ANALYSIS UNDER UNCERTAINTY *for* DECISION MAKERS (AU4DM) NETWORK

6. **Jaime Catalina**
7. Bruce Garvey
8. David Stainforth
9. Gianluca Pescaroli
10. Sunny Modhara

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Forecast-based Financing in the Red Cross Red Crescent Movement

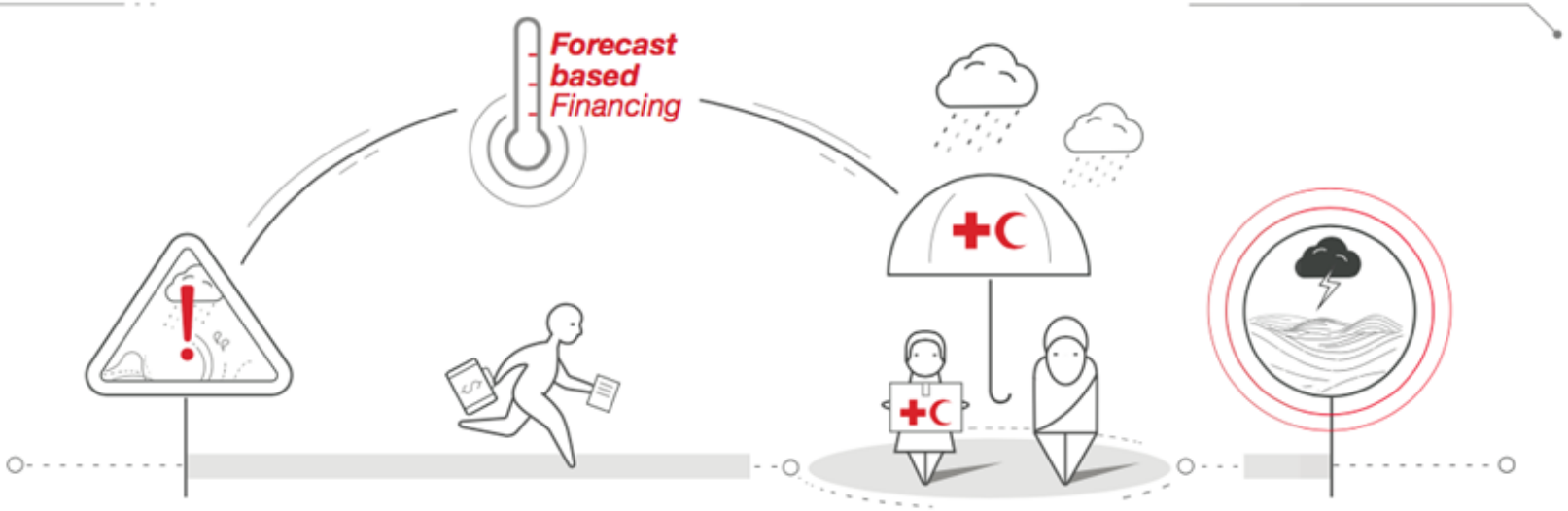
Climate Centre

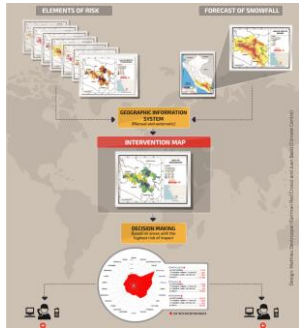
The challenge

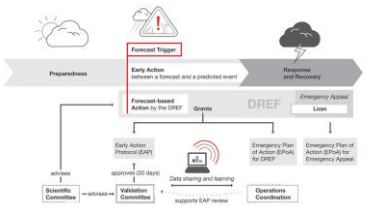
The opportunity

Approach

Climate Centre







Results and Feedback

Climate Centre

An FbF EAP was activated in Mongolia in the 2017/2018 winter season in anticipation of extreme winter conditions known as “Dzud”. An evaluation was conducted among FbF beneficiaries and comparison herder households.

