Strategic geotechnical asset management challenges

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Ground related risk to transportation infrastructure, The Geological Society
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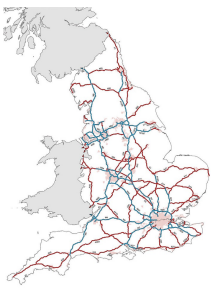
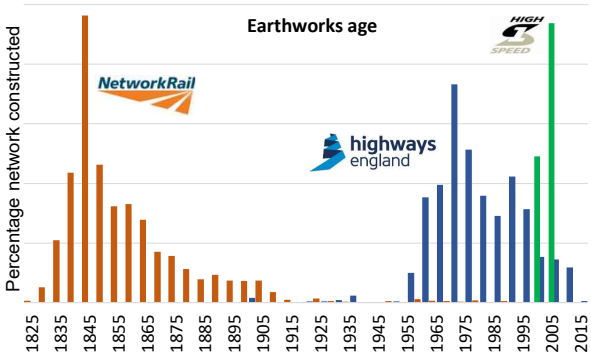
Examples

	Network Rail	Highways England	High Speed 1
Network length	9,800 miles of railways	4,400 miles of motorways & major roads	68 miles of railways
Coverage	England, Scotland & Wales	England	Channel tunnel to London
Earthworks	191,000	49,000	2,500



Earthworks age

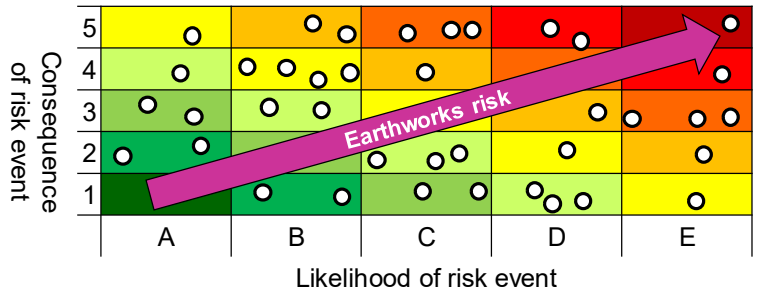


Definition of strategic asset management

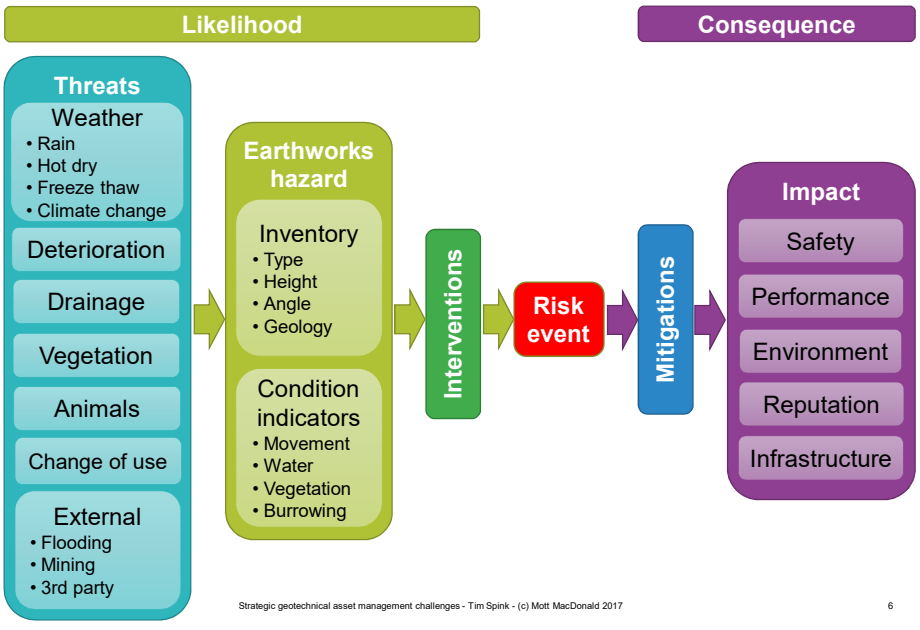
Level	Coverage	Purpose
Strategic	Whole organisation	• Asset management policy development • High level, long-term corporate investment planning • Target setting & corporate KPI reporting
Tactical	Sub-area of organisation	• Detailed medium-term works planning • Works prioritisation
Operational	Individual scheme of works	• Optimisation of scheme design

