UNIVERSITY OF LEEDS

EPSRC Network on
Resilient and Sustainable Infrastructure

26/27 September 2011
University of Cambridge

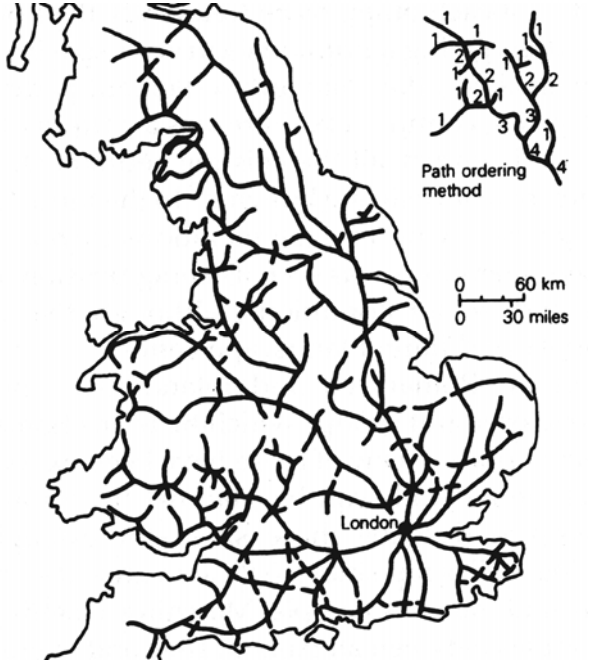
University of Leeds Summary

Barry Clarke

Institute of Resilient Infrastructure

Philosophy

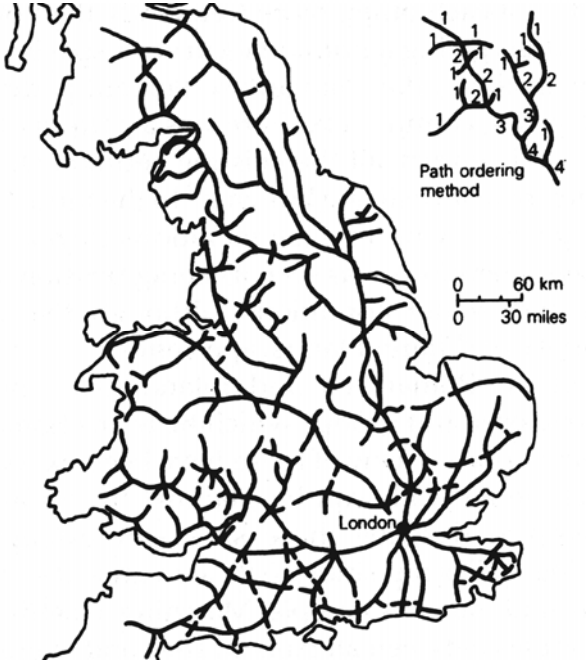
