Ad Hoc Expert Meeting on

Climate Change Adaptation for International Transport: Preparing for the Future

16 to 17 April 2019

Evidence based approach to holistic risk analysis

Presentation by

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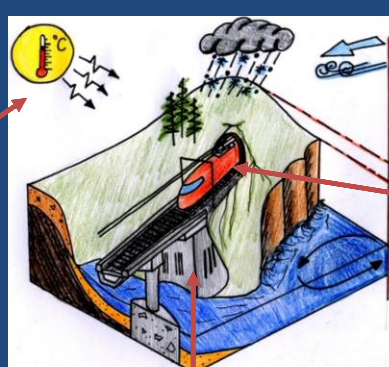
Risk = f(Hazard, Vulnerability, Consequence)

Hazardous Weather

e.g. extreme heat



Consequence of Failure

e.g. organisation, users or stakeholders

Vulnerable Elements

e.g. assets and services

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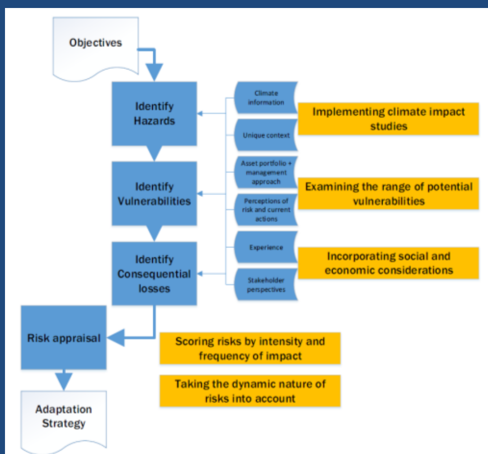
UIC INTERNATIONAL UNION OF RAILWAYS — RAILADAPT

RSSB A Better, Safer Railway — Tomorrow's Railway and Climate Change Adaptation



- How is the **UK climate and weather going to change** in the future?
- What are the **impacts** of climate change and extreme weather going to be on the GB railway?
- What is **being done already** or **can be done** about the impacts of climate change and extreme weather?
- How can we **evaluate the cost and benefits** of dealing with impacts of climate change and extreme weather?

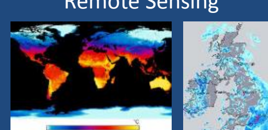
Hazards

Weather Observations

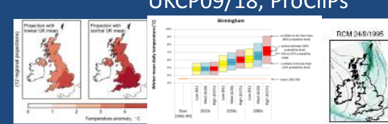
IoT Sensors for Infrastructure

Crowdsourcing

Remote Sensing



Probabilistic projected changes and modelling e.g. UKCP09/18, ProCliPs

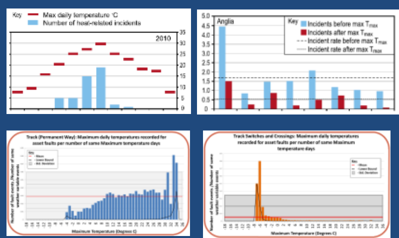


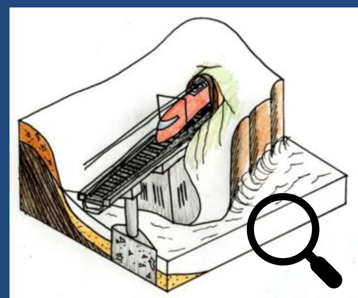
Technical Documents e.g. IPCC AR5

Climate Analogues and Experience

Vulnerability

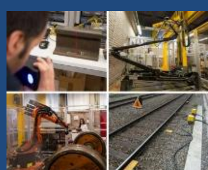
Failure Rates/Probabilities





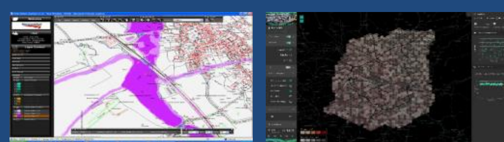
International Analogues

Remote Condition Monitoring



Risk Profiles

Vulnerability Tools



Consequence

What is the purpose of a railway?

