received a partnership grant in 2016 to apply a practice theory approach to the water-energy-food nexus, focused on consumption practices in kitchens in the UK. Following a research agenda co-produced with stakeholders through a series of workshops (funded by an earlier Nexus networking grant), the domestic kitchen was chosen as the site for examining the practices that generate demand for water-energy-food resources, how these practices are embedded in the routines of everyday life, and the infrastructures required to support these. The project aims to identify ways of influencing water-energy-food demand in domestic spaces, and to understand how grounded, practice-based approaches could be incorporated into policymaking.



Ian Christie (winner of Nexus Network photo competition)

Nexus Brexit

A year in advance of the UK's referendum on EU membership, Dr. Guy Ziv and Elizabeth Watson at the University of Leeds received a networking grant to examine the potential impacts of Brexit on nexus issues. Using a fuzzy cognitive mapping (FCM) approach, they hosted two workshops for invited experts from the food, energy and water domains, which highlighted the complex interactions and uncertainties

associated with Brexit across these interlinked sectors. Four key vectors, identified as likely to change in a Brexit scenario, were modelled in greater depth: GDP; political control; size of UK population, and net migration to the UK. Energy demand was most affected by a change in GDP, while water and food demand were more affected by changes in the size of the population.

Biomass fuel at the nexus in urban Ghana



Michael Pollack on Flickr

Dr. Sujatha Raman of the University of Nottingham received a partnership grant in 2016 to carry out research on traditional biomass fuel use by urban households in Ghana. Her project takes a bottom-up nexus approach, looking at how households manage food, fuel and waste, in the context of other household pressures. The research has used in-depth interviews and ethnographic observation to examine the views and practices of households, and identify how insights from the bottom-up nexus could refine national and global-level policies to encourage cleaner stoves and fuels, and forest conservation.

“ Policy initiatives have tended to take a siloed approach to the problems arising from use of biomass, targeting ‘clean energy’ from specific artefacts (e.g. improved cookstoves)...The challenge is to put biomass fuel at the nexus with food, waste, the environment, and most of all, with people and practices. ”

Dr. Sujatha Raman

Understanding the land-water-food nexus in north-west Kenya

Professor Dame Henrietta Moore, director of the Institute for Global Prosperity at UCL, received a partnership grant to examine the land-water-food nexus dynamics between the Cherangany forest reserve and the semi-arid Kerio Valley regions of Elgeyo-Marakwet in Kenya. The project has

collated, reviewed and greatly extended research data on the land-water-food nexus in relation to historic and potential future environmental changes. It has a particular focus on the possible implications of nexus interactions for local biodiversity loss and livelihood resilience in the region.

“ There is increasing need for localised and grounded research to achieve a fuller understanding of the interconnections between local cultural and environmental resilience dynamics. ”

Professor Dame Henrietta Moore

Organic resource use in rural Ethiopia

Professor Euan Phimister, from the University of Aberdeen, received a networking grant in 2015 to facilitate a collaboration between his research team and farmers, householders and policymakers from Halaba District and its wider region in Ethiopia. Subsequently, the team has received a partnership grant to expand and carry this work forward, with a focus on questions such as: how to increase

the amount of organic matter incorporated into the soil to improve soil fertility, water conservation and production for food, fibre and fuel? How to improve water availability, its use and governance? What are the impacts of economic constraints, cultural and social norms on the adoption of relevant new technologies by individuals and communities?

The energy-climate-food security nexus in Northern Ireland

Professor Sally Shortall from Newcastle University (and formerly Queen's University Belfast) received a partnership grant to explore the energy-climate-food security nexus in Northern Ireland. Drawing on analysis of how global changes in climate and energy supply relate to Northern Ireland's regional food security, her project has brought together a cross-disciplinary team of researchers with a range of stakeholders (including farmers, food retailers and processors, the NI Department of Agriculture & Rural Development, community networks and environmental NGOs). Together, they have developed a range of plausible scenarios for the future of the food system. The risks associated with these scenarios have then been explored in greater depth, with the aim of developing contingency plans and building

regional resilience. This project also aims to establish an ongoing network of stakeholders and researchers focused on NI food security in the face of nexus challenges.



Will Bakker on Flickr

Engaging with business

From the start, meaningful engagement with business was a core aim of the Nexus Network. We recognised that many companies are grappling with changing patterns of production, resource use and consumption that pose long-term business risks – as well as creating some opportunities.

