

UK Infrastructure Transitions Research Consortium

*Long term dynamics of interdependent
infrastructure systems*

An EPSRC Programme Grant

Jim Hall
Oxford University

Tyndall^oCentre
for Climate Change Research

UKERC
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Propositions

- Transformations of infrastructure systems are required in order to:
 - mitigate carbon emissions
 - adapt to a changing climate and build resilience to extreme events and man-made threats
 - prepare for demographic changes e.g. ageing
 - provide the reliability and service required for a 21st Century advanced economy
- Inter-dependence between
 - infrastructure networks (energy, transport, water, waste, telecoms)
 - the economy and society
 - land use and the built environmentis a complexity, a constraint and an opportunity
- The legacy of decisions and timescales of change are long. Potential for lock-in abounds
- Uncertainties are endemic, but decisions need to be made



Research challenges

1. *How can infrastructure capacity and demand be balanced in an uncertain future?*
2. *What are the risks of infrastructure failure and how can we adapt national infrastructure to make it more resilient?*
3. *How do infrastructure systems evolve and interact with society and the economy?*
4. *What should the UK's strategy be for integrated provision of national infrastructure in the long term?*



The Investigators



Prof Jim Hall (University of Oxford) is Director of the ITRC



Prof Nick Jenkins (Cardiff University) is an expert in energy supply and transmission



Dr Nick Eyre (University of Oxford) is an expert in energy demand



Prof John Preston (University of Southampton) is an expert in transport systems



Prof Chris Kilsby (Newcastle University) is an expert in water resource systems



Prof Tom Curtis (Newcastle University) is an expert in waste water systems



Prof William Powrie (University of Southampton) is an expert in solid waste and geotechnics



Prof Cliff Jones (Newcastle University) is an expert in the reliability of computer-based systems



Dr Seth Bullock (University of Southampton) is an expert in complex systems



Dr Stuart Barr (Newcastle University) is an expert in geospatial data analysis



Prof Robert Nicholls (University of Southampton) is an expert in the impacts of climate change



Prof Peter Tyler (University of Cambridge) is an expert in regional economics



Prof Mark Birkin (University of Leeds) is an expert in analysis of demographic change



Dr Jim Watson (University of Sussex) is an expert on socio-technical transitions and the governance of energy systems

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... plus a wider research team

- 42 person-years of researchers
- 4 PhD students
- Cambridge Econometrics, CEH Wallingford, Cranfield University
- stakeholder champion: Roger Street
- programme manager: Ben Kidd
- affiliated students and projects

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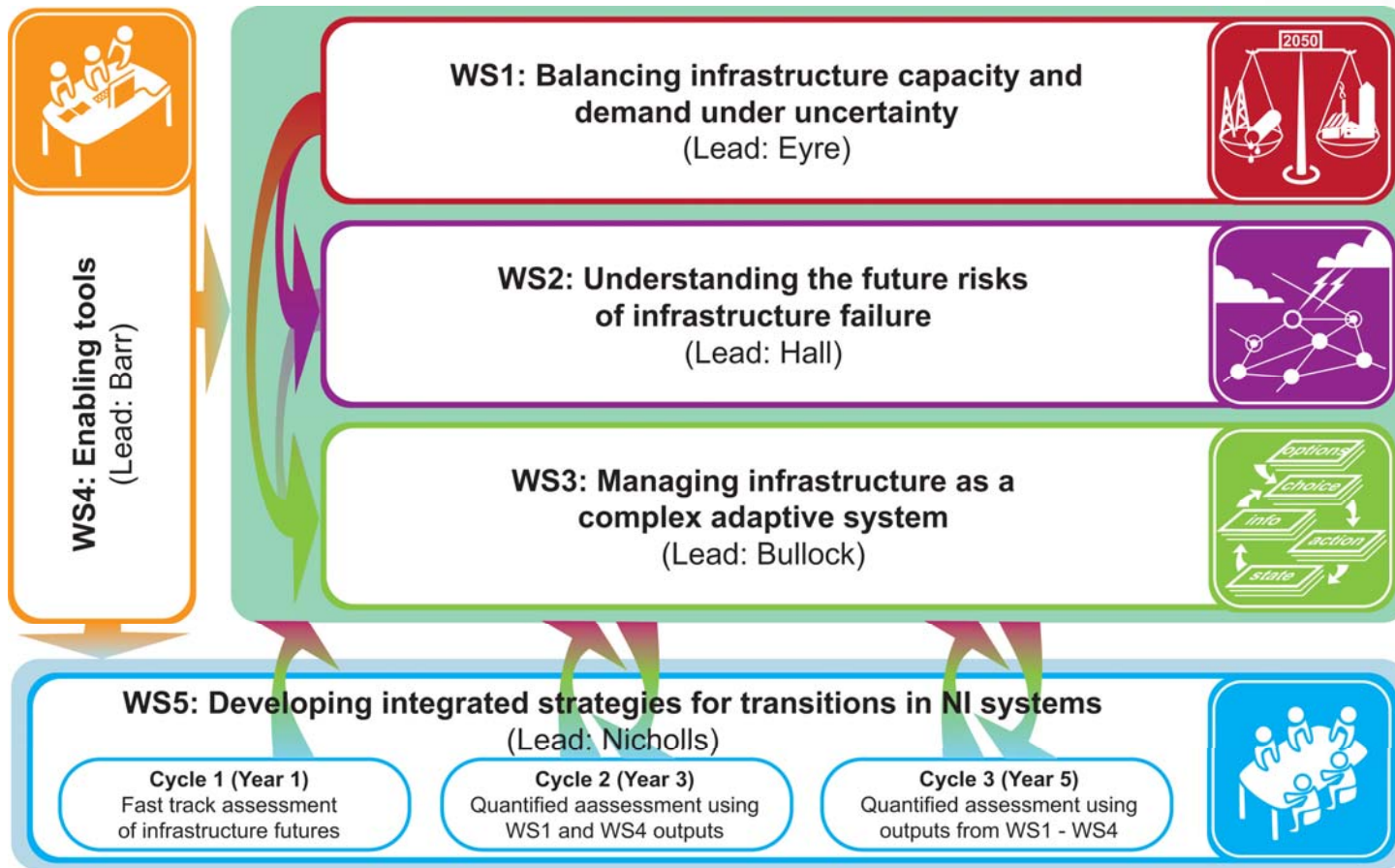