FbF intervention: distribution of unconditional cash grants and animal care kits

Key benefits: FbF contributed to

- Assistance came just as winter conditions were becoming extreme
- Households were short on hay and fodder reserves → FbF cash assistance allowed beneficiaries to stock hay/fodder before extreme conditions
- Enabled herders to buy hay at discounted rates (early enough before price surge)
- FbF assistance *may* have contributed to reduced animal newborn mortality *(results pending)*.

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Profiling uncertainty: a multi-faceted problem?

	Identifiable / Known	Unidentifiable / Unknown
Predictable / Known	Q1. Known-known (I know what I know) *A simple/tame linear problem* Certainty + Bias Validated data, formal & tacit knowledge Established processes & formal procedures	Q2. Known-Unknowns (I know what I don't know) *Largely, a complicated problem* Caution & perception Inevitable surprises (e.g. terrorism, hurricanes) Contingency Planning & emergency response
Unpredictable / Uknown	Q3. Unknown-Knowns (I don't know what I know, or I think I know but turns out I don't) *Complicated problems with element of wickedness* Amnesia, denial & blind-spots Pseudo- Black Swans, Grey Swans e.g. 2008 crash, thinking about the unthinkable	Q4. Unknown-Unknowns (I don't know what I don't know) *A 'wicked problem'* Ignorance, real uncertainty Terra incognita, True Back Swans e.g. ??

"Combining quantitative and qualitative aspects of problem structuring in computational morphological analysis". *Its role in mitigating uncertainty in early stage design creativity and innovation and how best to translate it into practice.* PhD thesis B Garvey

Strategy Foresight

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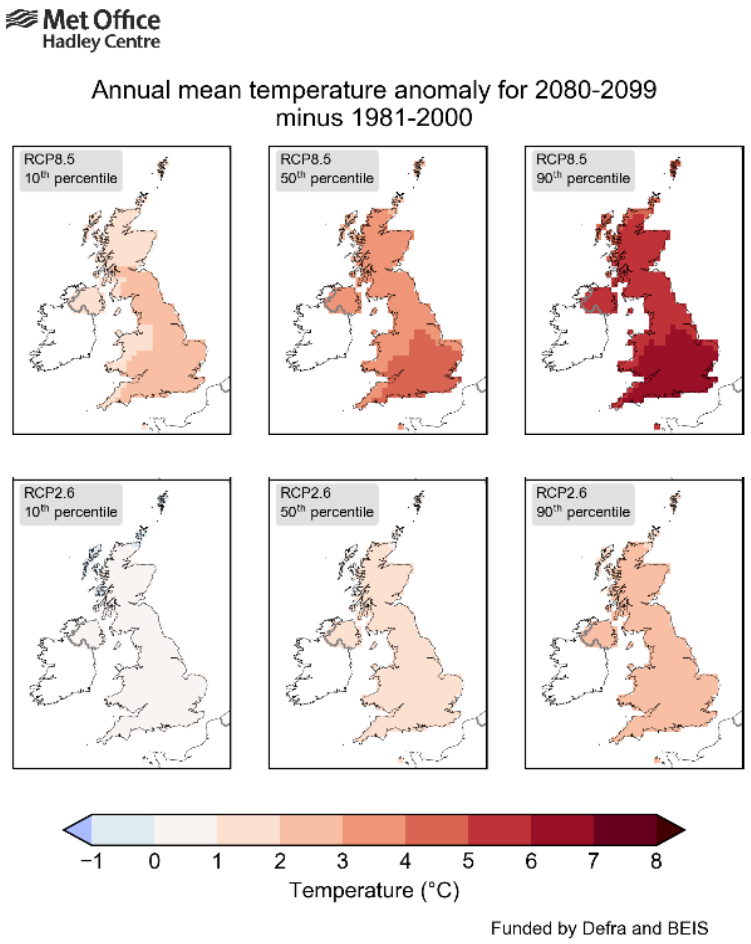
Climate Change Predictions for Decision Support

Prof. David Stainforth, LSE, d.a.stainforth@lse.ac.uk

- Problem: How to make predictions/projections of future climate at the regional/local scales relevant to adaptation decisions e.g. for infrastructure construction and management.
- Approach: Computer models of the climate system.
- Sources of uncertainty:
  - Societal response to climate change - future emissions.
  - Mathematical chaos – the butterfly effect.
  - Model error – large scale and small scale (the hawkmoth effect).
  - The relationship between observations and models, historic responses and future responses.

