ROADS CReDo TRANSPORT USE CASE DEPENDENCIES RAIL

CReDo's current asset owners have identified transport interdependencies as critical for planning responses to climate events. To enable road and rail networks to join CReDo as asset owners, we mapped out requirements for expanding CReDo into these sectors.

KEY INSIGHTS

Both local and national highway authorities and rail infrastructure operators need to plan future investment based on risks from flooding and the associated cascading infrastructure failures.

What will we do with better insights?

- Amend design specifications
- Target assets for flood risk mitigations

How do I measure my asset network resilience?

- Criticality of asset – costs incurred from failure of asset
- Vulnerability of asset – likelihood of an asset failure, with total costs incurred across predicted failures

ROADS ASSET CRITICALITY RAIL

The failure of road and rail network assets has implications for the infrastructure network and the UK economy.

ROADS PROVIDE CRITICAL ACCESS TO OTHER ASSET NETWORKS

During severe weather events, some critical infrastructure networks deploy containment measures to slow or avoid asset failures. These networks rely on road transport. For example, when sewage pumping stations fail, water companies transport sewage with tankers instead. Similarly, when an asset's power supply fails, back-up diesel generators are transported to the sit.

RAIL DISRUPTION HAS WIDESPREAD NATIONAL IMPACTS

In the rail use case, few assets are likely to be critical to the whole infrastructure system. Unlike the road network, the UK rail network is more dependent on critical infrastructure networks than vice versa.

However, the rail network has wider strategic importance. According to a 2021 report for the Rail Delivery Group, rail freight contributes over £2 billion to the UK economy every year. Additionally, 1.4 billion passenger rail journeys were taken between March 2022 and March 2023. Climate emergency-induced cascading failures that impacts the railway network could cause mass disruption and economic losses.

DRAINAGE ASSETS INFLUENCE FLOODING SEVERITY OF NEARBY CRITICAL INFRASTRUCTURE ASSETS

Highway authorities and railway infrastructure operators manage drainage assets to prevent flooding from their networks. Drainage capacity affects localised flooding levels, in turn affecting the performance of nearby critical infrastructure assets.

ASSET VULNERABILITY

Road and rail network assets are susceptible to flooding or cascading failures.

HOW ARE ROADS VULNERABLE TO FLOODING?

Road bridges and other civil infrastructure are vulnerable to scour caused by heavy rain and flooding which can lead to collapse or reduced load-carrying capacity. Moreover, geotechnical assets (typically adjacent to roads) are at risk of landslips and can lead to road closures.

ASSETS VULNERABLE TO CASCADING INFRASTRUCTURE FAILURES

Road networks increasingly rely on telecoms and power networks for traffic management. In remote areas, fault reporting is often done with cell phones. Variable message signs, lighting, traffic signals, and CCTV cameras are vulnerable to power outages, with consequences for road safety.

HOW IS RAIL VULNERABLE TO FLOODING?

Rail bridges and other structures are vulnerable to scour, which can lead to collapse or reduce the load-carrying capacity of the structure. This reduction in capacity can affect which freight services can operate or impact the maximum linespeed, causing delays. Moreover, geotechnical assets are at risk of landslip and the track ballast itself can be washed away, destabilising the rails. In some locations the traction power supply systems and signalling systems can be short-circuited when wet, stopping normally signalled train operation, in turn causing significant delays.

ASSETS VULNERABLE TO CASCADING INFRASTRUCTURE FAILURES

Signalling assets, telecoms cabinets, and track circuits are powered by railway-owned distribution network operator (DNO) cubicles, which in turn rely on the power distribution network. Rail operating centres, which control signalling for wide swathes of the network, also rely on the power grid.

DATA REQUIREMENTS

To make full use of CReDo, highway authorities and rail infrastructure operators need to share data on asset types vulnerable to flooding and external infrastructure failures. To model the impacts of road and rail asset failures on the whole system, existing asset owners within CReDo need to share additional data. The diagram below illustrates which asset datasets are required, what attributes are needed in each dataset, and which asset owners own these datasets.