Our work with business stakeholders has been led by Dr. Jake Reynolds and Dr. Gemma Cranston at the Cambridge Institute for Sustainability Leadership (CISL), drawing on CISL’s twenty-five year track record of building business leadership capacity to tackle global challenges.

Natural Bridge workshop on business-led action from nexus thinking, April 2015



In April 2015, the Nexus Network convened a workshop at the University of Cambridge, attended by forty senior business leaders and academics. The event explored the dependencies of business supply chains on nexus-linked resources and commodities. Three interactive sessions (on dairy, cotton and timber) investigated how nexus thinking could be applied to think through some of these production challenges. Discussions at the workshop revealed that, while nexus issues are not necessarily at the top of corporate agendas, the effects of these interactions are being felt at different parts of many value chains, and have implications for maintaining licenses to operate, and for brands and reputations.

Nexus Network

↑ Participants at the Natural Bridge workshop in Cambridge, April 2015

“ Although there are ‘legitimate concerns that co-operation with business could compromise independence or resemble consultancy rather than fundamental research... neither need be the case. Companies need sound, multidisciplinary, long term research engagement to address the dilemma of managing the food-energy-water-environment nexus while maintaining bottom line and competitive performance.”

Dr Jake Reynolds, Cambridge Institute for Sustainability Leadership

Nexus 2020

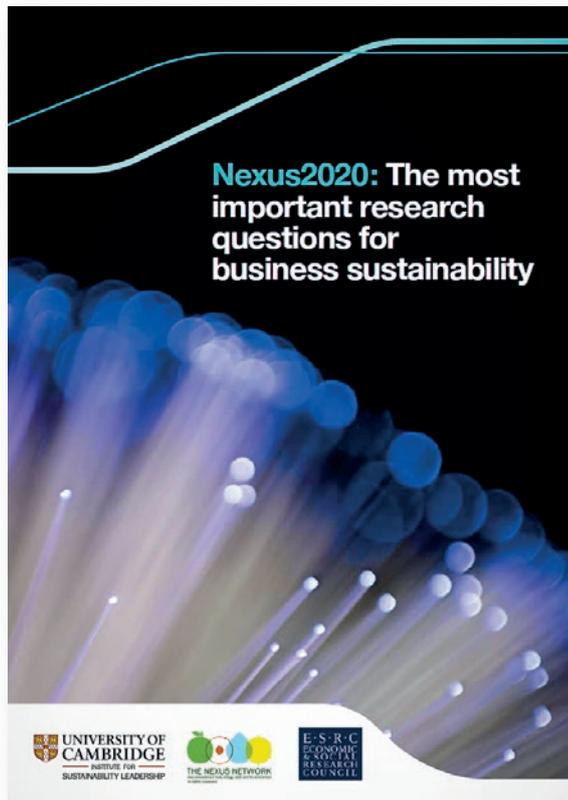
The most ambitious aspect of the Nexus Network’s engagement with business was the Nexus2020 project. Over a number of months, this convened senior business people and leading researchers to identify the most important questions facing companies as they try to manage impacts and dependencies on food, energy, water and the environment. The project gathered a total of 722 questions over a five month consultation process. This was followed by an intensive two day workshop, at which a core group of business leaders and academics whittled the list down to the forty questions seen as most vital to managing the nexus.

These questions were clustered around five themes, representing priority areas for future research and cross-sector collaboration:

1. Incentives for change;
2. Collaboration and stakeholder engagement;
3. Investing in sustainability;
4. Supply chains taking a landscape approach;
5. Making better policy.

A crucial feature of the Nexus2020 exercise was the co-creation of research questions by business and academia. This ensured that the final list of questions is both relevant to business and answerable through multi-disciplinary research.

In October 2016, the results of the Nexus2020 exercise were published as a paper in the journal *Sustainability Science* (<https://link.springer.com/article/10.1007/s11625-016-0402-4>). This was followed by a final report in December 2016 aimed at a business audience (available at www.thenexusnetwork.org/nexus2020-business-report/).



← The Nexus 2020 final report.



← This paper was published in October 2016 as a co-authored output by participants at the Nexus2020 workshop.