Infrastructure development



- National logistics

- Regional networks

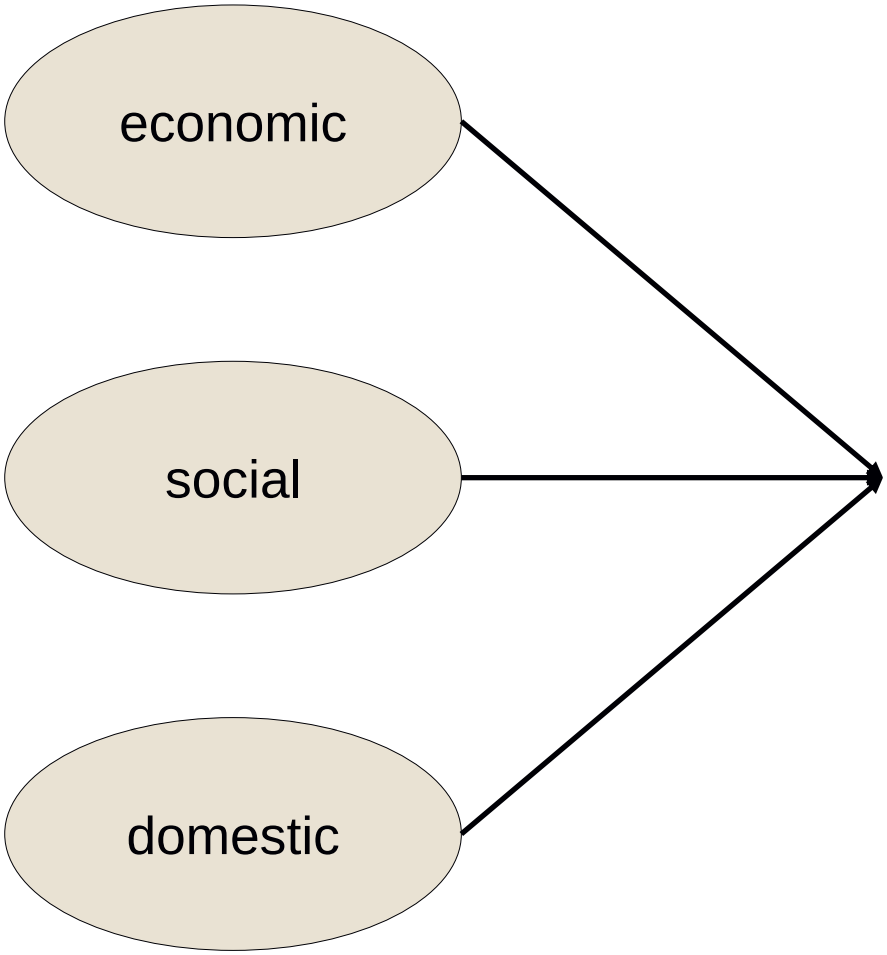
Infrastructure development

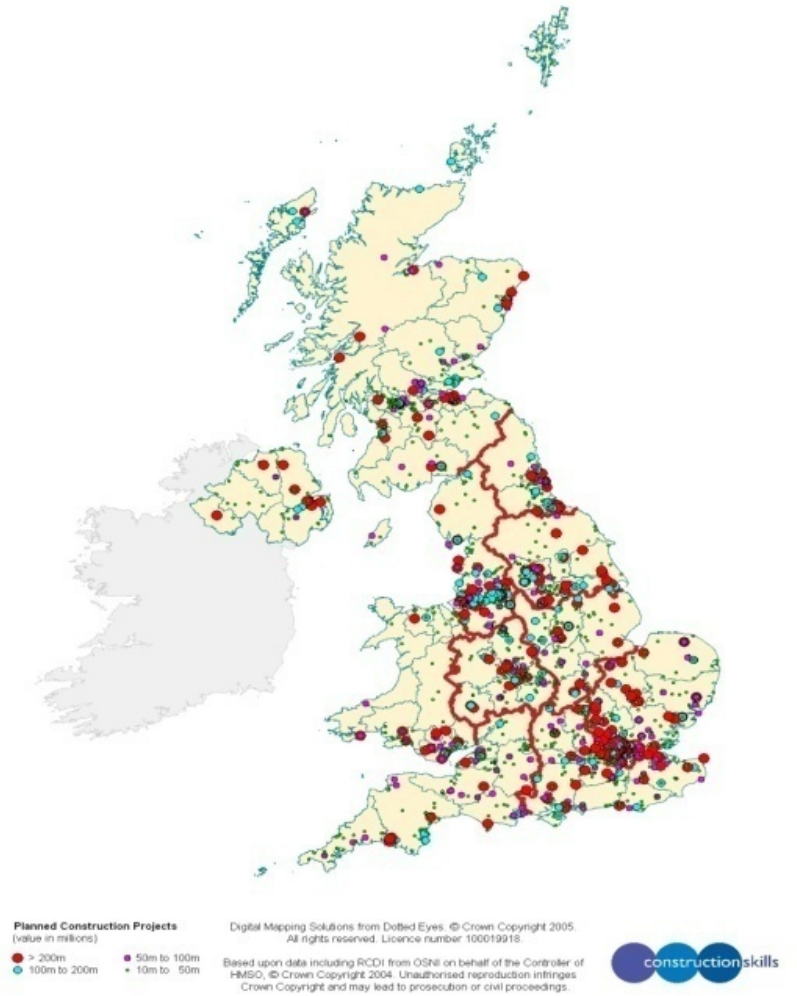


- National logistics
- Roman military (100)

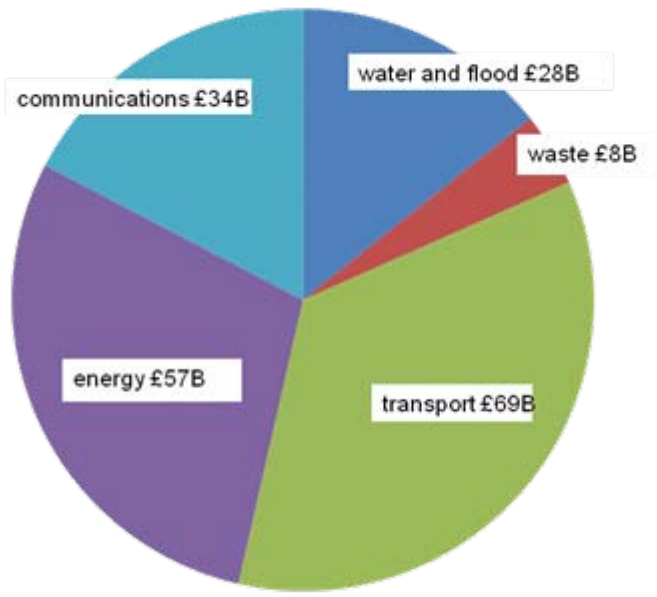
- Regional networks
- Turnpikes (1770)