Risk definition

Risk = Likelihood x Consequence

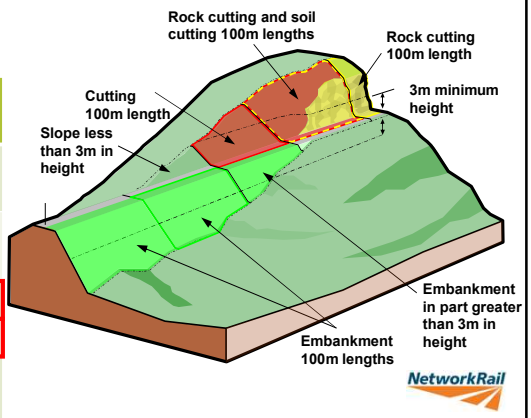


Risk bow tie diagram

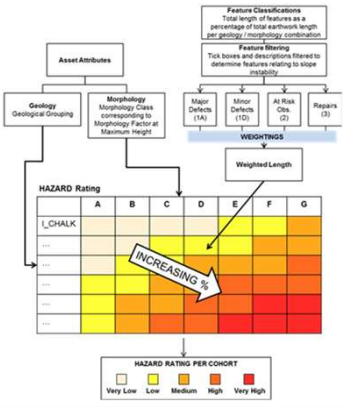


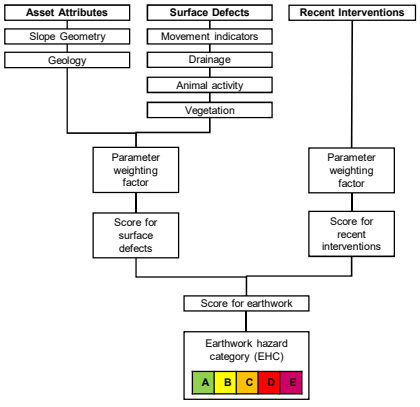
Earthworks hazard - inventory

	Network Rail	Highways England
Minimum height	3.0m	2.5m
< Minimum height	Excluded	Minor earthwork
Segmentation	~100m	No
Geometry	Lidar	Assessed
Knowledge	100% of >3m	100%