“ This report highlights the benefits of co-design between the private sector and researchers by using a collaborative approach to shape research priorities that will inform policy and innovation. ”
 Andy Gibbs, Head of Economic Performance & Environment, ESRC

Reflections from a multidisciplinary team

The Nexus Network's core team spanned several universities and a range of disciplines. Here, some of our team members offer their reflections on the process of stimulating, supporting and communicating transdisciplinary research.



Professor Ian Bateman University of Exeter (environmental economist and Nexus Network Co-I)

"From its outset the Nexus Network has been a consciously ambitious undertaking, attempting not only to unite across the different academic perspectives needed to understand the complexities of the relationships between people and the environment, but also to bring together the diverse groups of real world public sector and business decision makers necessary to make those relationships more sustainable.

Given this vaulting ambition, perhaps a reasonable assessment should not be to examine whether the Network succeeded or not, but rather to consider the extent to which it shone some light onto why those relationships are so fraught. And in those terms the Network has proved a significant success. From an

academic perspective, the need to unite the natural and physical sciences with economics and the political and other social sciences has

been flagged up as the crucial intellectual advance needed to provide adequate guidance for future decision making.

It is to the credit of the Network that this challenge has been elucidated as never before. The network has also highlighted both the practical necessity of working with public and business decision makers and the tremendous intellectual input that

they bring to these endeavours. Only through collaboration across disciplines and partnership with decision makers will we co-design, co-develop and co-implement sustainable solutions to the human-environment challenge."

“The need to unite the natural and physical sciences with economics and the political and other social sciences has been flagged up as the crucial intellectual advance needed to provide adequate guidance for future decision making.”

Professor Ian Bateman



Dr. Jake Reynolds and Dr. Gemma Cranston CISL, University of Cambridge (sustainable business and Nexus Network Co-Is)



“Many companies do not utilise ‘nexus’ terminology at all and when they do encounter it may view the idea –with some justification – simply as a rebranding of past attempts to handle interdependence and complexity in decision-making.

As a result the term is associated mostly with academic discourse. In response we have sought to focus on real business problems as opposed to theoretical nexus arguments, viewing them as live arenas in which to study nexus challenges in such a way that they can be addressed as well as theorised. Business problems invariably have one or more sets of

interdependencies at their heart that cannot be addressed through mono-disciplinary research.

Our key learning from the Nexus Network is that transdisciplinary research (conceived and implemented with – as opposed to for – its users) is our preferred approach. Given the different motivations of business and academia, transdisciplinarity is not an easy path to follow. Yet the benefits are worthwhile: the opportunity to apply outstanding research capabilities to environmental and social challenges at a global scale through high-impact corporate value chains feels like a prize worth pursuing.”

“Our key learning from the Nexus Network is that transdisciplinary research (conceived and implemented *with* – as opposed to *for* – its users) is our preferred approach.”

Dr. Jake Reynolds and Dr. Gemma Cranston



Dr. Saurabh Arora and Professor Lyla Mehta SPRU and IDS, University of Sussex (development studies and Nexus Network Co-Is)



“As researchers focussing on the global south, we were initially rather wary of the ‘nexus’. This was not simply due to the abundance and overuse of fuzzy buzzwords in fields such as development studies, but because we felt that most nexus framings presented the interdependencies between food, water, energy and the environment as objective and

“As researchers focussing on the global south, we were initially rather wary of the ‘nexus’.”

Dr. Saurabh Arora and Professor Lyla Mehta

adequately measurable. It also appeared that ‘nexus’ was a rather different problem for experts and policy makers than for local people who live with and recognise resource interconnections in everyday life. The trade offs around ensuring water, food and energy security for some at the cost of others tended to be

depoliticised, thus obscuring the dynamics of social power underpinned by hierarchies based on gender, class, location, race, ethnicity and caste.

We responded by calling for the need to foreground alternate 'nexus' framings that emphasize action for environmental and social justice in resource politics; the strengthening of the rights of marginalised actors and social

movements over centralised control by powerful state and corporate actors; alliances between historically-marginalised subaltern groups to further resistance against dispossession and expulsion from resources; solidarity among grassroots movements to create sustainable localities that link up and work together democratically. Only time can tell how successful this foregrounding has been and will be."