... plus a remarkable group of project partners

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Northumbrian Water
Ordnance Survey
Parsons Brinckerhoff
Royal Haskoning
Scottish and Southern Energy
Swanbarton
Town and Country Planning Association
Transport Scotland
UK Water Industry Research
United Utilities
Veolia Environmental Services
Willis
Yorkshire Water

Structure





Improving decision making



Balancing infrastructure capacity and demand under uncertainty



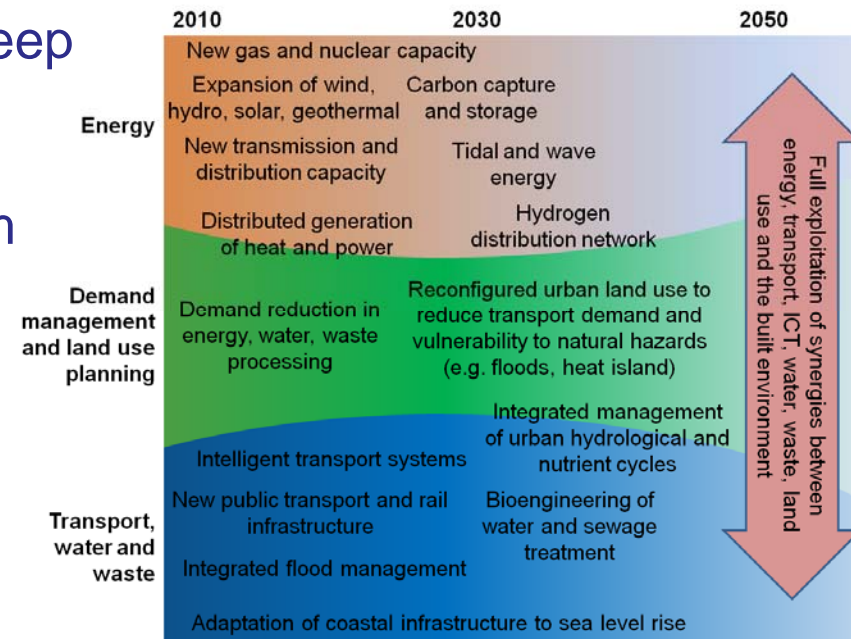
Understanding the future risks of infrastructure failure



Infrastructure as a complex adaptive system

In order to identify **transition strategies** that:

- Exploit-dependence rather than being vulnerable to it
- Robust to uncertainty (min-max, least regrets, info-gap)
- Adaptable (flexible design) and keep options open (real options)
- Resilient (resistance to shocks, capacity to recover and learn from failure)
- Can demonstrably lead to more sustainable outcomes



Outcomes

A new generation of methods for modelling capacity, demand and interdependence in National Infrastructure systems.

National network models to analyse the vulnerability of interdependent infrastructure systems to failure.

Pioneering simulation models of how infrastructure, demography and the economy evolve in the long term.

