School of Civil Engineering
FACULTY OF ENGINEERING

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The value of climate information in transport resilience decisions

David Dawson,
Research Fellow

27th April 2017

Valuing Infrastructure Conference, Leeds

The Leverhulme Trust

National Infrastructure

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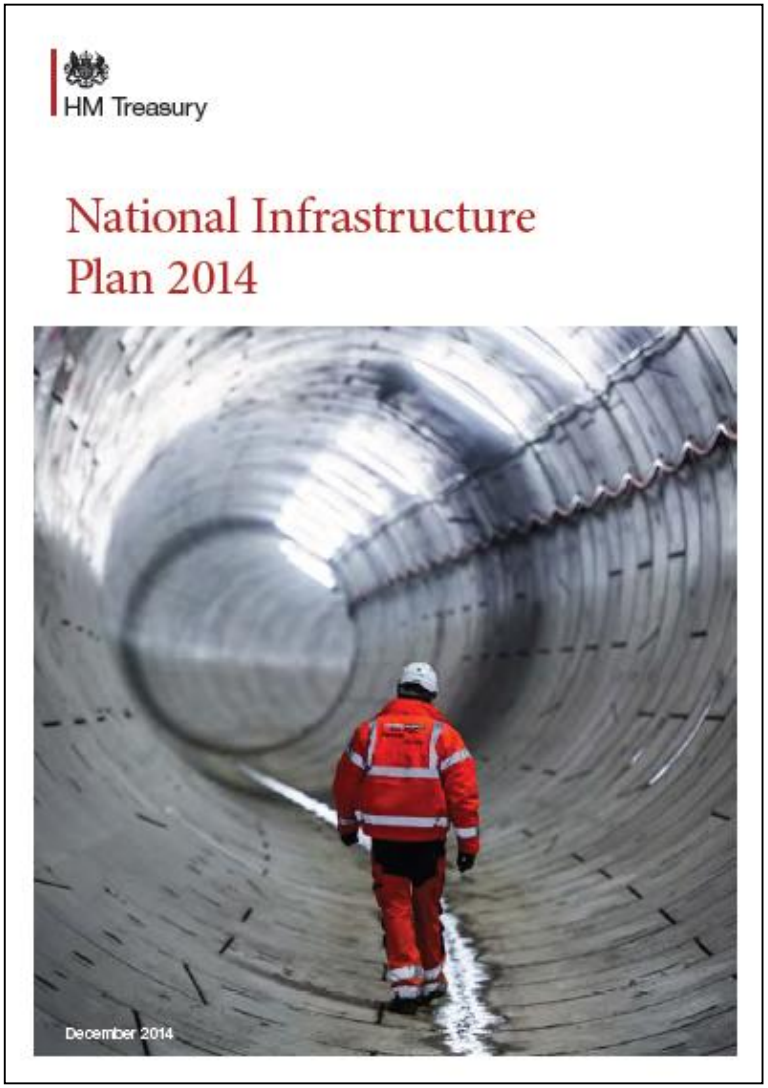

"…is in a deteriorating condition, and increased rates are leading to more frequent disruption to networks and services" (HM Treasury, 2011)

"**Climate change will also shape future infrastructure**, testing the **sustainability and resilience** of our networks" (HM Treasury, 2014)

"£460 billion of planned investment. **A third of which is planned for the transport sector**." (HM Treasury, 2014)