Scale of infrastructure spend





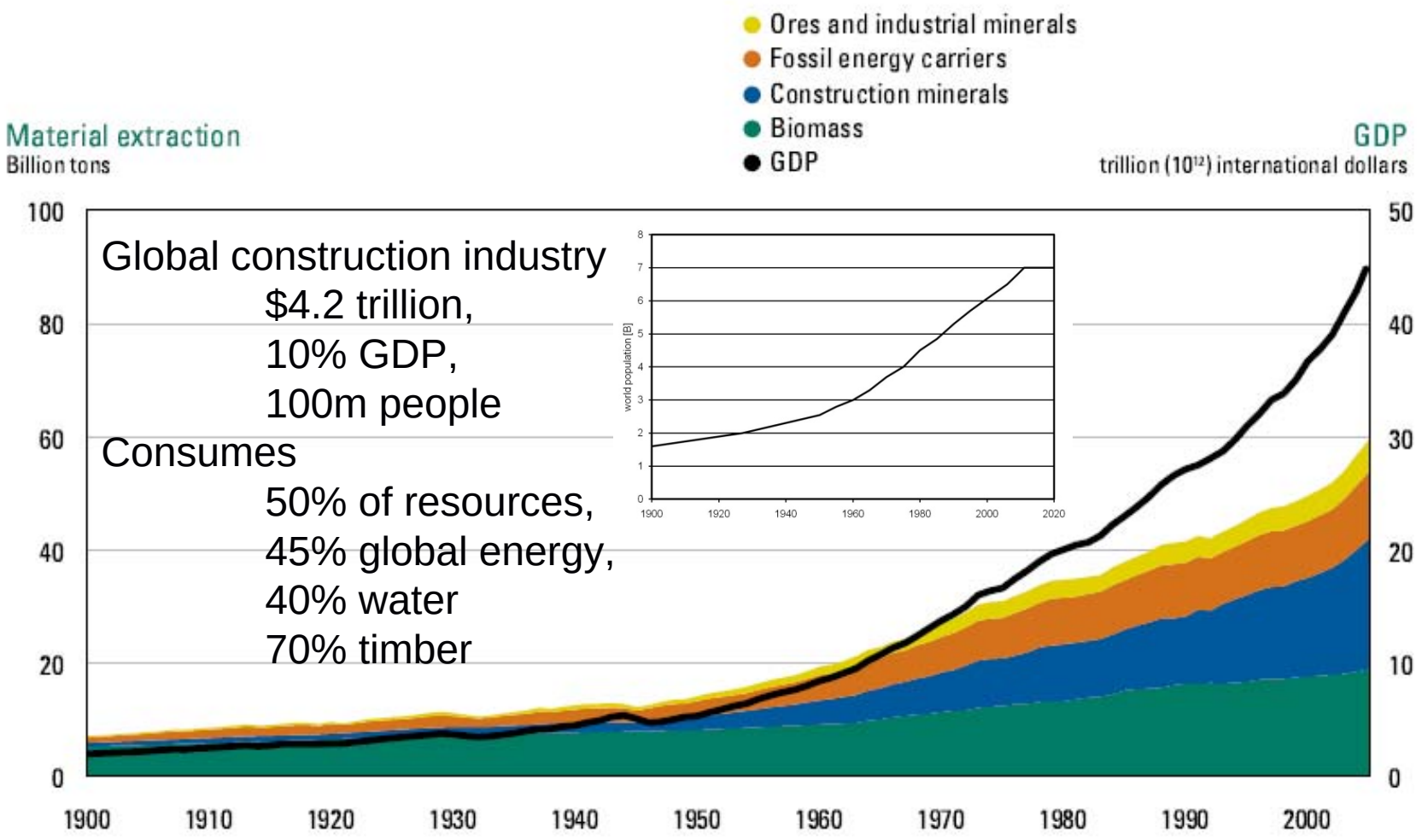
The importance of infrastructure



Annual spend on economic infrastructure

- Economic infrastructure is one of nine pillars of competiveness
- The UK ranks 33rd in the world in terms of the quality of its economic infrastructure
- Infrastructure UK, NIP and NIP2
- USA, UK and India using infrastructure spend to stimulate economy