Dr. Ruth Welters University of East Anglia (Nexus Network Communications and Impact Manager)

"Through my efforts to communicate the work of the Nexus Network, I have encountered a diversity of ways in which the nexus concept is understood. In the natural science community, the fact that nexus elements are "inextricably linked" is to state the obvious. Many social science colleagues understood the nexus in a different way, focusing rather on the tensions and trade-offs between elements and pointing to the need to consider impacts

on, and involvement of, people, power and politics. While our experience has revealed

“Many social science colleagues understood the nexus in a different way, focusing rather on the tensions and trade-offs.”

Dr. Ruth Welters

diverse understandings and foci for research, this hasn't deterred people from getting involved in the Nexus Network. There are now almost 2000 people on our mailing list, and this vibrant community has contributed through blog posts, research, reports, and participation in events

to the creation of space for debate, sharing and learning."

Conclusions and lessons for ESRC, UKRI and the research community

For people dedicated to the pursuit of breakthrough ideas, the UK's research community can be surprisingly conservative. There is a tendency to favour incremental tweaks over radical upheaval of the policies and structures for funding and collaboration. Disruptive change seems to occur no more than once-in-a-generation.

So in 1965, the Science and Technology Act established the procedures for creating research councils, as a contribution to Harold Wilson's ambitions for the "white heat of the scientific and technological revolution." In 1993, William Waldegrave as science minister published his "Realising our Potential" white paper, which called for a new partnership between public and private research, and the establishment of six new research councils.

And we are now in a moment of equivalent – perhaps greater – change. The Higher Education and Research Bill – currently making its way through Parliament – will draw all seven research councils, Innovate UK and HEFCE's quality-related funding under the new strategic umbrella of UK Research and Innovation (UKRI).

This nine-headed hydra will formally spring into life in April 2018. But detailed work is already underway to ensure that it delivers the step change in UK research and innovation performance that Sir John Kingman, inaugural chair of UKRI, and Sir Mark Walport, its recently appointed chief executive, have promised.

Collaboration and cross-disciplinarity are at the heart of the vision for UKRI, which is accompanied by six objectives:

- a greater focus on cross-cutting issues that are outside the core remits of the current funding

bodies, such as multi-and inter-disciplinary research;

- a strengthened, unified voice for the UK's research and innovation system;
- improved collaboration between the research base, business and the commercialisation of discoveries;
- better mechanisms for the sharing of expertise and best practice – for example, around management of major projects and large capital investment;
- more time for research leaders to focus on strategic leadership through the centralisation of back and middle office functions; and
- improved quality of evidence on the UK's research and innovation landscape through the pooling of multiple datasets.

UKRI will also oversee the Global Challenges Research Fund, which will invest £1.5 billion into development-linked research by 2020; and the new Industrial Strategy Challenge Fund (ISCF) for collaborative research to support innovation, productivity and priority technologies.

The challenge-led approach of GCRF and ISCF, and the ambition for strategic coordination through UKRI, are well suited to cross-cutting issues like the food-water-energy nexus. And it is not only the nexus that will benefit from greater investment: links across human health, urbanisation, land use and biodiversity are equally important.

To date, much of the discussion about UKRI and the new challenge-directed funding schemes has been characterised by an enthusiastic, yet still-



↑ Sir Mark Walport, who will be the inaugural chief executive of UK Research and Innovation.

fuzzy commitment to new forms of collaboration – across disciplines, across sectors and between researchers and research users in business, government or civil society.

Now we have to get serious about new ways of working. To realise the potential of the new funding structures, we need to invest time, effort and resource in growing connective tissue across the UK's research and innovation system.

As the Nexus Network has shown, transdisciplinary research takes us out of our theoretical and methodological comfort zones, and highlights the diversity of ways to understand problems. Getting users involved as coproducers in the design of research projects can further expand our horizons, and ensure the uptake, relevance and impact of our research.

What specific lessons have we drawn from the Nexus Network that could assist ESRC and UKRI during this period of transition?

Creating spaces for transdisciplinary engagement

- **The flexible terminology of “the nexus” is useful as a convening mechanism** to link disparate disciplines and perspectives, and highlight interconnections;
- **Facilitating transdisciplinary engagement is often messy, expensive, and takes time.** End points may not be as envisaged at the outset. It requires patient, flexible investment;
- **Creating spaces and trading zones for engagement is crucial** for transdisciplinary conversations and collaborations;
- **Thematic events are a fruitful way of garnering interest** in an event from a wide range of people beyond academia. However, **incentives to attend such events are limited for many stakeholders**, unless such events are linked to clear outcomes (e.g. policy, business or research funding impact);
- **Innovative formats for events should be encouraged** in order to stimulate creative thinking and diminish the hierarchies or boardroom dynamics that can be associated with more traditional formats.