Approach 1 – e.g. UK Climate Projections 2009/2018

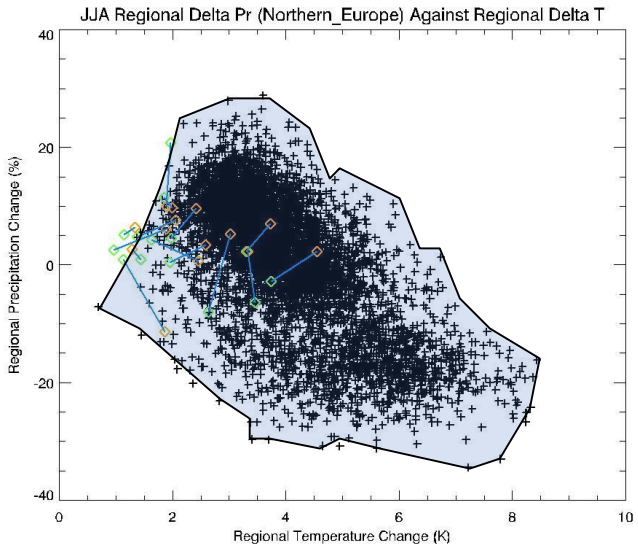
- Explore model uncertainties and process into probability forecasts.
  - Vary the way a model represents climate.
  - Assume that a model version which is “better” (rather than “good”) at representing the past is more usefully representative of the future.
  - Assume that a distribution of responses across models represents our (probabilistic) uncertainty of the future.
- Conceptual problems.
  - All climate models are very far from realistic.
  - Exploration of uncertainty is limited.
  - Assumptions are not well founded or understood.

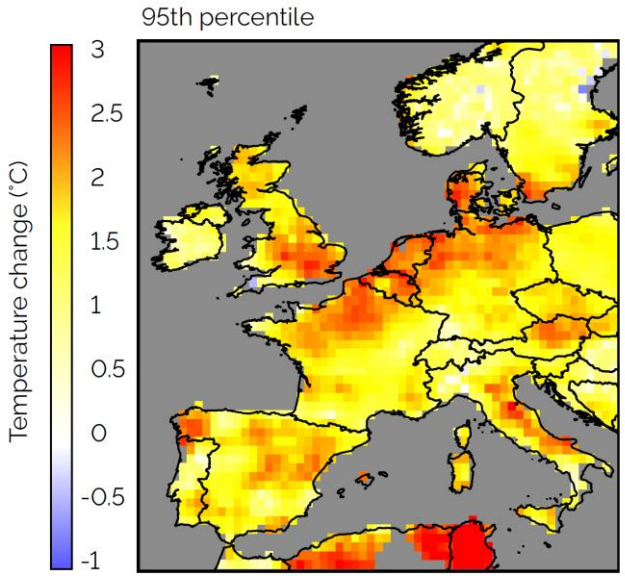


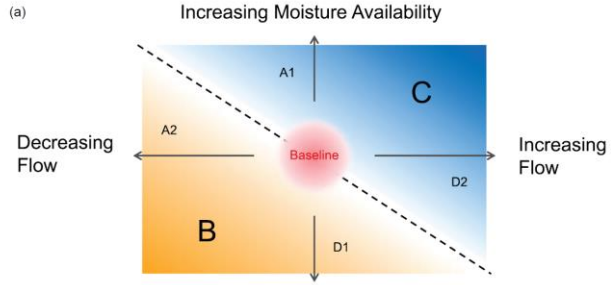
Source: UKCP 18
https://www.metoffice.gov.uk/research/collaboration/ukcp/land-projection-maps

Approach 2

- Accept that models have inadequacies and that there is a lack of the necessary methodological research so focus on **exploring possibilities without attempts to quantify probabilities.**
- Use models to explore the ranges and domains of possibility.
- Use physically based storylines/narratives of the response patterns which could impact decisions.
- Use observations to better understand the patterns of recent local changes in climate.