Earthworks hazard - condition

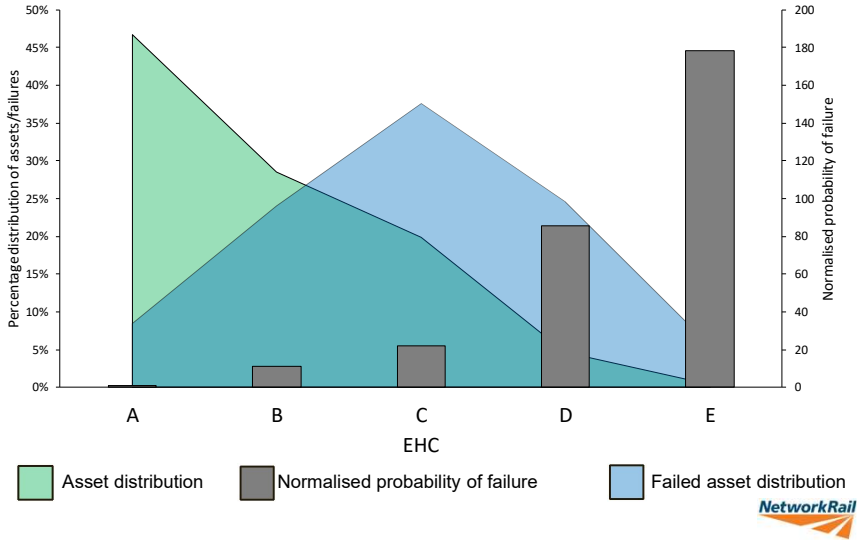




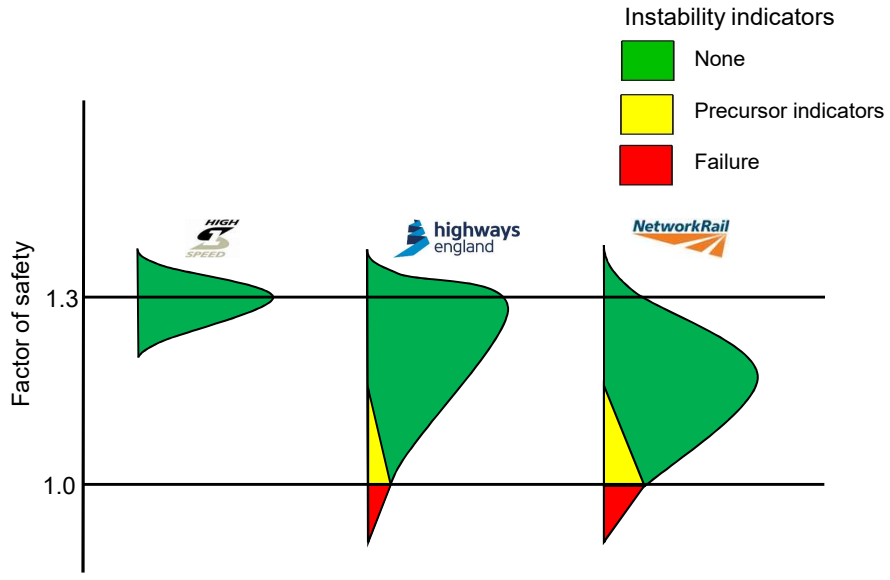
Subjective assessment
Defect level classification used
Earthwork level hazard rating trialled
Risk based frequency

Objective assessment
Earthwork level hazard category (EHC) used
Risk based frequency

Predicting failure



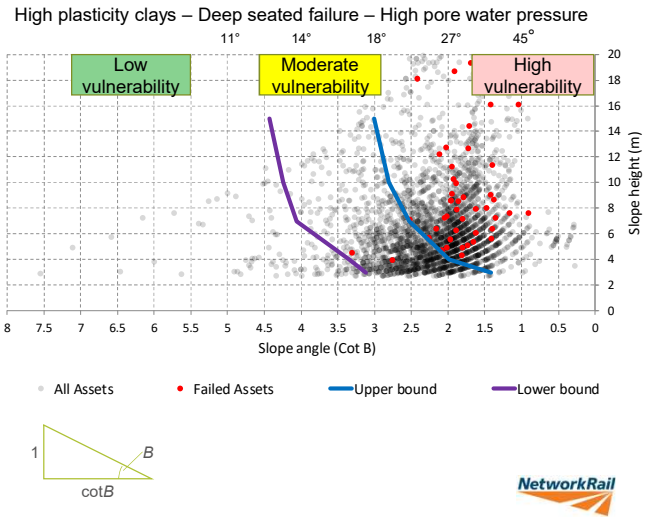
Distribution of factor of safety



Global Stability Resilience Appraisal (GSRA)

Stability chart boundaries vary with:
- Geology
- Failure mode
- Pore pressure conditions

