

A Network Approach to Resilience: UK's Infrastructure Transitions Research Consortium

Interview with Professor Jim Hall, ITRC, Oxford University

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Cross-Sector 'Network' Approach to Infrastructure and Resiliency

Transportation, energy, telecommunications, water and other infrastructure sectors are all essential interconnected elements that have enabled activities we take for granted in modern society. Achieving a high degree of resiliency and sustainability in these networks of infrastructure requires consideration of the interdependencies among different assets and the corresponding social and economic activities they support. However, these networks are often managed in a siloed manner, leading to missed opportunities for planners, developers and operators to collaborate and converge.

In an increasingly resource scarce environment, highly integrated approaches to infrastructure development will be critical for governments and private developers/operators. New projects will need to address not only rising demand but also pressing existential threats such as climate change and global pandemics. Furthermore, new "smart" approaches involving extensive digital modeling, open data policies, and advanced information and communications technologies (ICT) have the potential to enable new modalities for cross-sector collaboration and convergence. Identifying these relationships and opportunities could smooth the path for high-risk, high-reward public infrastructure initiatives by mobilizing private sector resources and capabilities. While these technological achievements have been groundbreaking, the massive scale and essential nature of public infrastructure calls for effective governance to manage their application and achieve truly transformative benefits.

Infrastructure Transitions Research Consortium – Modeling Interdependencies in Infrastructure Networks

To better understand the relationship between the theoretical potential of such technologies and the reality of their practical application in physical systems, Washington CORE reached out to Professor Jim Hall of Oxford University to discuss his undertakings in the United Kingdom.

Professor Hall is the Director of the Infrastructure Transitions Research Consortium (ITRC), a consortium of seven leading UK universities and 55 private and public sector partners that has developed the pioneering "National Infrastructure System-of-Systems Model", or NISMOM. As part of ITRC's ambitious goal of creating system simulation models for energy, transport, water, waste and ICT at the national level, ITRC researchers collaborate closely with