Methods, skills and capacity building

- **“Nexus-thinking” may have utility beyond food, energy and water.** However there is a danger that a buzzword of this sort is able to obscure or “render technical” issues, which are at their core, social and political, rather than technical and managerial. To avoid this pitfall, **it is important that critical approaches are supported**, which highlight the political nature of these challenges;¹⁰
- **There’s no such thing as a “nexus method”**, but a diverse range of methodological approaches can help to illuminate the complexity of nexus interactions, and facilitate transdisciplinary engagement in research and practice;
- The distinction between qualitative and quantitative methodologies is only one dimension of epistemic culture, and **methodologies can be usefully mapped according to multiple dimensions**;
- There are **strong pressures for certain kinds of knowledge production** which leave their imprint in knowledge practices;
- **Methodological approaches are required which go beyond simple integration or “joined up thinking”** to question power dynamics and facilitate transformation.

Funding transdisciplinary research

- **There is a clear demand for smaller, flexible grants** of £5K– 150k (currently a gap in UK research council funding). This is especially crucial for early-career researchers;
- **Flexibility in grant giving is key to supporting creative approaches** – e.g. funding non-traditional partners (such as NGOs) or awarding short fellowships to support work that doesn't fit into a conventional project model;
- **It is important to provide funding for the processes of co-design of research:** putting together bids is complex and time-consuming, particularly if non-academic partners are involved;
- **Efforts to bridge disciplines & sectors require trust.** This takes time to build, and patient investment is needed if relationships are to be incentivised and sustained.

¹⁰ R. Cairns and A. Krzywoszynska (2016) 'Anatomy of a buzzword: the emergence of the 'water-energy-food nexus' in UK natural resource debates'. *Environ. Sci. Policy*, vol. 64, pp. 164–170



Engaging stakeholders in transdisciplinary research

- **Business participation in transdisciplinary research remains unusual:** academics do not necessarily have the networks nor the experience to work productively with time-poor executives;
- **One starting point is to bring business practitioners and researchers together to co-design research questions,** and agree priorities and ways of working together (as we did with the Nexus2020 project);
- **Placing the user at the heart of the research process** can give researchers the opportunity to study fundamental questions while delivering nearer-term value to companies or policymakers;
- **User-centric multidisciplinary research has the potential to influence policy, business practices,** and in some cases commercial strategy, with positive effects on nexus challenges.

Brokers and boundary-spanners

Working in these new ways isn't easy. Academic reward systems still tend to privilege mono-disciplinary work. Metrics and evaluation systems are underdeveloped. Career paths are less predictable and more risky.

In the past year, there have been various efforts to address these issues. Work by the Academy of Medical Sciences on "team science" and the British Academy's "Crossing Paths" report stand out as particularly helpful.¹¹

Further insights come from "Rethinking Interdisciplinarity", a short book by Felicity Callard and Des Fitzgerald, based on their experience as social scientists of collaborating with neuroscientists through the Hub at the Wellcome Collection. As Callard and Fitzgerald describe, "We set out to write about things that usually get pushed under the carpet: the often deeply-etched disparities in institutional power across the social sciences, humanities and neurosciences...the day-to-day, here-and-now relations and feelings through which collaborative work gets done."¹²

These issues need more discussion as UKRI moves from an idealised blueprint to an operational reality. More creative experiments – of which the Nexus Network is one example – will be required. And focus needs to turn to the people who can make collaborations work; and the skills, training and capacity that they will need.

Some of these people are researchers in universities; others work in knowledge exchange, or in funding agencies. More will be found in the businesses, public bodies and NGOs that academics need to partner with, if the UK is succeed in scaling up the volume and intensity of its collaborative, problem-oriented research and innovation. All of them are brokers and boundary-spanners: the T-shaped people on which the success of UKRI – and our capacity to navigate the nexus – will ultimately rest.