Failures mainly in high vulnerability



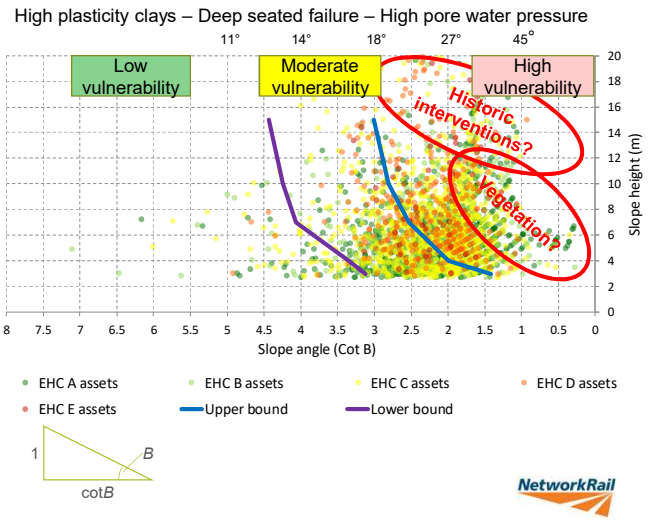
Global Stability Resilience Appraisal (GSRA)

Stability chart boundaries vary with:
- Geology
- Failure mode
- Pore pressure conditions

Failures mainly in high vulnerability

FoS & condition poorly aligned
- Failure vs precursors
- Progressive failure
- Extreme weather events
- Degradation rates vs inspection interval

Challenges:
- Combined approach to improve predictability
- Historic interventions
- Vegetation impact



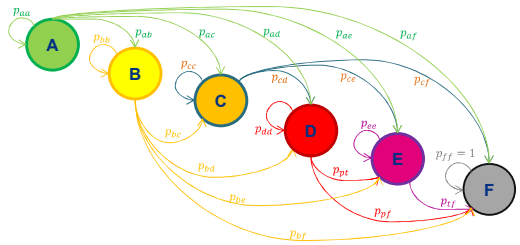
Condition degradation analysis

Analysis of all available earthwork condition inspections

Probabilistic method

Outputs condition state change matrix for a given time period

Assessed by:
- Earthwork type
- Geology
- GSRA vulnerability



Start condition \ End condition	A	B	C	D	E	F
A						
B						
C						
D						
E						
F						

Stays same
Degradation
Failure
Improvement

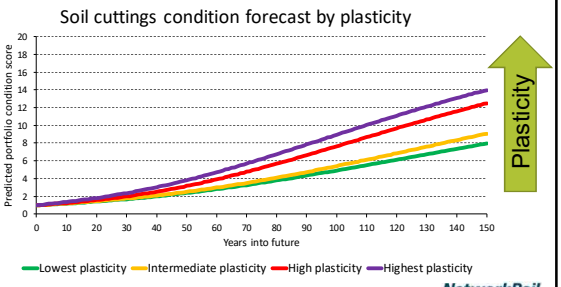
Degradation rates

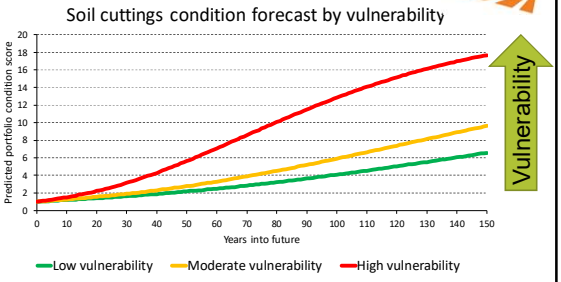
Degradation matrices applied to artificial portfolio for visualisation

Degradation rate increases with:
- Plasticity (liquid limit & clay fraction) ~2x
- GSRA vulnerability ~3x

