Moving towards a resilient transport network for the future: integrating meteorology, engineering and social perspectives

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Getting the trains to run on time
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• What will be the nature of the UK transport system in 2050, both in terms of its physical characteristics and its usage?
• What will be the shape of the transport network in 2050 that will be most resilient to climate change?
Change is normal

- EU roadmap Future of Transport 2050
  - Modal shift – “business as usual” not an option
- Over past 50 years in UK
  - 800% increase in road traffic
  - $1:1 \rightarrow 8:1$ road:rail tonne kms of freight moved
- Changing climate (whatever the cause)
  - “Anyone is allowed to have their own opinion, but not their own facts” - Sir John Beddington
- Changing social environment
  - Travel more and for different reasons
Prediction is very difficult, especially about the future (Niels Bohr)

- So what future should we plan for?
  - “Resilience” as flexibility rather than resistance
- How can transport infrastructure be flexible?
  - Maintenance cycles
- Current tools
  - Qualitative not Quantitative
  - Value capacity over resilience
    - Discounting the future
Modelling infrastructure resilience

• Physical infrastructure responds over different spatial and time scales
  • Short-term local drainage,
  • Long-term stability of embankments
  • Response to more intense rainfall in a drier climate?

• Network response is not necessarily the sum of individual infrastructure responses

• What defines network failure?
  • travel delay or events which close the network
User-centred resilience

• Passengers are concerned with mobility rather than particular travel modes
• Infrastructure owners are concerned with revenue
• Mobility is embedded in a wide range of social relationships
  • Not just economic
    • although may have economic consequences
    • e.g. Support for an ageing population
Plausible Futures

• Although we don’t know the destination we know the factors that could change:
  • Social drivers for transport demand
  • Economic supply and demand for transport
  • Environment and Climate
• These need to be included in any analysis
• Multiple perspectives on resilience are also required
Case study route

- London-Glasgow route corridor chosen
  - Economically important
  - Climatic factors vary
  - Geographic diversity
  - Significant sub-routes
Climate and Weather

- **UK Climate Projections (UKCP09)**
  - presents probabilities of different future climates
- **Weather Generator**
  - statistical method of creating sequences of future daily (or hourly) weather that are consistent with climate change projections
  - for a particular location

2050s: 33%/67% probability level
Summer & Winter mean precipitation
Social and Economic

- Many different organisations do forecasts.
- Only sure fact is all of them are wrong.
- Key is the ability to include:
  - Change in behaviour (modal shift)
  - Change in infrastructure and technology
  - Change in attitude (acceptance of disruption)
  - Change in population (and demographics)
  - Change in economy (demand and supply)
  - Change in technology
Calculating Resilience

What has been considered

- Modal choices
- Numbers of users
- Types of users
- Attitudes to disruption
- Infrastructure condition

- Climate change
- Weather Generator
- Not one but many iterations

Calculating Resilience
People do the funniest things

• Major study of travel behaviour
  • Over 2000 respondents
  • What do people currently do?
  • What would people do in the event of disruption?
  • When has a journey failed?
“We travel for fulfilment” (Hilaire Belloc)

• On average long distance travellers decide not to travel if likely delays exceed 2 hours

• ‘Failure’ of public transport
  • Exceeding 45 minute delay
  • Overnight rescheduling without a hotel/refund
  • Toilet facilities / heating are not working
“Half the fun of the travel is the aesthetic of lostness” (Ray Bradbury)

• ‘Failure’ with private transport
  • Exceeding 60 minute delay
  • Road closures
• Less likely to cancel

• 42% would not know exactly which route to follow from London-Glasgow
  • (c.f. 27% rail travellers)
Modal shift

- In heavy snow and ice:
  - $22\%$ people will attempt to travel even when an official warning of ‘not to travel unless absolutely necessary’ is in place.
  - $+25\%$ people do not travel.
  - Rail is a preferred mode.

- In heavy rain:
  - $+6\%$ people do not travel.
  - Rail is the preferred mode.

- In very hot weather:
  - $+4\%$ people do not travel.
  - Air is the preferred mode.
Calculating Resilience

What has been considered

- Modal choices
- Numbers of users
- Types of users
- Attitudes to disruption
- Infrastructure condition
- Climate change
- Weather Generator
- Statistics of network behaviour
- Delays and Recovery
- Calculating Resilience
Calculating resilience

1000 journeys today

1000 journeys in 2050

Change in resilience

Measured as changing number of journeys considered to have ‘failed’
Percentage change of rain-related journey failures relative to baseline for 2050s and 2080s (central estimates)

- **Summer**
  - medium emissions
  - high emissions

- **Winter**
  - medium emissions
  - high emissions
Disaster preparedness

- Electricity/telecoms – weeks
- Road/Rail – months
- Ports/Terminals – years

Aceh province – Jan 2005
ADF project photograph
Disaster preparedness

1. Design life of structure
2. Service life of structure
3. Emergency function of structure system

- Cost-benefit analysis?
- Whole-life cost?
- Resilience as a service?
Conclusions

• Resilience is not an ‘extra’
• Transport must be considered as a system
  • Climatic, Environmental and Social elements
  • Multiple stakeholder perspectives
• Transport infrastructure development needs to be considered with DRM in mind
  • Especially in developing areas
Other projects

- LivingRAIL
  - Barriers (technical and policy) to modal shift to rail
  - Such modal shift must consider disruption
- RSSB – TRaCCA
  - Developing knowledge throughout the rail industry
  - Metrics and Systems thinking in disruption analysis
- MOWE-IT
- Wind Alarm systems
  - Using new NR weather data to improve preparedness, response and recovery to extreme events
- iBUILD – interdependent infrastructure
  - New business models for urban infrastructure development