(b)

Narrative	Key Processes										Precipitation Change
	Arabian Sea/ Indian Ocean SST	Atmospheric Moisture	Horizontal Tropospheric Temperature Gradient	Himalayan Snow Cover	Anthropogenic Aerosol Forcing	ITCZ movement northwards	Strength of Westerly Jet	Extent of irrigation	Influence of dry Northerlies	Influential Tele-connections	
A1	⇧	⇧	⇧	⇩	⇩	⇧	⇧	⇩	⇩	La Niña	↑
A2	⇧		⇩	⇧	⇧	⇩	⇩	⇧	⇧	El Niño EQUINOO	↓
B	⇩		⇩	⇧	⇧	⇩	⇩	⇧	⇧	El Niño EQUINOO	↓
C	⇧	⇧	⇧	⇩	⇩	⇧	⇧	⇩	⇩	La Niña	↑
D1	⇩		⇩	⇧	⇧	⇩	⇩	⇧	⇧	El Niño EQUINOO	↓
D2	⇩	⇧	⇧	⇩	⇩	⇧	⇧	⇩	⇩	La Niña	↑

Lessons and Key messages

- We shouldn't create a separation between climate change research and the decisions we want it to inform. It is unlikely, in the near future, that we can achieve one-size-fits-all in climate predictions.
- Diversity of climate services methodologies would improve system/societal resilience.
- Research inertia holds back the development of approaches which provide practical decisions with reliable and relevant information on climate change.
  Academic research needs to be both a) more theoretical / blue skies, to understand the constraints and possibilities, and b) more focused on what information can be provided to support specific decisions.
- Responding to the threats of climate change would be better supported by science if communicators were clearer about which results are fundamentally robust (e.g. the seriousness of the potential consequences) and which are conditional, assumption dependent and likely to change (e.g. the projected details of physical climate and social responses).

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Problem Statement

Dr. Gianluca Pescaroli, lecturer in organisational resilience, UCL –I RDR

- *How to improve organisational resilience in the face of cascading disasters?*
- Elements of uncertainty such as:
  - ✓Non - linear escalation of secondary emergencies;
  - ✓approaching single hazards vs understanding common vulnerabilities;
  - ✓lack of information sharing and changed behaviours that sounds like: "Do we know what to do when technology fails?".
- How we deal with it: We created a research group @ the UCL Institute for Risk and Disaster Reduction.

Approach

- We tried to understand the implications of cascading disasters exploring wide area power failures and GNSS outages. Outputs:
  - Perceptions of cascades in the LRP: high risk vs low integration in policies, open issues in defining operational thresholds and need for training (Pescaroli 2018);
  - GAP analysis defining some of the critical points in preparedness in London;
  - Guidelines for supporting the training and the situational awareness of emergency operators and business continuity.

Results and Feedback

- Challenges include: increase information sharing; understanding citizen's priorities in case of tech disruptions; assessing decisional thresholds and gaps in resilience.
- Limits: need for interdisciplinary and inter-organisational dialogue, trust development, adapt the standard format of communication.
- Improvements through vulnerability scenarios, developing BCM to assure the shift to low-tech organisational procedures.
- The research community can support improvements keeping complexity simple (sounds easy, isn't it)?