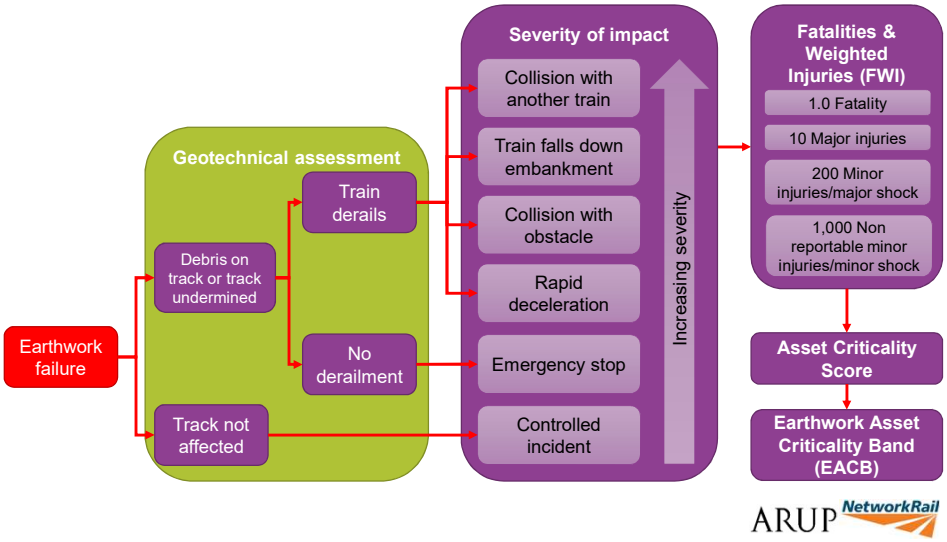
First time for evidence based degradation rates for a national portfolio

Challenges:
- Pooled degradation rates from across asset owners
- Variation in degradation rates with asset age