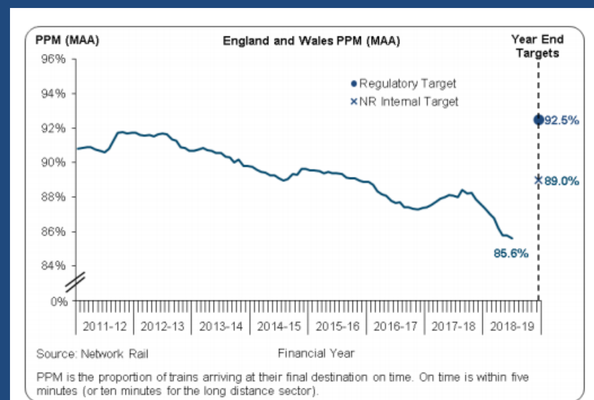
Who are the users and stakeholders?

- Passenger / Freight mobility
- Economic and Social activity
- Environmental mitigation (modal shift)

- It provides a service…
- …which can sometimes fail (risk)
- Investment / maintenance / renewal / repair activities are justified by mitigating risk

Key metrics in modern rail

- Public Performance Measure (PPM)
- % of trains arriving "On Time"
- Trains are punctual if they are ≤5 mins late for short-distance and ≤10 mins late for long-distance



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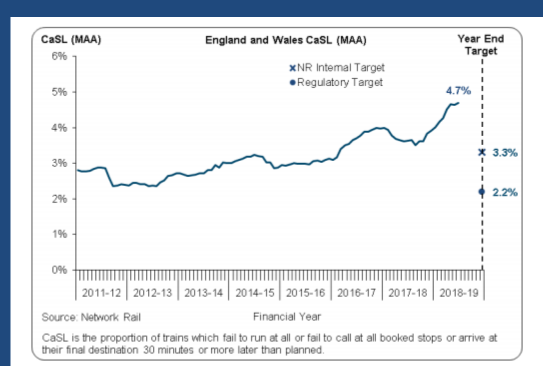
Key metrics in modern rail

- Cancellations and Significant Lateness (CaSL)
- % of trains which arrive at final destination > 30 mins from planned arrival, or full/part cancelled or missed calls



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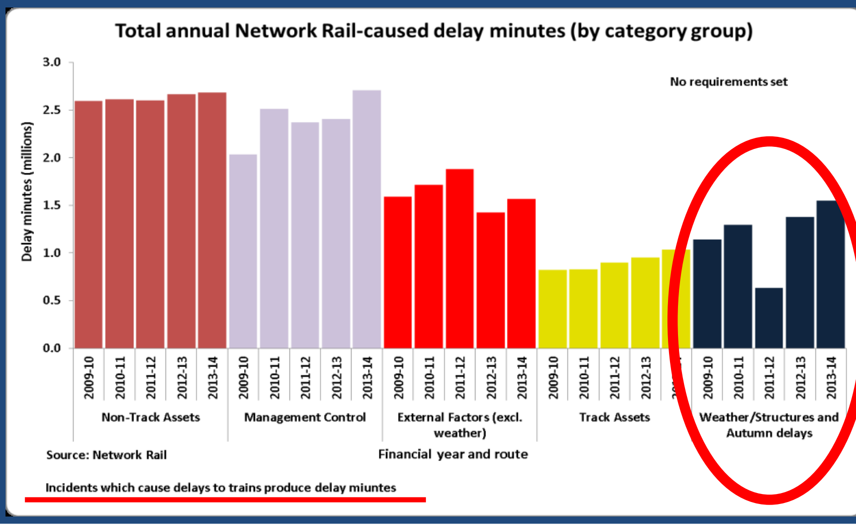
Delay Minutes



Life can only be understood backwards…

- Delay minutes (and thus PPM/CaSL)
  - Excludes 'severe' weather

“no reasonable or viable economic mitigation was possible against the impact of the weather” (DAB 2014)

  - Calculated verses a daily timetable
- Poor links to infrastructure condition or cause
- Therefore not a basis on which to make adaptation (i.e. investment) decisions
- “Past performance is not indicative of future results”