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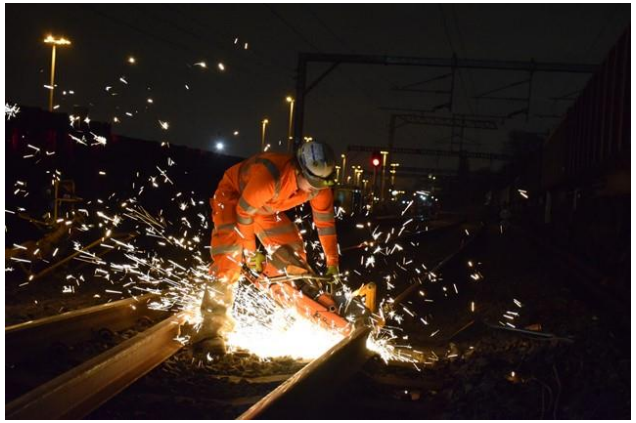
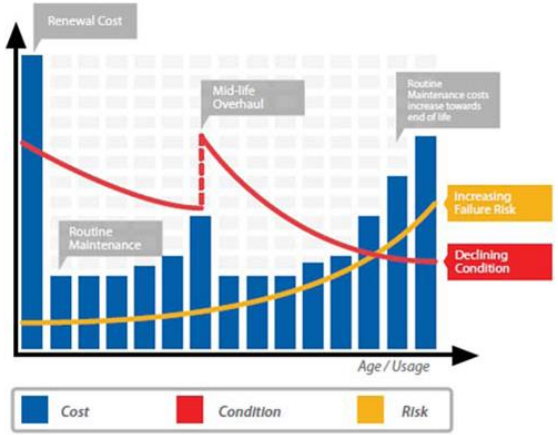
Decision-Making at Network Rail





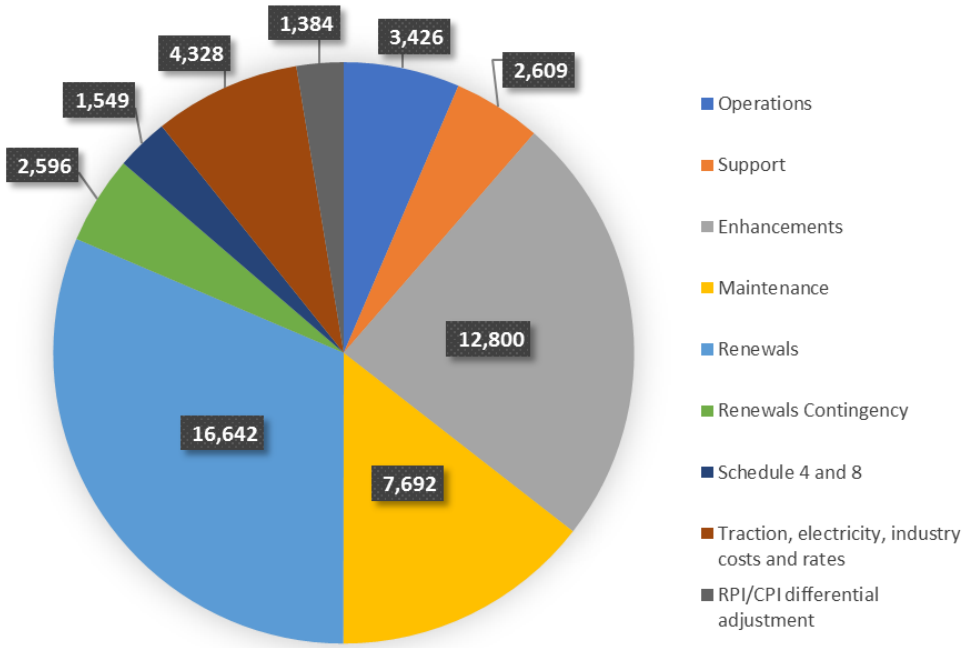
By Sunny Modhara

Network Rail: who are we and what do we do?