Required attributes — Location | Capacity | Design characteristics | Connections to power supplies | Containment measures

Road asset data

- Roads — Location, Design characteristics
- Drainage systems — Location, Capacity
- Geotechnical assets — Location, Design characteristics
- Bridges — Location, Design characteristics
- Electric signs — Connections to power supplies

Rail asset data

- Buildings — Location, Containment measures
- Structures (e.g. bridges) — Location, Design characteristics
- Telecoms equipment — Location, Design characteristics
- Traction power supply — Location, Design characteristics
- Signalling power supply — Location
- Signalling system components — Location, Containment measures
- Signalling Control Centre — Location
- Track formation and alignment — Location

CONNECTIONS TO OTHER ASSET NETWORKS

Water

Road: Locations of backup generators

Road: Locations of tanker depots

Road: Tanker routes

Telecoms

Road: Locations of backup generators

Power

Road+Rail: Distribution network power supplies

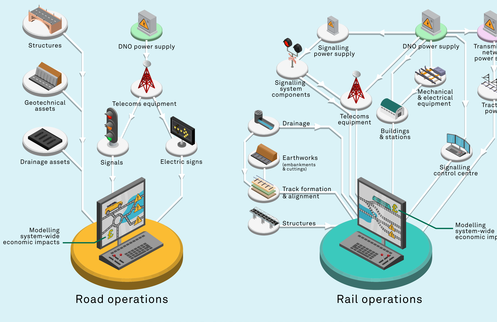
Rail: Transmission network power supplies

TECHNICAL DEVELOPMENT REQUIREMENTS

The diagrams below illustrate knowledge graphs of the road and rail sectors, which outline the connections between assets at risk of flooding or external failures. To represent these sectors within CReDo, the individual failures of assets in these knowledge graphs need to be modelled. The connections in these graphs can be used to model knock-on effects of asset failures on the whole system.

- Flooding impacts to be modelled for Assets
- Potential new asset owners
- Assets already in CReDo

INCORPORATING ROAD/RAIL NETWORK ASSETS INTO SYSTEM-WIDE CASCADING FAILURE MODEL



MODELLING SYSTEM-WIDE IMPACTS

INCORPORATING ROAD NETWORK ASSETS INTO NEW ECONOMIC MODELS

Incorporating road operations into CReDo enables the ability to model the impact of flooding on the costs of containment measures deployed for water treatment and telecoms assets. This modelling could involve the following steps:

- Show most effective routing for tankers (that will have width and height restrictions for using certain roads) from the depot to pumping station or to the destination on a flood impacted road network. This should take into account the road closures and speed restrictions.
- Estimate operating costs (e.g., fuel and driver) and time impacts of deploying containment measures, such as the use of tankers to transport water.
- Decision making by the highway and local authorities can also be supported by comparing standard assumed costs of routing tankers and generators to site against the costs arising from the flooding simulation for different flooding risks. The assumption is that tankers and generators will have to travel longer or slower routes, leading to higher fuel costs. This is more likely to be true in more remote areas with sparser road coverage.

ADAPTING EXISTING ECONOMIC MODELS FOR ROAD AND RAIL NETWORKS

CReDo has implemented an economic model that calculates the total economic costs to the system from individual asset failures. This needs to be adapted for road and rail network assets. However, the methodology relies on parameters that do not translate neatly to a road or rail context:

- Units of service
- Number of customers per asset
- Willingness to pay for each unit of service

To adapt the methodology to road and rail network assets, more research needs to be done on what these parameters would be. Alternatively, another methodology to model the economic costs of asset failure could be developed.

ENABLING REQUIREMENTS

Connect with and engage key experts within road and rail organisations for further research.

Strategic resilience planners

- Create credible business cases for investment in climate adaptation measures.
- Develop a consistent methodology to measure asset resilience that is inter-operable across sectors.

Asset data strategy teams

- Is the required data available?
- Where is the data stored?
- How easily can it be shared?

Asset managers and engineers

- Does your organisation have asset failure models for your network that can simulate flooding?
- If not, then you will need to engage with expert elicitation processes and your maintenance teams to create more detailed failure models for your assets OR provide past data on flooding- induced asset failures.

CReDo