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…but it must be lived forwards

Søren Kierkegaard

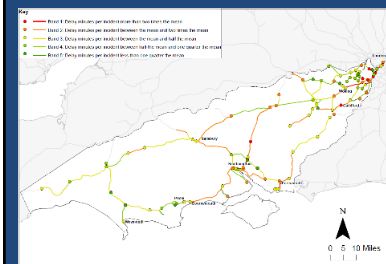
- What is required:
  - basis for adaptation decision making
  - scalability across the industry
    - local identification of 'critical'
    - strategic choices about service
    - next week to next century
  - inclusive of different/external stakeholders and interdependencies…

Identifying **risks** to improve **resilience**

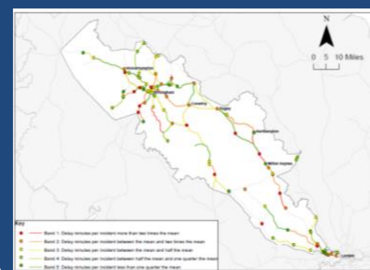
- **Unplanned events** (eg. extreme weather) and asset **breakdown** may disrupt **network operations** and impact **service levels**
- Twin challenge of day-to-day **incident response & maintenance** along with long-term **upgrades/renewals**
- With **finite resources** there is a need for efficient **resource allocation** to **prioritise** interventions/actions

Allocating resources to high risk locations promotes:
✓ **Value-for-money**
✓ **Focused risk management = Improved resilience**

Network Criticality

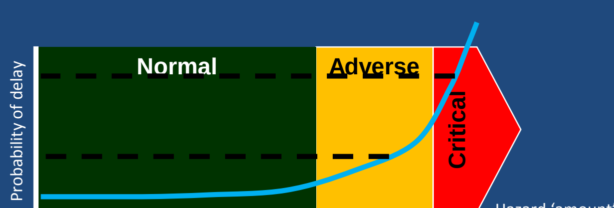


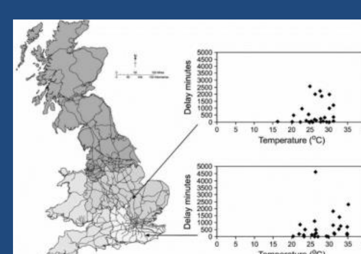
- Identify location-based **single points of failure – formalise priority locations** with high **service performance risk** to aid **decision-making** for resource allocation
- **Regional-scale** assessment – relative priorities for management regions at high level of **granularity**
- Based on **observed fault/disruption** data – captures network **behaviour** (NR TRUST system) through metrics of **asset failure consequence** as delay minutes



Infrastructure Service Availability

- In this case 'journey (un)availability'
- Probability that a given 'element' of the system will cause *N* minutes delay
  - 2 minutes / 5 minutes / 20 minutes
  - May be stakeholder specific





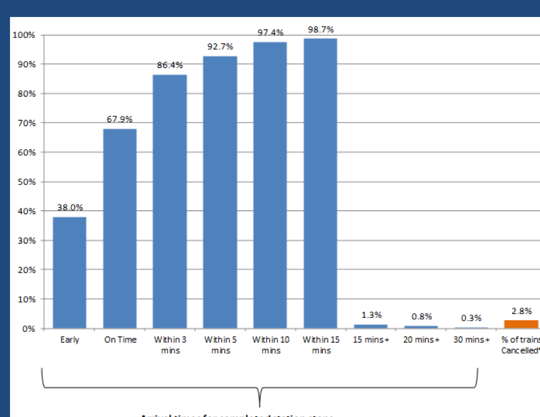
…it is the journey that matters

Ernest Hemingway

- Individual JA/criticality for ‘elements’ can be quantified
  - specific high-vulnerability elements identified and targeted for adaptation in a consistent way
- The vulnerability of a route can be quantified
  - combination of elements along that route
  - for a typical ‘basket’ of hazards (‘stress-testing’)
- The vulnerability of regions, or nationally
  - aggregation of routes
  - weighted by passenger- or service-numbers
  - weighting factors for different stakeholders
    - Infrastructure only
    - Rolling-stock, staffing, stations etc.