Network Rail (NR) is the UK's rail infrastructure operator, managing:

- 20,000 miles of track
- 40,000 bridges
- 2500 stations
- Signalling, power and communications assets and others
- Largest UK purchaser of electricity
- 34,500 employees

Budget value of **£50bn** over 5 years (2019-2024)



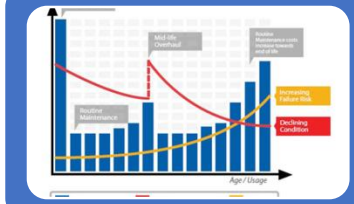
Passenger and freight growth

Pace of digitalisation / automation

Devolution to Operating Routes

Demand for cost efficiencies

Key decisions at Network Rail



Strategic decisions (up to 40 years)

- Long term cost and performance
- Whole network scenario analysis

Planning decisions (up to 7 years)

- Asset specific work plan to deliver required outputs
- Optimisation of work along line of route

Delivery decisions (up to 3 years)

- Maximising the productivity of possessions
- Minimising disruption to passengers and freight operators

Operational decisions (real time to one month)

- Predicting and preventing failures affecting services
- Detection, diagnostics and prognostics

General decision structure

System Knowledge:

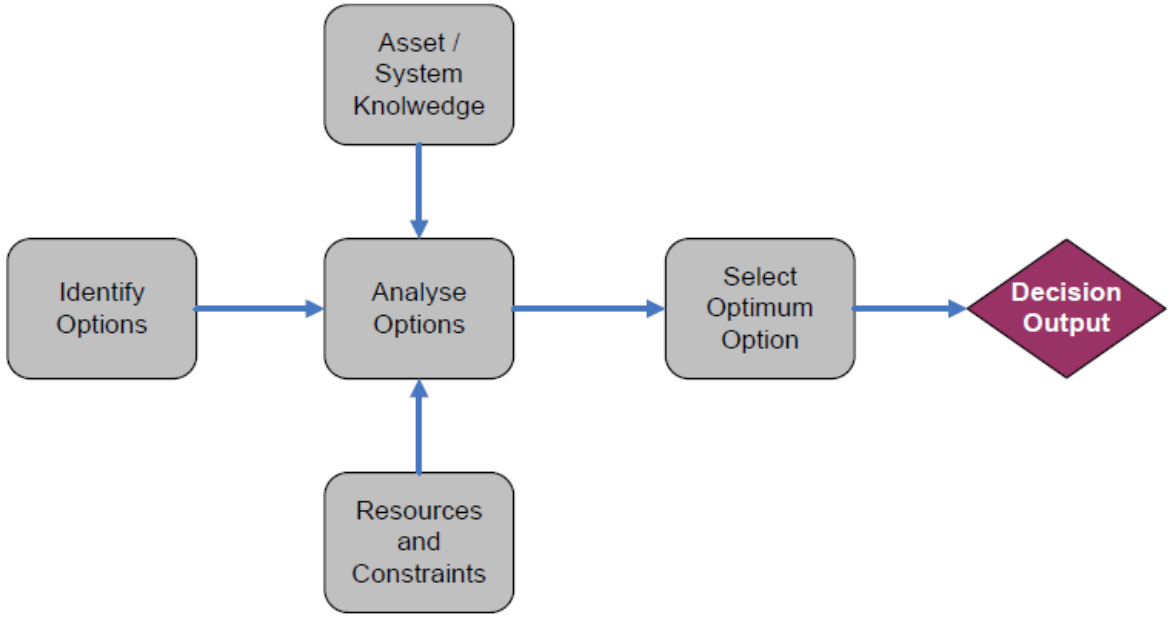
Good decisions require accurate information:

- Asset age/condition/work history
- How assets degrade with age/usage
- Intervention effectiveness on condition/failure

Resources & Constraints:

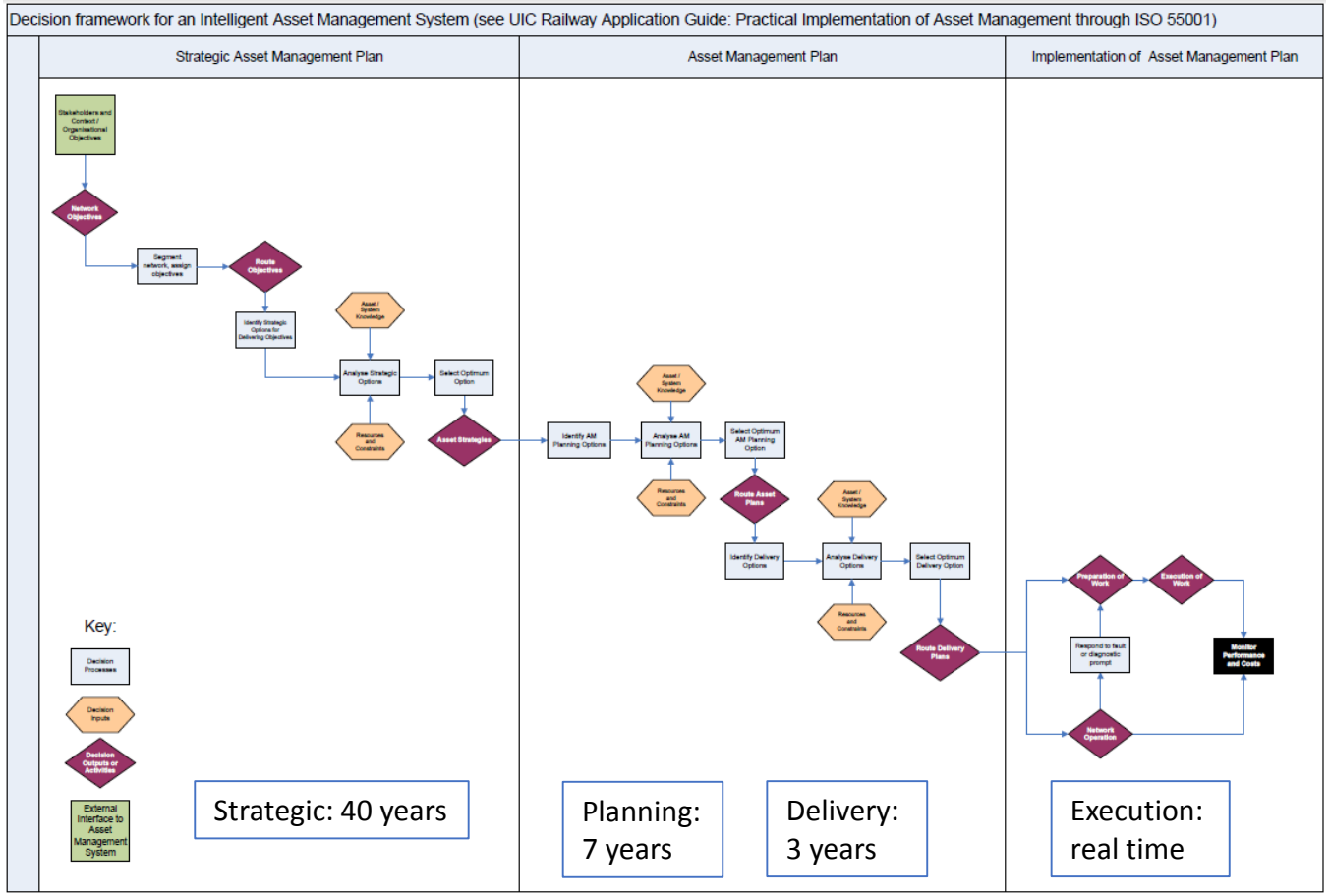
Feasibility of each option depends on resources:

- Human
- Funding/budget
- Access restrictions



A framework for line-of-sight decision-making

- Connects the core decisions from strategy to implementation
  - Repeated decision structure
  - Implementation is prescriptive and instinctive
- Supported by a large number of infrastructure managers and suppliers
  - Definitions and descriptions
  - Benchmarking and comparison
- Lifecycle costing models employed at the strategic phase
- Accounting for uncertainties at the asset level: variable degradation, intervention effectiveness etc.
- Other forms of potentially dominant sources of uncertainty yet to be accounted for e.g. weather, railway access, project management



Strategy → Implementation