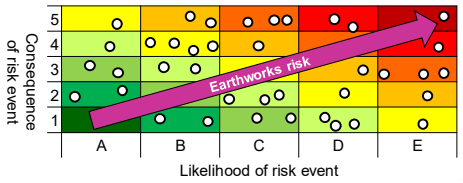


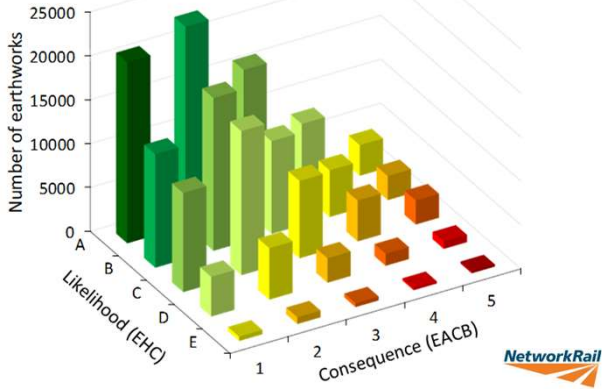


Consequence – safety impact

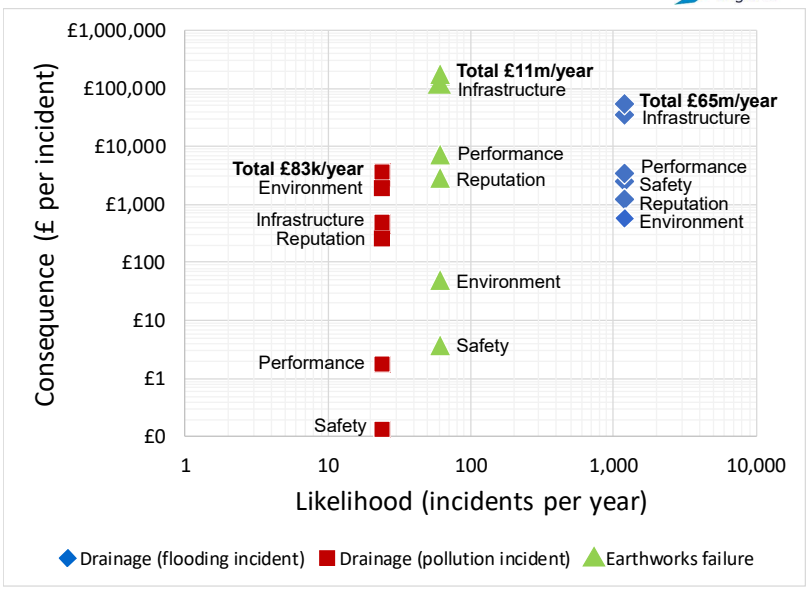


Safety risk matrix

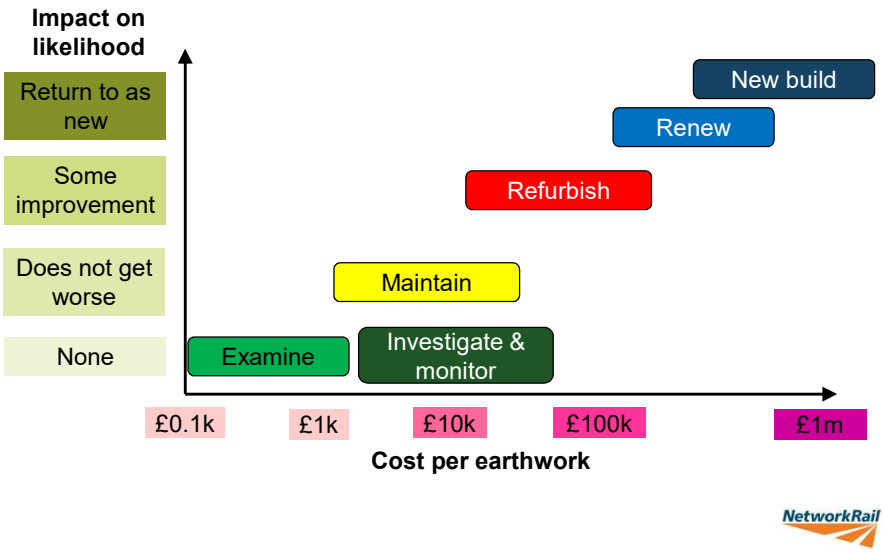




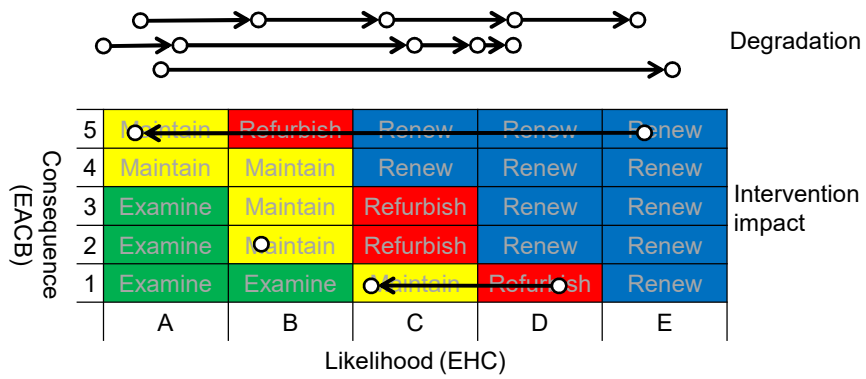
Multiple risks, multiple assets



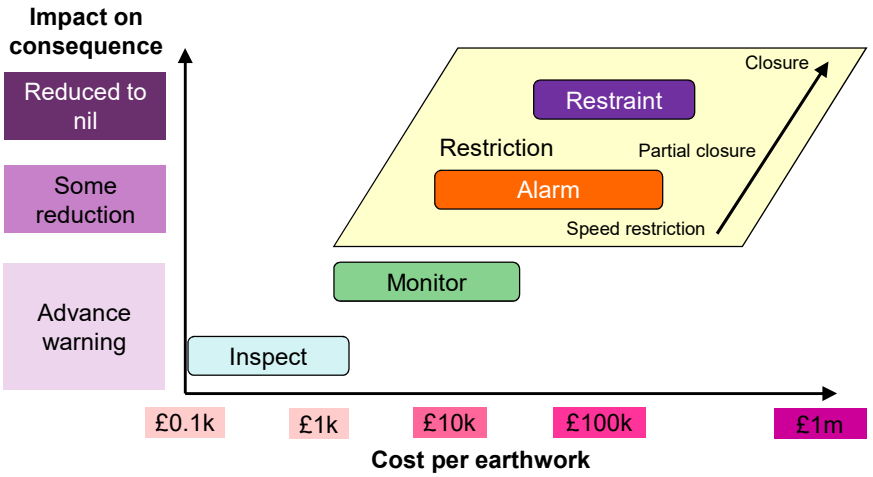
Intervention options



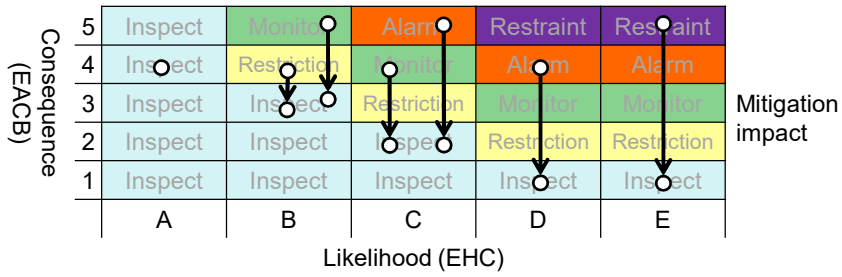
Intervention impacts on risk matrix



Mitigation options



Mitigation impacts on risk matrix



Intervention policy options

Increasing safety risk

Rock cuttings

Consequence (EACB)	A	B	C	D	E
5	Maintain	Refurbish	Renew	Renew	Renew
4	Maintain	Refurbish	Renew	Renew	Renew
3	Examine	Maintain	Renew	Renew	Renew
2	Examine	Maintain	Refurbish	Renew	Renew
1	Examine	Examine	Maintain	Refurbish	Renew

Likelihood (EHC)

Soil cuttings

Consequence (EACB)	A	B	C	D	E