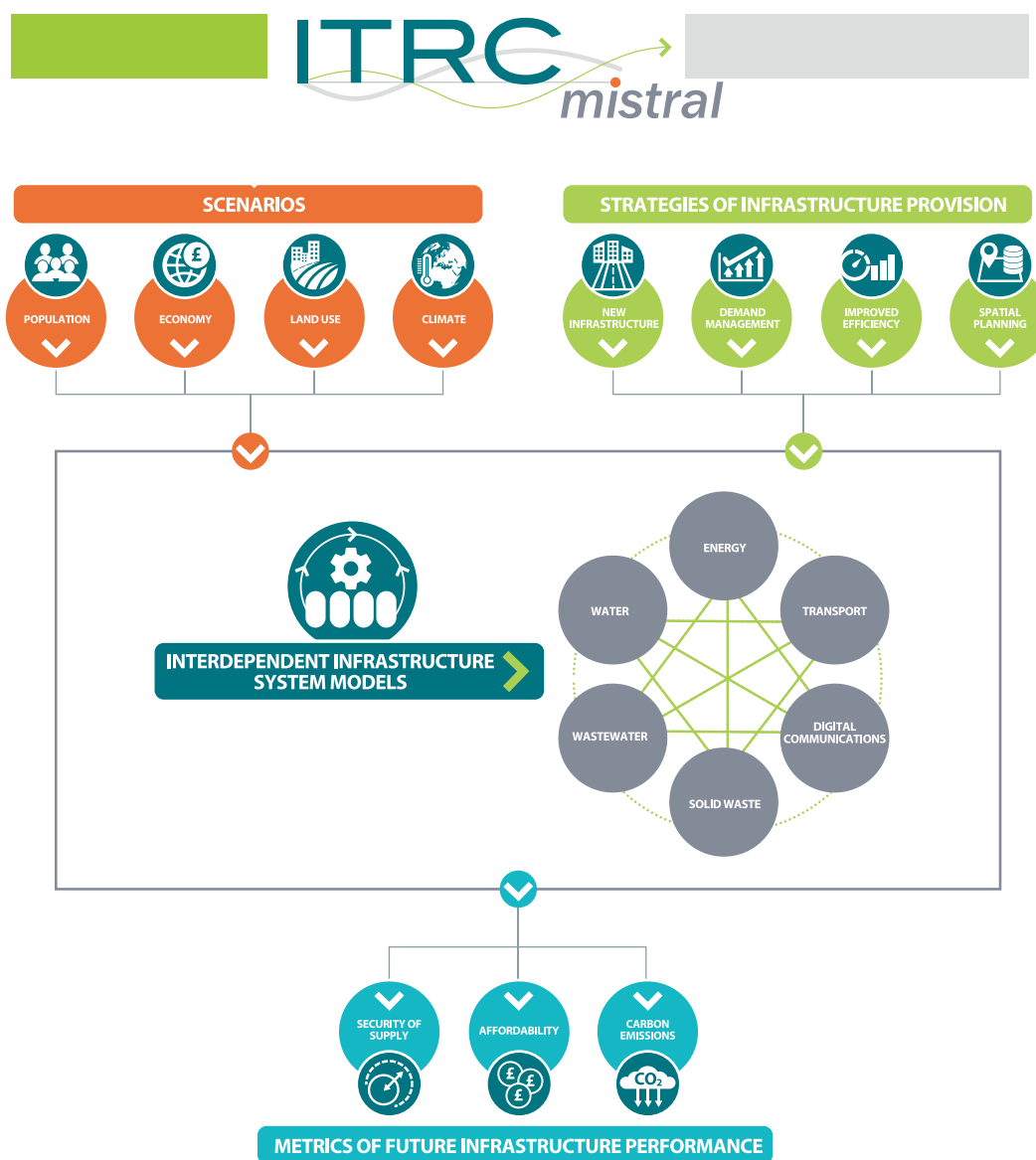


**Professor Jim Hall, ITRC,
Oxford University**

In addition to his role directing the ITRC, Jim Hall is the Director of the Environmental Change Institute at the University of Oxford. His research focuses on the management of climate-related risks in infrastructure systems, in particular those related to flooding, coastal erosion and water scarcity.

stakeholders, including government agencies working in infrastructure, infrastructure owners and operators, and consultants. The ITRC successfully applied for grant funding to establish NISMOD, and has received further resources for its Multi-Scale Infrastructure Systems Analytics (MISTRAL) program to “radically extend infrastructure systems analysis capability” from local to global scales.

This digital tool for infrastructure simulation modeling, system planning, and risk & resilience assessments has been applied to inform the planning and prioritization of investments in public infrastructure in the UK. NISMOD was designed with the objective of analyzing interdependencies between infrastructure networks including energy, transport, digital, water, and waste management to better understand vulnerabilities and how these networks fail via large-scale simulation modeling under a range of possible scenarios, investment plans, policies, and stresses. These scenarios might include natural hazards stemming from climate change or deliberate attacks on critical national infrastructure represent, with outcomes of these experiments used to target adaptation investments to points of weakness in the overall network.



Conceptual diagram of NISMOD, showing how the modeling of cross-sector infrastructure interdependencies under various scenarios can inform infrastructure development planning and prioritization.

In addition to public authorities, private sector stakeholders have a crucial role in financing, building and operating assets, and ITRC’s planning and modeling assists them in identifying and managing risks in infrastructure networks. According to Professor Hall, infrastructure operators may have intimate knowledge of their sectoral assets but less familiarity with cross-sectoral interdependencies, thus NISMOD serves as an important platform for communication and information sharing.

NISMOD and the UK's National Infrastructure Assessment

In an effort to identify infrastructure needs and priorities, the UK, led by the National Infrastructure Commission (NIC), conducted its first National Infrastructure Assessment in 2018. The NIC is an independent executive agency tasked with making recommendations on energy, transport, water and wastewater (drainage and sewerage), waste, flood risk management and digital communications infrastructure investments, allowing for long-term planning and analysis occurring outside of the political cycle. The 2018 assessment made recommendations on a range of issues including climate resiliency, urban growth, transportation and digital technology.

The landmark effort utilized ITRC's NISMOD to model changing demand for transport, energy and water services under a variety of scenarios and assumptions to reveal trade-offs, opportunities and bottlenecks. The application of this tool helps center infrastructure planning and investment prioritization around a detailed understanding of vulnerabilities and the impacts of different adaptation options.

Outside of the UK National Infrastructures Assessment, utility companies, engineering consultants, the Institution of Civil Engineers and other UK agencies have utilized NISMOD to target investments to address risks and synergies. ITRC's innovative approach has also been used to investigate the proliferation of electric heating and how that increase could be used in relation to intermittent electricity supplies from renewables. Other synergies between electric vehicle charging and renewable energy supply could be investigated as well. In the area of mobility, the NISMOD tool has also supported the UK Department for Transport in identifying points of vulnerability in its multi-modal transportation network, and to inform the Environment Agency's long-term investment strategy for flood protection.

ITRC on the Global Stage and the Role of Governance in Promoting Resiliency and Sustainability

Internationally, simplified versions of ITRC's models for infrastructure planning have been utilized in Curacao, Saint Lucia and Ghana. Researchers at ITRC are also working with the World Bank to support the development of a "global resilience platform", as well as informing the prioritization of multi-modal transport decisions in the context of climate change in Tanzania, Viet Nam and Argentina.

Professor Hall opined that addressing interdependencies and building resilience requires government or regulatory intervention to ensure that infrastructure owners and operators utilize these technologies to address large scale externalities and system risks. While individual sectors may achieve benefits within their own silos, forward-looking public-private-academic initiatives like ITRC may be essential to achieve truly integrated solutions. On the surface, innovative technologies may appear to provide easy solutions to complex challenges in infrastructure development, but the vast number of interdependent stakeholders, assets, and scenarios necessitate leadership and coordination.

Website Link: itrc.org.uk

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