Network Rail CP6 Metrics

- Station to station
- Minute to minute
- “Whole journey” focus
- % of trains arriving to the minute at every station from ‘early’ through to ‘30 minutes after’ the timetable
- On Time - % of station stops where train arrived <1min late
- Cancellations - % trains cancelled



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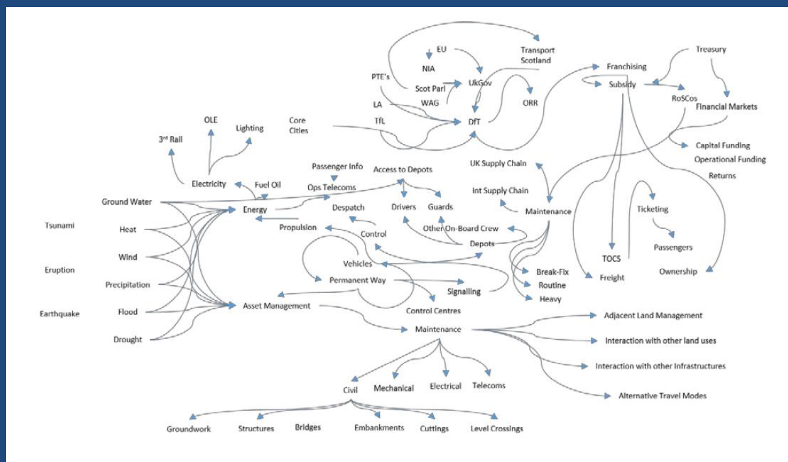
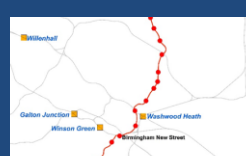
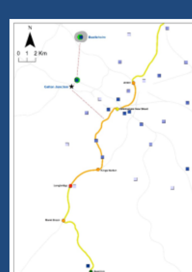


Including interdependencies in criticality…

Cross-sector asset information and locations – where are assets and how are they connected?

Cross-sector network criticality – spatial correlations in risk?





Cross-sector consequence metrics – similar fault reporting and service impacts? Where are the system boundaries?

Date	27/07/2013
Incident Number	831423
Incident Description	GW1 EXTERNAL POWER FLR XGJ
Incident Reason	XK
Incident Reason Name	EXTL POWER
Incident Category	506
Incident Category Description	External other
Section Start Name	GALTON JN
Section End Name	
Section Name	Galton Jn
Route Name	London North Western

DISTRICT	82
DISTRICT NAME	Major Projects West
REF NO	14
DATE AND TIME OF INCIDENT	27/07/2013 09:03
VOLTAGE	132
CAUSE	99
CAUSE DESCRIPTION	Cause Unknown
CAUSE GROUP	Unclassified or Unknown
Customers affected	0
Customer Minutes Lost	0
Primary Number	
Primary Name	Bustleholm - Smethwick 1 (Galton Junction) 132kV

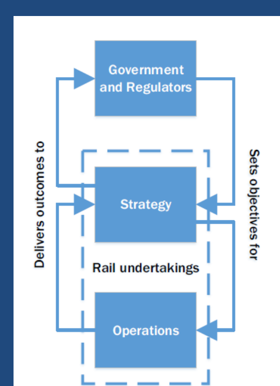
The future depends on what you do today

Mahatma Gandhi

- Poor assumptions:
  - Engineers are representative of general public
  - The future will be just like today (but with extra widgets)
- Future patterns of service use, climate, maintenance, adaptation measures and/or new services / infrastructure can be evaluated with system modelling

Recommendations

- Identifying failure pathways (from root cause, to failure, to consequence)
- Multiple perspectives/stakeholders (organisations, passengers, governance)
- System-wide – elements beyond infrastructure (people and operations)
- Role of sensing/IoT – observe weather/hazards and asset condition?
- Data and information sharing/requirements? (asset location and condition information)
- Develop new/standardise metrics – role of regulators? e.g. ORR
- End to end journeys across modes and interdependencies
- What is the best for system users/passengers?



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UKRRIN