5	Maintain	Refurbish	Renew	Renew	Renew
4	Maintain	Maintain	Renew	Renew	Renew
3	Examine	Maintain	Refurbish	Renew	Renew
2	Examine	Maintain	Refurbish	Renew	Renew
1	Examine	Examine	Maintain	Refurbish	Renew

Likelihood (EHC)

Embankments

Consequence (EACB)	A	B	C	D	E
5	Maintain	Maintain	Renew	Renew	Renew
4	Examine	Maintain	Renew	Renew	Renew
3	Examine	Maintain	Refurbish	Renew	Renew
2	Examine	Maintain	Refurbish	Refurbish	Renew
1	Examine	Examine	Maintain	Refurbish	Refurbish

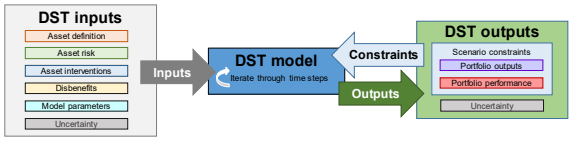
Likelihood (EHC)

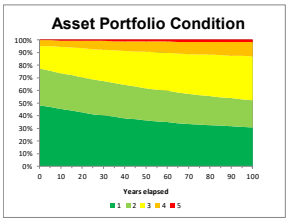
Strategic Decision Support Tool (DST)

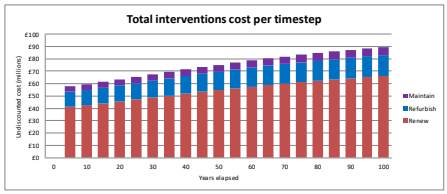
highways england

DST balances
- Degradation
- Interventions & mitigations
- Various policies & scenarios

Outputs
- Costs & whole life costs
- Optimum intervention policy
- Condition & risk profiles