3 national assessments of how national infrastructure can be transitioned to a more sustainable configuration:

- Year 1: 'Fast track' analysis of possible futures for infrastructure in the UK
- Year 3: Assessment of future prospects infrastructure demand and capacity and appraisal of technology and policy options
- Year 5: Assessment report of the risks of infrastructure failure and the implications for strategies for infrastructure provision

Datasets of national infrastructure, demography, economy, demand and climate hazards



Programme

		2011				2012				2013				2014				2015				RA months and institution	Lead academic
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
WS1 Balancing infrastructure capacity and demand under uncertainty																						Dr Nick Eyre (Oxford)	
1.1	Modelling framework for capacity/demand analysis																					18(A) (Newcastle) + 18(A) (unallocated)	Hall
1.2	Establish scenario dimensions and parameterise uncertainties																					12 (Southampton)	Nicholls
1.3	Regional multi-sectoral economic scenarios																					Cambridge Econometrics	Tyler
1.4	Geographical patterns of urbanisation and demand																					18 (Leeds)	Birkin
1.5	Energy CDAM																					24 (Cardiff) + 18 (Oxford)	Jenkins/Eyre
1.6	Transport CDAM																					24 (Southampton)	Preston
1.7	Water CDAM																					18 (Newcastle)	Kilsby
1.8	Waste CDAM																					18 (Newcastle) + 12 (Southampton)	Curtis/Powrie
WS2 The future risks of infrastructure failure																						Prof Jim Hall (Newcastle)	
2.1	Spatial scenarios of climate-related extremes																					18 (Newcastle)	Kilsby
2.2	Assimilate spatial models of climate related hazards																					6 (Newcastle)	Hall
2.3	Characterise the vulnerability and interdependence of NI																					12 (Newcastle)	Barr
2.4	Interdependent network models																					24(A) (Newcastle) + 18(A) (unallocated)	Hall
2.5	ICT and cascading failure																					1 PhD (Newcastle)	Jones
2.6	Economic consequences of NI failure																					24 (Cambridge)	Tyler
WS3 Infrastructure as a complex adaptive system																						Dr Seth Bullock (Southampton)	
3.1	Co-evolution of urban/industrial land use and infrastructure provision																					24 (Leeds)	Birkin
3.2	Economic implications of long term changes in infrastructure supply and demand																					1 PhD (Cambridge)	Tyler
3.3	Dynamic network models																					24 (Southampton)	Bullock
3.4	An new generation of NI complex system models																					12(A) (Southampton) + 16(A) (unallocated)	Bullock
WS4 Enabling tools																						Dr Stuart Barr (Newcastle)	
4.1	Spatial database development																					12(A) (Newcastle)	Barr
4.2	Tools for uncertainty and sensitivity analysis																					4 (Newcastle)	Hall
4.3	Tools for decision analysis																					4 (Newcastle)	Hall
4.4	Info-gap analysis for development of robust transition pathways																					1 PhD (Newcastle)	Hall
4.5	Real options analysis for development of transition pathways																					1 PhD (Newcastle)	Hall
WS5 Co-production with stakeholders of integrated transition strategies																						Prof Robert Nicholls (Southampton)	
5.1	Co-production Cycle 1: alternative infrastructure futures																					12(A) (Newcastle) + 12 (Southampton)	Hall/Nicholls
5.2	Infrastructure governance																					24 (Sussex)	Watson
5.3	Co-production Cycle 2: Interdependent systems' transition pathways																					24(A) (unallocated)	
5.4	Co-production Cycle 3: Dynamic adaptive transition strategies																					24(A) (unallocated)	
Project Management																						Prof Jim Hall (Newcastle) (PI)	
Project management support and coordination																						24 (Newcastle)	Hall
Web site construction and maintenance																						4 (Newcastle)	Barr
Stakeholder coordination																						12 (Oxford)	Street

Programme review (MS2) and co-production Cycle 2 (Task 5.3) prioritise opportunities for final phase of innovation and integration

Programme review (MS2) targets further tool development

Key
MS Milestone
A Anchor researcher



Next steps and forthcoming events

ITRC Assembly:

- 15 June: Stakeholder workshop to review approach and initial results for the Year 1 Fast Track analysis (Task 5.1)
- 16 June: ITRC researchers assembly
- 17 June: Expert Advisory Board meeting

7 June: Infrastructure Resilience and Adaptation showcase event

24 June: ARCC workshop with Scottish government and stakeholders

30 June: Infrastructure Resilience conference at Leeds University

tba: Network Rail infrastructure adaptation workshop

September 2011: launch workshop for ITRC Work Stream 2

January 2012: Launch of the ITRC Fast Track analysis (national conference)

March 2012: Invited session on Infrastructure Sustainability at the Planet Under Pressure global conference London (joint with World Bank and OECD)



UK Infrastructure Transitions Research Consortium

For further information visit :

<http://itrc.org.uk/home/>

or email:

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