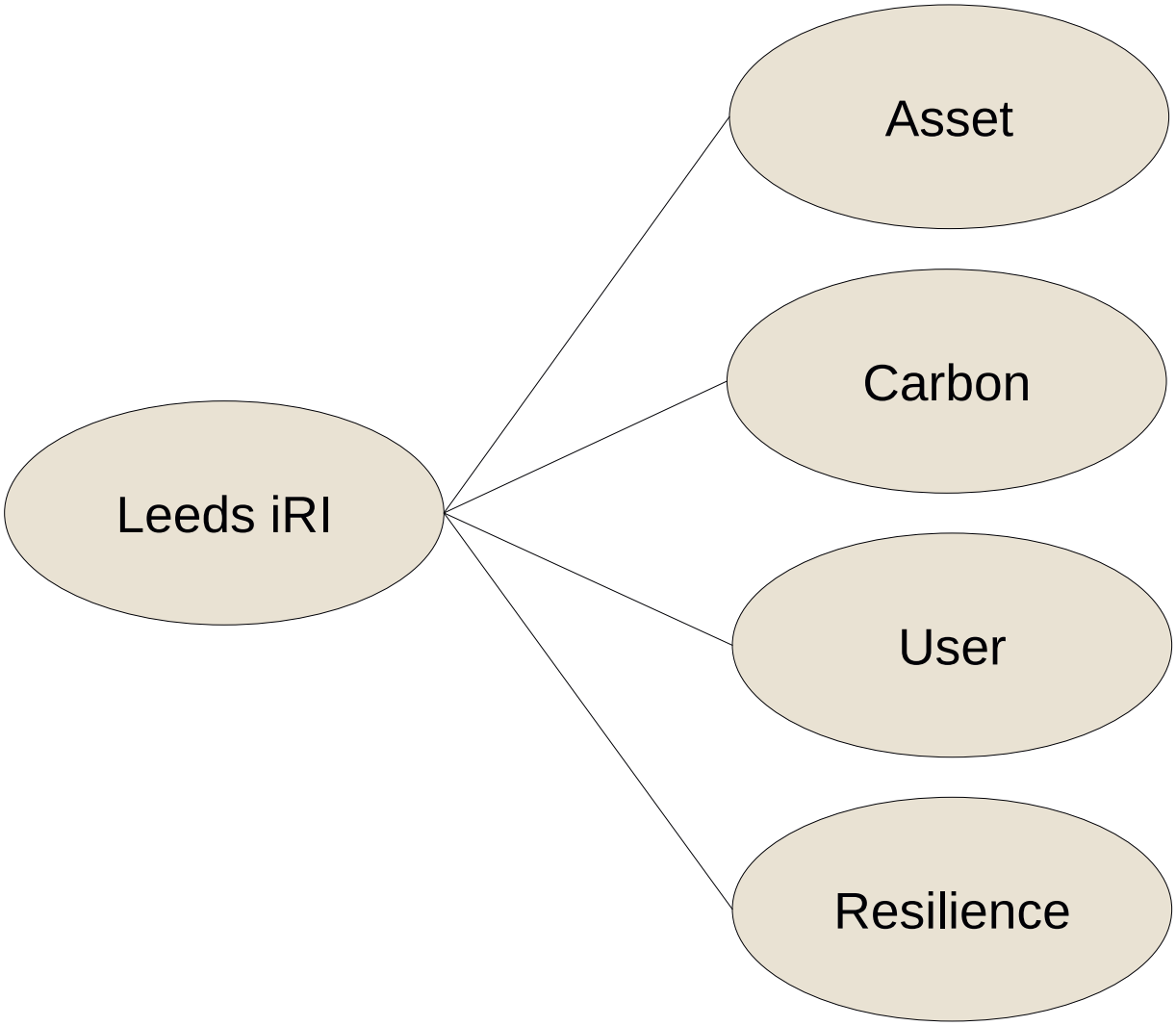
The Anthropocene Age



Source: Krausmann *et al.*, 2009

Themes

Resilient themes

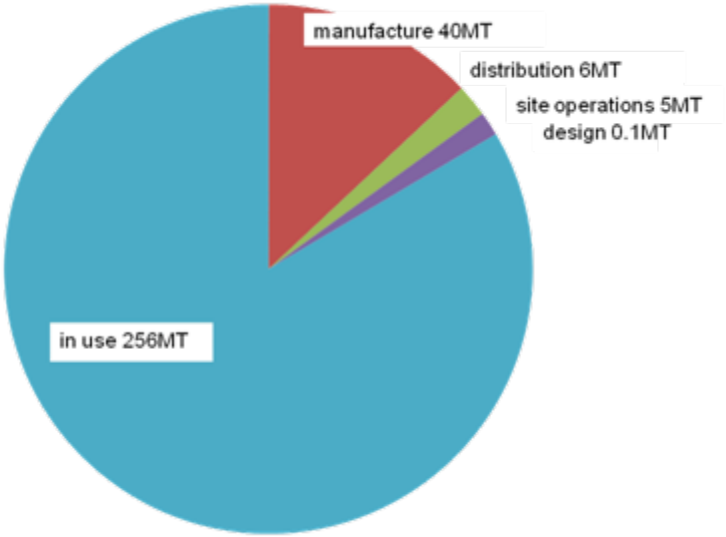


Current projects

- Integral bridges
- Resilient networks
- Asset management
- Ground stabilisation
- Reducing vulnerability
- Undermining infrastructure
- Transport properties of concrete
- Multiple utility service companies
- Lattice structures for composite frames
- Future energy decision making for cities
- Deep underground permanent storage of CO2
- Competency within organisations and individuals
- Supercritical CO2 for stabilisation of industrial waste
- Concrete degradation, cements for radioactive waste, stonework cleaning…