↑ **The British Academy and Academy of Medical Sciences have made timely contributions to debates over interdisciplinarity, ahead of the launch of UKRI.**

¹¹ <https://acmedsci.ac.uk/policy/policy-projects/team-science> • <http://www.britac.ac.uk/blog/crossing-paths-%E2%80%93-british-academy-report-interdisciplinarity-uk-universities>

¹² Callard, F. and Fitzgerald, D. (2015) Rethinking interdisciplinarity across the social sciences and neurosciences. Palgrave Pivot.

Appendix: Nexus Network publications and funded projects

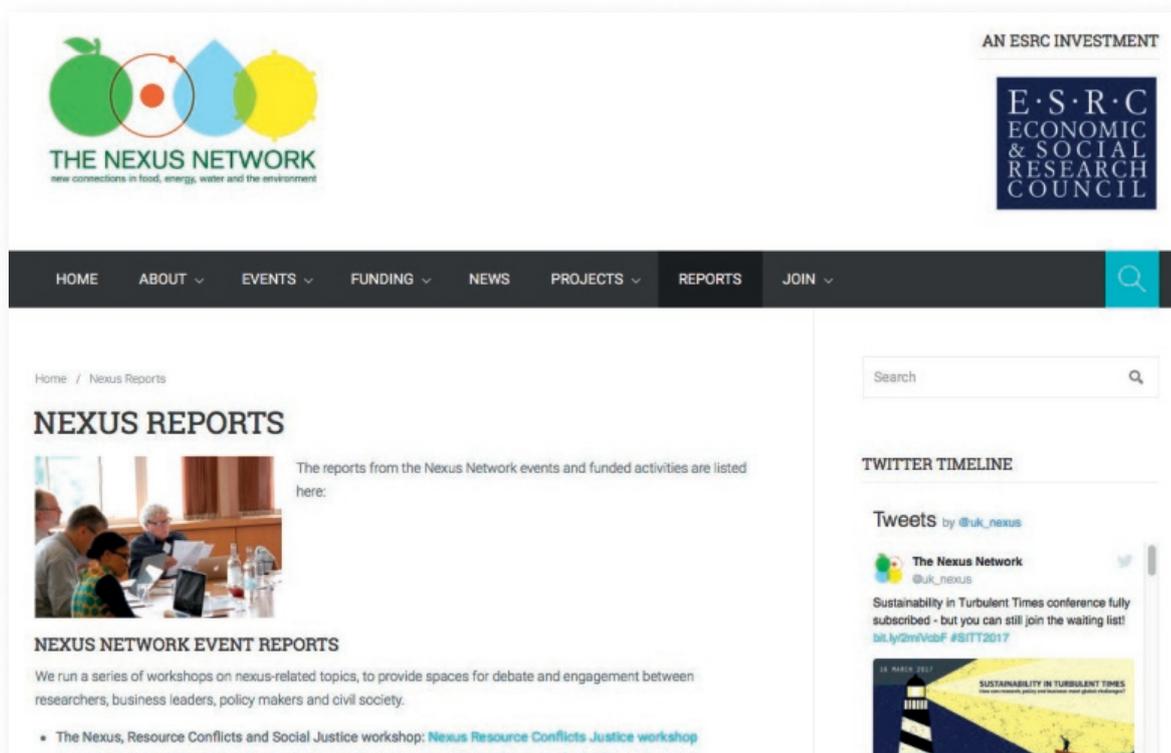
In July 2014, the Nexus Network commissioned a series of thinkpieces to scope and define nexus debates across the linked domains of food, energy, water and the environment. This incentivised rapid idea generation, and

highlighted opportunities for further research, which were pursued through subsequent grant calls.

All the thinkpieces are available to download at: www.thenexusnetwork.org/nexus-reports/

Table 1 Nexus Network written outputs

	Authors	Paper title
1	Joe Williams, Stefan Bouzarovski Erik Swyngedouw (2014)	Politicising the nexus: Nexus technologies, urban circulation, and the coproduction of water-energy
2	Frances Harris and Fergus Lyon (2014)	Transdisciplinary environmental research: A review of approaches to knowledge co-production
3	Christian Stein, Jennie Barron and Timothy Moss (2014)	Governance of the nexus: from buzz words to a strategic action perspective
4	Tatiana Thieme and Eszter Kocacs (2014)	Services and Slums: Rethinking Infrastructures and Provisioning across the Nexus
5	Ben Martin, Peter Cruddas and Paul Hutchings (2015)	Imagining a Sewerless Society
6	Fiona Charnley, Dale Walker and Kzenija Kuzmina (2015)	Fast-Moving Circular Goods 2025
7	Frederik Dahlmann (2015)	Integrating Impact Investment and Nexus Thinking – opportunities and challenges



← A full set of reports from Nexus Network events and funded projects are available on our website.