Climate Change & Transport

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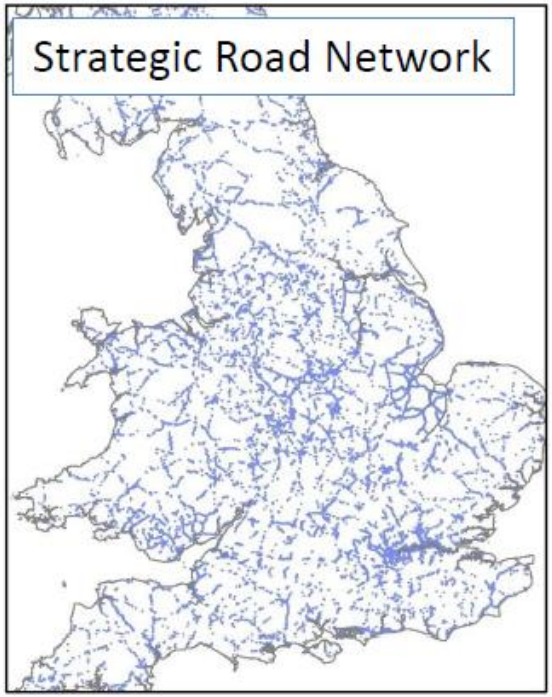
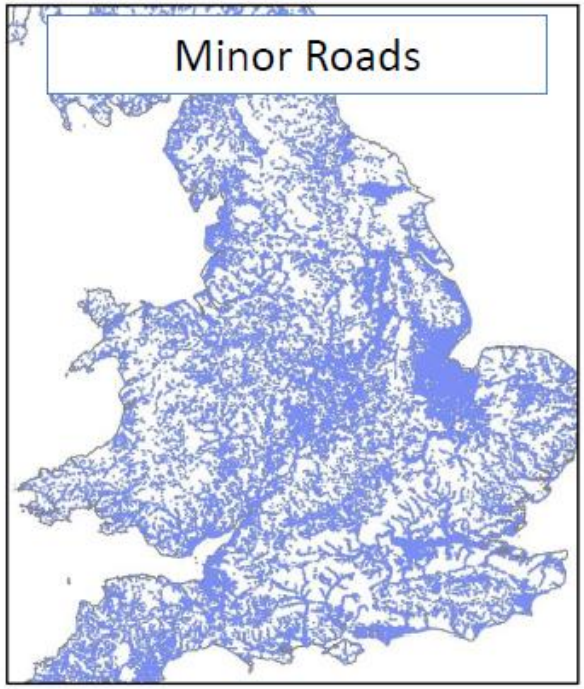
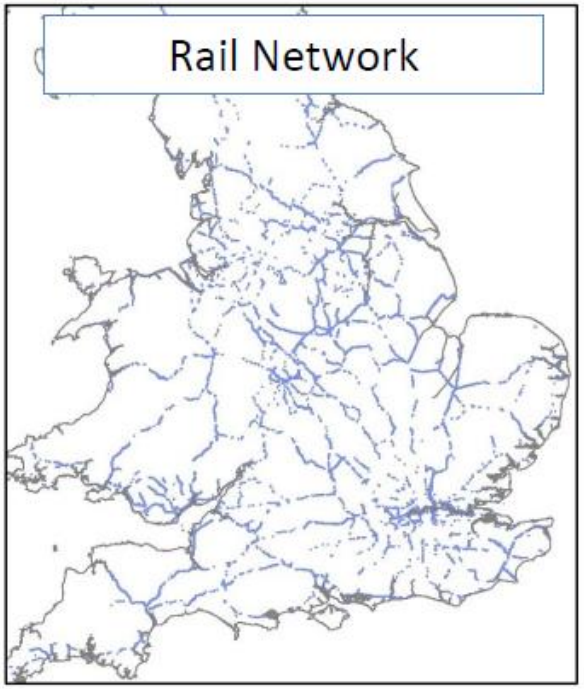
Networks located in *known* flood risk areas (no time period)



~7,000 km (14%)
Defend: ~£21 billion
Re-Build: ~£220 billion



~29,000km (10%)
Defend: ~£90 billion
Re-Build: ~£450 billion



~3900km (25%)
Defend:~£11 billion
Re-Build: ~£390 billion

Are we realistically going to defend/rebuild all these areas?