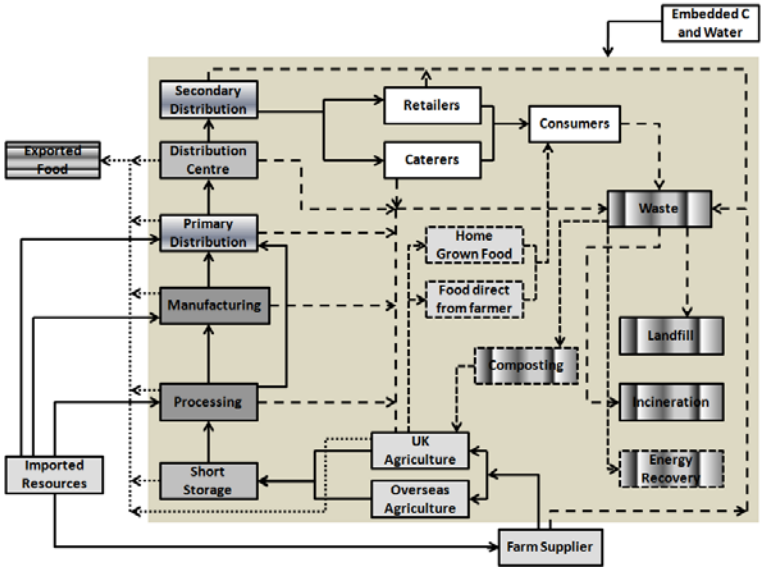
Projects

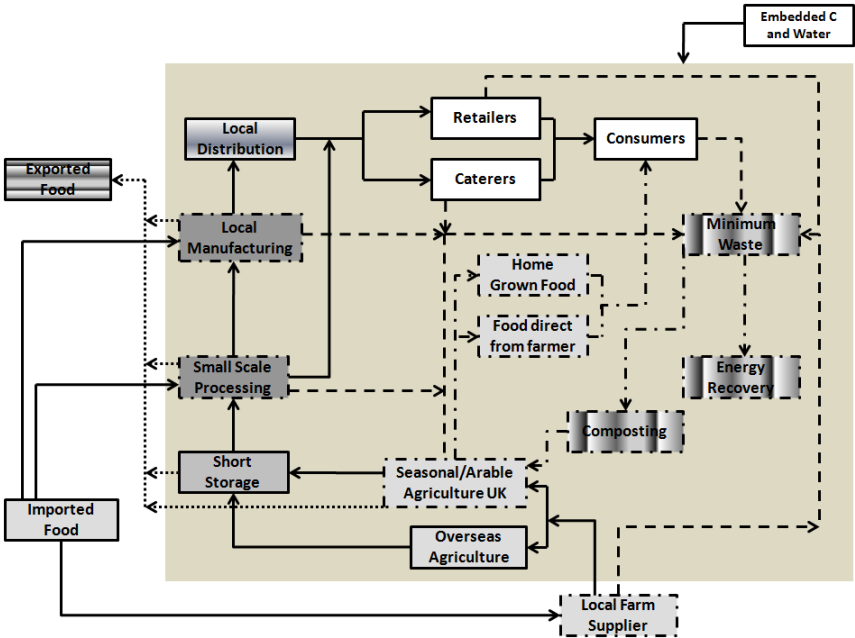
User focused infrastructure (Clarke et al)



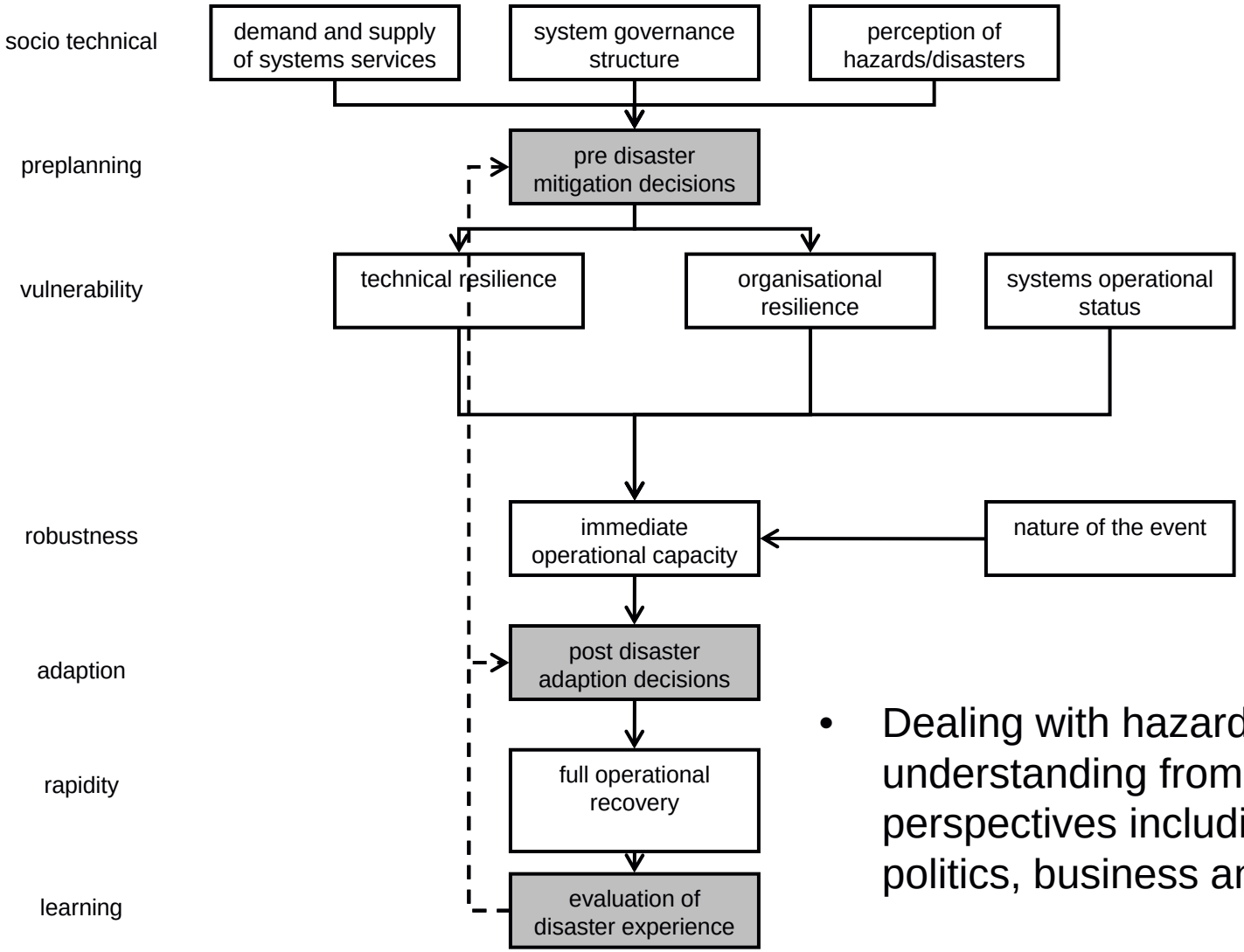
Carbon emmisions for construction

- A low carbon and sustainable future must involve the users in the energy and water infrastructure that underpins all other systems
- Move towards multi functional networks