	Authors	Paper title
8	Jo Smith, Anke Fischer, Paul D. Hallett, Hilary Homans, Pete Smith, Yakubu Abdul-Salam, Hanna Emmerling and Euan Phimister (2015)	Sustainable use of organic resources for bioenergy, food and water provision in rural Sub-Saharan Africa
9	Maria Sharmina, Claire Hoolohan, Alice Bows-Larkin, Paul Burgess, James Colwill, Paul Gilbert; David Howard, Jerry Knox and Kevin Anderson (2015)	The nexus in a changing climate: a critique of competing demands for UK land
10	Subhes Bhattacharyya, Nicola Bugatti and Hannes Bauer (2015)	The bottom-up approach to energy, food and water security in West Africa
11	Roger Fradera, David Slawson, Laura Gosling, Hilary Geoghegan, Poppy Lakeman-Fraser, Karen Makuch, Zen Makuch, Kaveh Madani, Kate Martin, Raphael Slade, Hilary Geoghegan, Andy Moffat and Muki Haklay (2015)	Exploring the Nexus through citizen science
12	Jake Reynolds and Gemma Cranston (2015)	Nexus thinking: can it slow the Great Acceleration?
13	Andy Stirling (2015)	Developing 'Nexus Capabilities': towards transdisciplinary methodologies

Table 2 Nexus Network funded projects

Programme	Principal investigator	Title	Grant
Thinkpieces	Various	www.thenexusnetwork.org/nexus-reports/	£60,000
Networking grant	Candice Howarth	Nexus shocks network	£19,782
Networking grant	Matt Watson	The Domestic Nexus: interrogating the interlinked practices of water, energy and food consumption	£19,992
Networking grant	Guy Ziv	Nexus Impacts of Britain's exit from European Union (Nexus-Brexit)	£20,000
Networking grant	Euan Phimister	Network of Organic Resource use in rural Africa (NORA)	£19,900
Networking grant	Steffen Boehm	Agroecological business: Connecting civil society, SMEs and consumers to nature and the land	£19,498
Networking grant	David Demerritt	The Nexus in Parliament: Supporting parliamentary engagement with environmental and social interdependencies	£17,425
Defra fellowship	Anna Krzywoszynska	Defra fellowship	£18,803
Partnership grant	Matt Watson	Reshaping the nexus at home: Engaging policy understandings of kitchen practices and how they can change	£119,310
Partnership grant	Sally Shortall	The Energy-Climate-Food Security Nexus: Developing a multi-stakeholder deliberative governance model in Northern Ireland	£100,814
Partnership grant (GCRF)	Euan Phimister	Improving Organic Resource Use in Rural Ethiopia (IPORE)	£150,000
Partnership grant (GCRF)	Henrietta Moore	Unraveling complexity: Understanding the land-water-food nexus in Elgeyo-Marakwet, north-west Kenya	£51,000
Partnership grant (GCRF)	Sujatha Raman	Biomass Fuel at the Nexus: Policy Lessons from Bottom-Up Perspectives in Urban Ghana	£55,200
Partnership fellowship	Candice Howarth	Nexus shocks	£51,378
Total investment			£723,552

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University of Sheffield: James Wilsdon (Director)

University of Sussex: Rose Cairns (Network Coordinator); Andy Stirling (Co-I); Saurabh Arora (Co-I); Cian O'Donovan (acting Network Coordinator); Deborah Charman (Administrator)

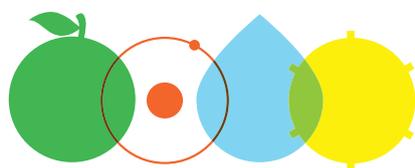
Institute of Development Studies: Lyla Mehta (Co-I)

University of East Anglia/University of Exeter: Ian Bateman (Co-I); Ruth Welters (Communications and Impact Manager)

Cambridge Institute for Sustainability Leadership: Jake Reynolds (Co-I); Gemma Cranston (Co-I); Hannah Tranter; John Pharoah

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THE NEXUS NETWORK
new connections in food, energy, water and the environment
An ESRC investment