Future uncertainty

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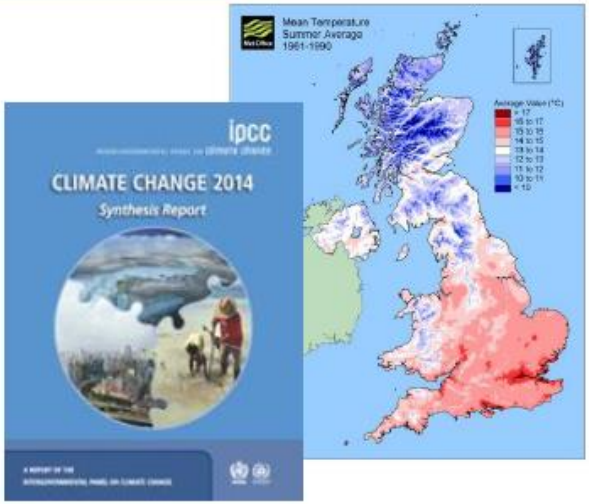
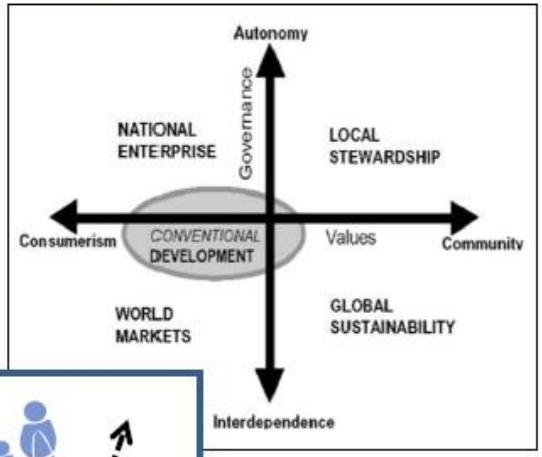
Today's infrastructure adaptations and investments have implications for future generations

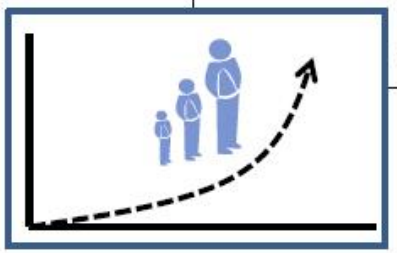


- Climate change scenarios
- Socio-economic futures
- Technology & behaviour

How do we 'best' make decisions considering these factors?



Resilience, policy & decision making for investment under uncertainty



Economics & climate change

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	Approach	Summary	Examples
Traditional economic decision support	Cost-Benefit Analysis	Values all costs and benefits to society of all options, and estimates the net benefits/costs in monetary terms.	Green Book, HMT (2007) AIACC (2006).
	Cost-Effectiveness Analysis	Compares costs against effectiveness (monetary/non-monetary) to rank, then cost-curves for targets/resources.	Boyd et al. (2006)
Uncertainty framing	Iterative Risk Management	Uses iterative framework of monitoring, research, evaluation and learning to improve future strategies.	EA (2011) Haasnoot et al (2013; 2014) Watkiss et al (2013)
Economic decision making under uncertainty	Real Options Analysis	Allows economic analysis of future option value and economic benefit of waiting / information / flexibility.	Linquiti and Vonortas (2012) Tourkolias et al. (2013) Jeuland & Whittington (2013)
	Robust Decision Making	Identifies robust (rather than optimal) decisions under deep uncertainty, by testing large numbers of scenarios.	Groves & Lempert (2007) Hulme & Dessai (2009) Hallegatte et al. (2012)
	Portfolio Analysis	Economic analysis of optimal portfolio of options by trade-off between return (NPV) and uncertainty (variance).	Crowe & Parker (2008) Hunt (2009)