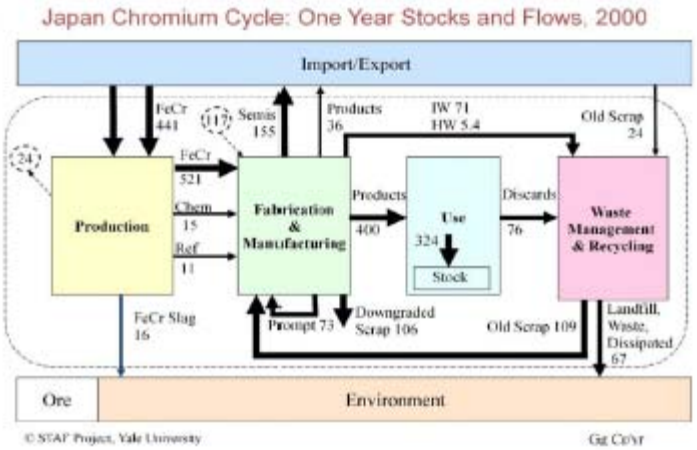
Reducing vulnerability (Wright et al)



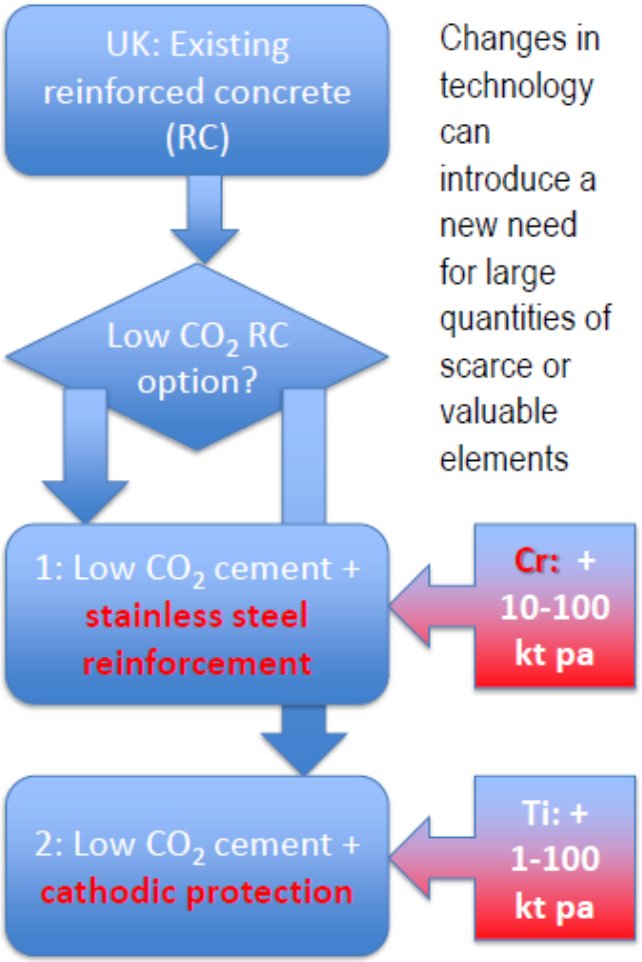
- Dealing with hazards requires an understanding from different perspectives including engineering, politics, business and community

Undermining infrastructure (Purnell et al)

- The UK's physical infrastructure is close to systemic failure and unable to deliver a low-carbon future.
- A radical programme of new green technology will place unknown stresses on the supply of materials not currently used in infrastructure –rare earth metals in wind turbines, Li & Co in electric vehicles, Cr & TI in low-carbon reinforced concrete.