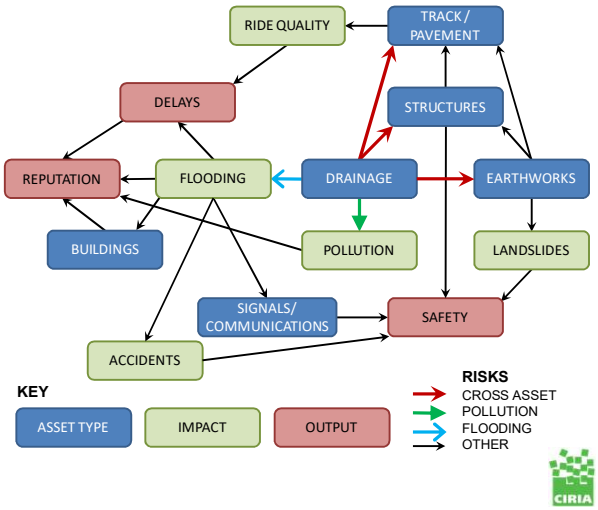


Cross-asset, fence to fence asset management

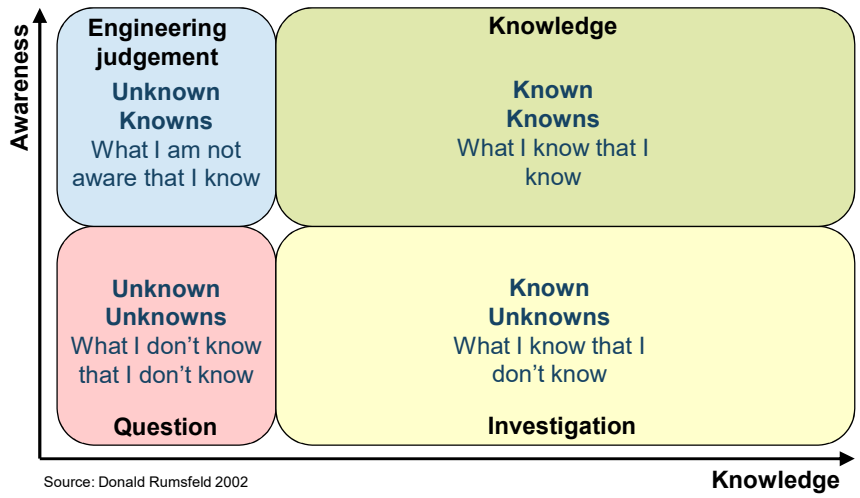
Cross-asset, fence to fence objectives:
- Reduce costs
- Reduce delays

Currently:
- Earthworks, drainage & vegetation

Challenges:
- Quantification of cross-asset interactions
- Planning DSTs
- Definition of new cross-asset business processes
- Breaking down of cooperate management silos
- Greater flexibility in budget management

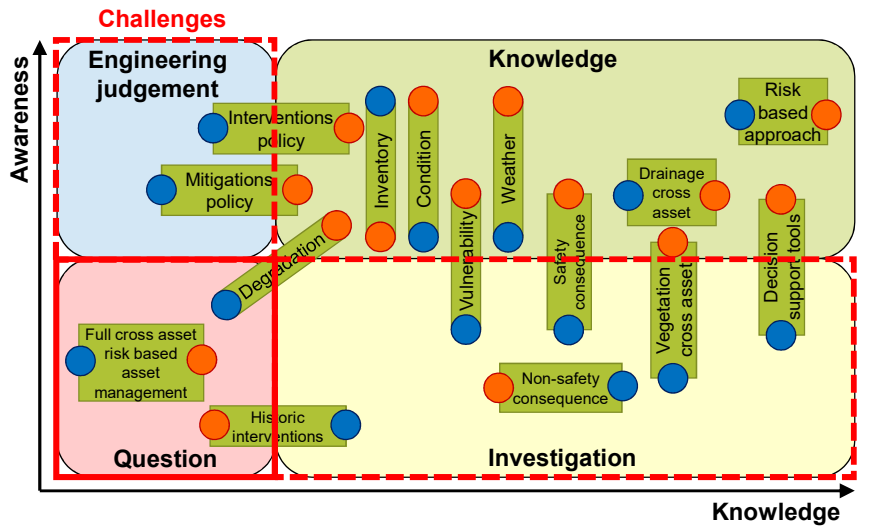


Summary



Source: Donald Rumsfeld 2002

Summary



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