Watkiss et al. 2014

Uncertainty & investment

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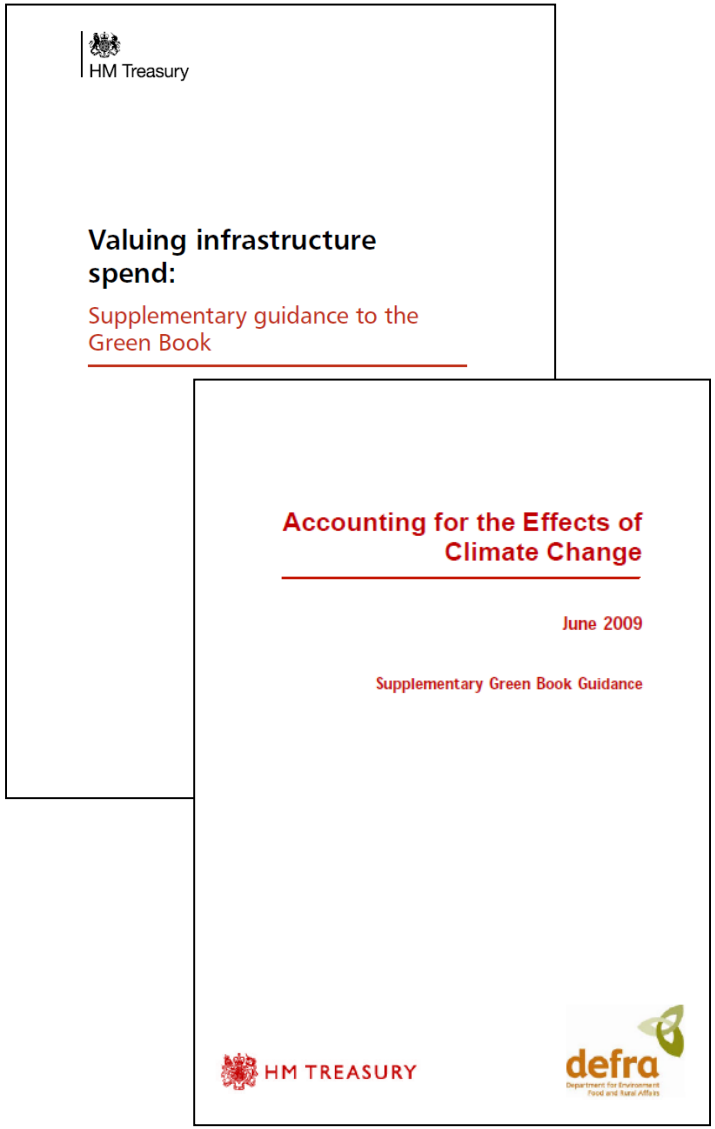
HM Treasury

Valuing infrastructure spend:

Supplementary guidance to the Green Book

Accounting for the Effects of Climate Change

June 2009

Supplementary Green Book Guidance

HM TREASURY

defra

Green Book updates (2009 & 2015):

ROA: framework to incorporate uncertainty and the value of information into decision making.

What is the value of updated climate projections?

''Can be technically challenging and information intensive.''

Can we do it on a spreadsheet with easily available data?

London-Penzance Railway Line

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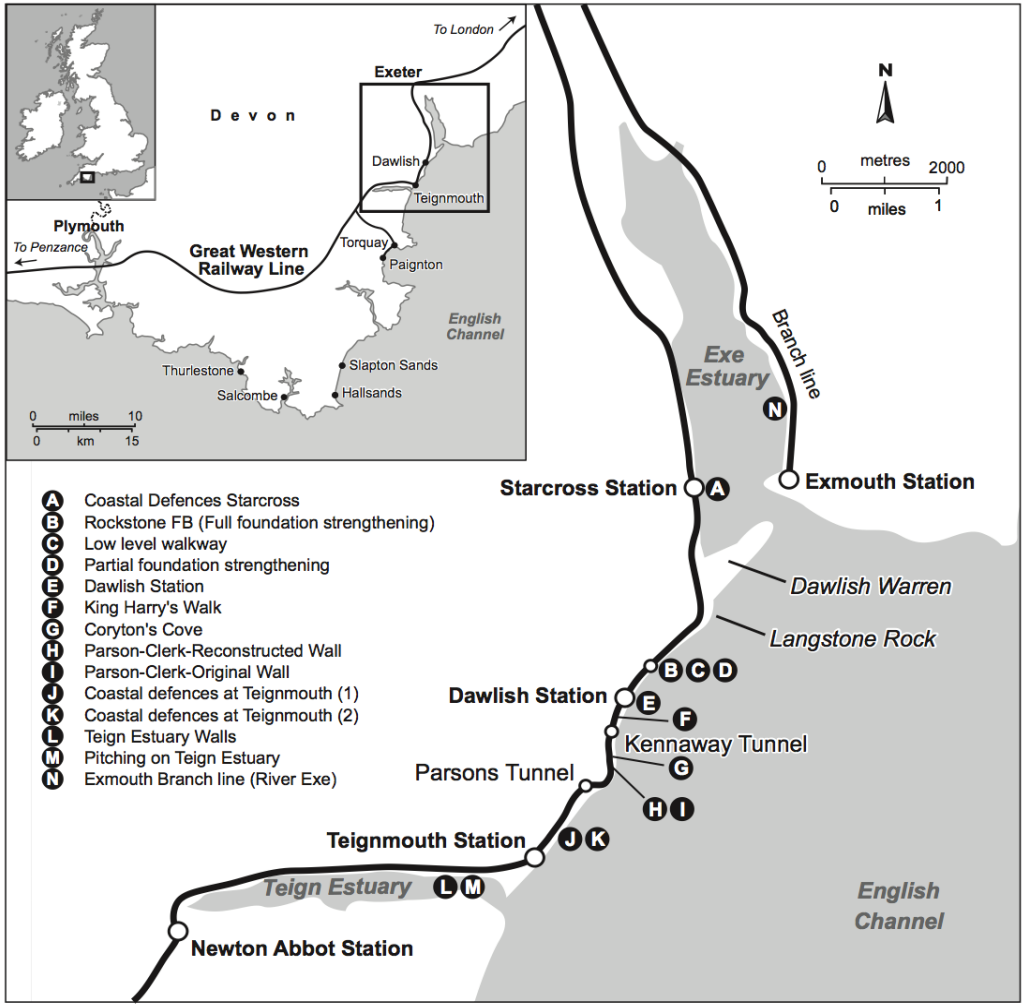