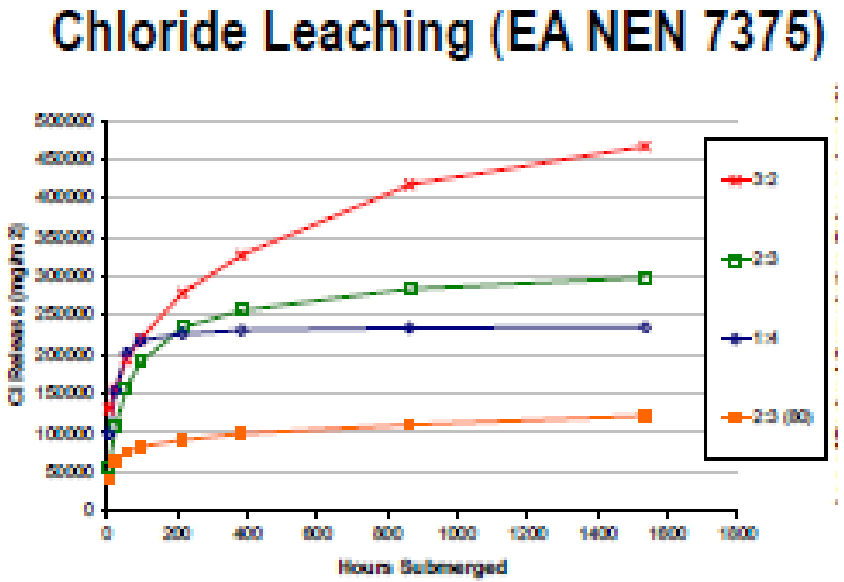


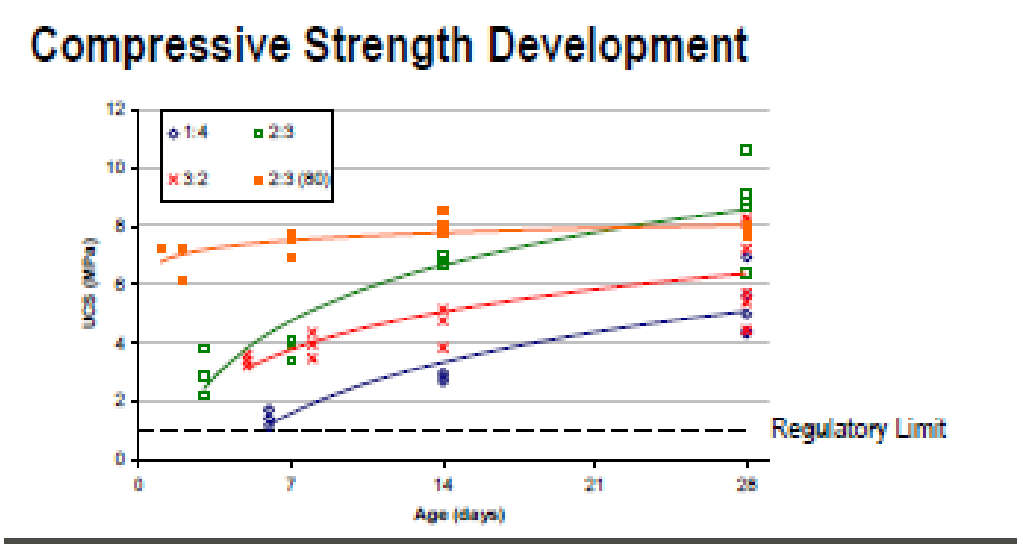
A simple S&F model for Chromium flows in Japan (Yale University, 2000)



Waste management (Black et al)

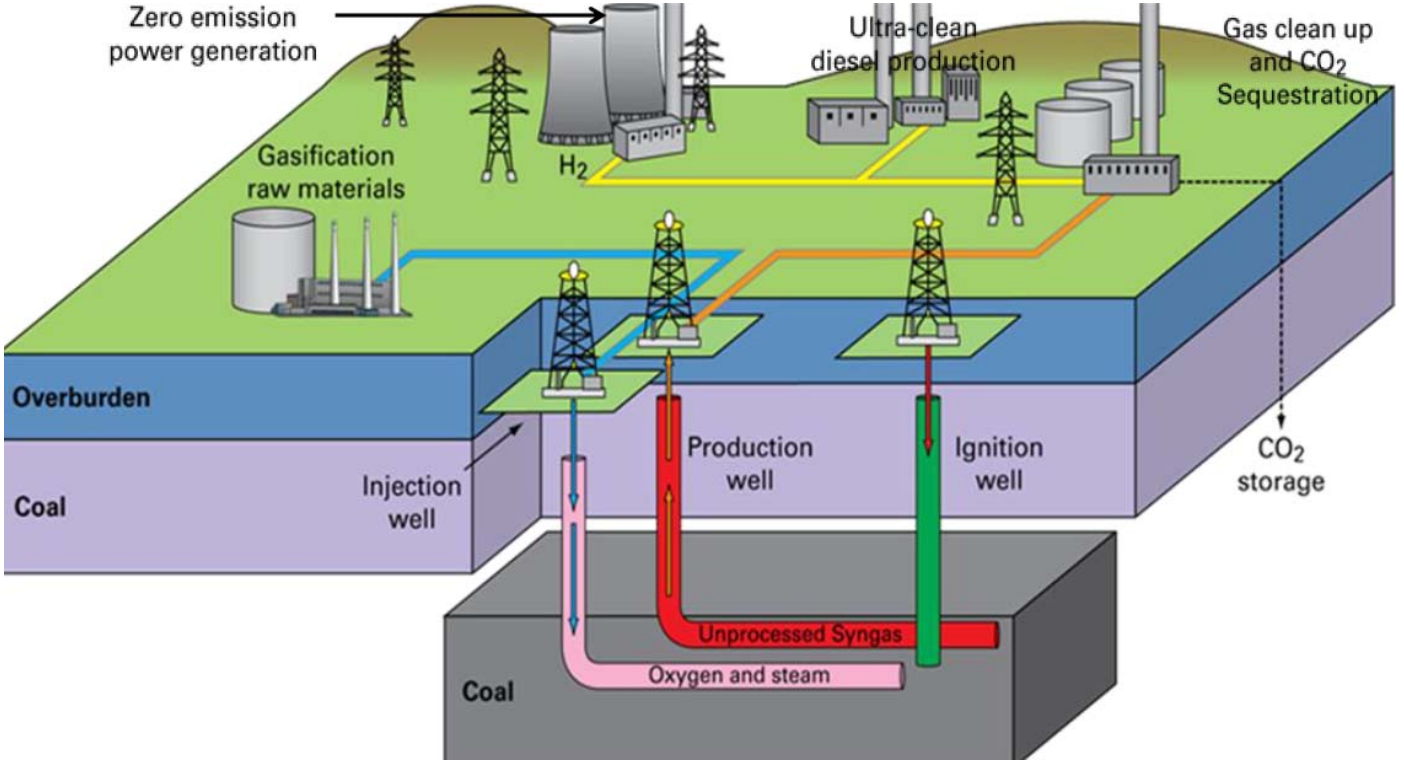
- Cleaning of flue gas emissions from the incineration of residual municipal solid waste in a modern energy from waste facility produces an absolutely hazardous waste stream.
- Investigating the potential of blending waste streams in order to solidify/stabilise APC residues. Wastes utilised include a PFA classed as unsuitable for construction (EN 450) and a waste, aluminium containing caustic solution resulting from an industrial cleaning process.





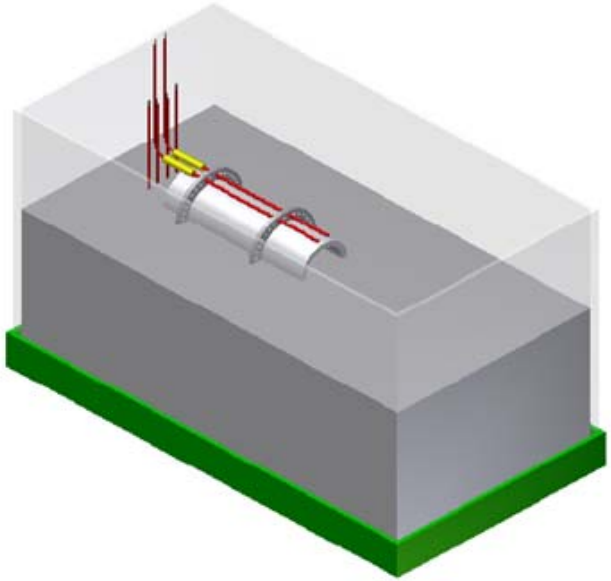
Underground coal gasification (Sheng et al)

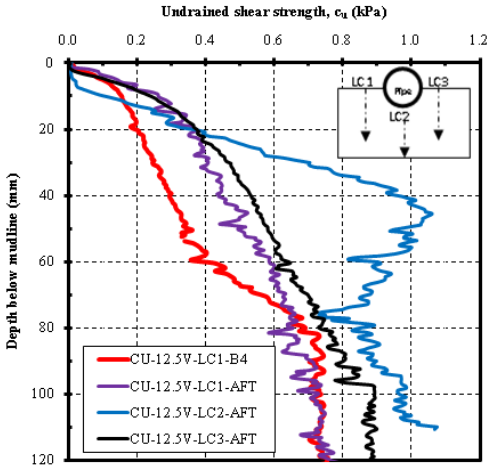
- Exploring a greener, safer and cheaper way of using coal from deep underground seams as an energy source. The depth is sufficient for UCG to be combined with Carbon Capture and Storage (CCS)

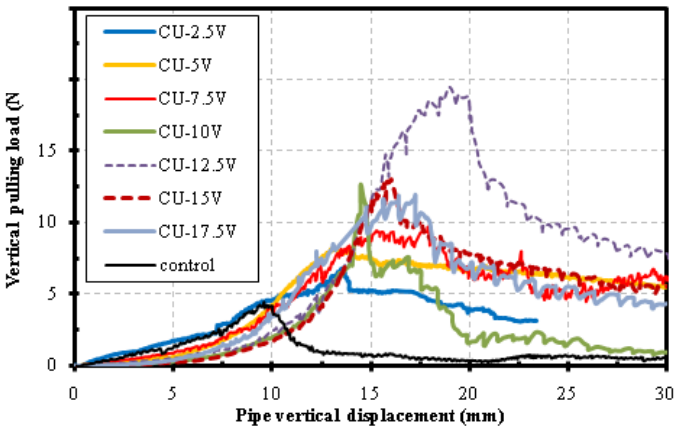


Sea bed stabilisation (Clarke et al)

- Instability problem of lateral buckling and axial walking of offshore pipeline linked with elevated operating temperature and pressure. Engineered buckle solution using electro osmosis. Laying the pipeline in a snake configuration where some specific sections are designed to move during operation while others relatively stable.







Finally

iRI ethos

- User-focussed technical approach
  - Joint research with social science (SRI, ITS, CSTSD…) with broad & deep technical reach back (materials, geotech, hydraulics, management, architecture, optimisation…)
- Resilience as the key to implementing sustainability
  - Resilient infrastructure is low-carbon infrastructure
- Research independent of nature of hazard/threat
  - Overarching ‘rules’ for resilient design e.g. quality
- Multiscale& multidirectional analysis
  - Components & systems, top down & bottom up
- Civil engineering as central policy maker