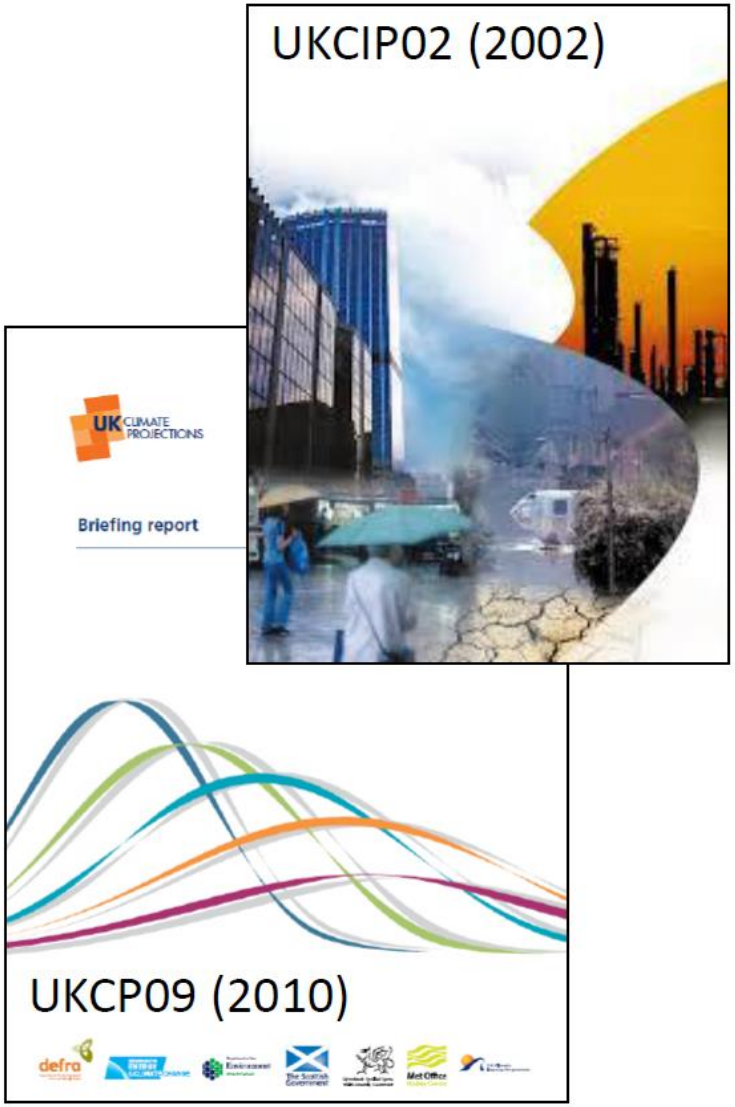

Economic impacts of closures

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Financial costs

- Annual maintenance expenditure
- ~~Delay charges for late running services (schedule 8)~~

Economic costs

- Value of time loss to rail users
- Indication of impact on wider economy

Simple approach to appraisal of impacts…. Wider impacts complicated & difficult to quantify (at present…)

Applying ROA @ Dawlish

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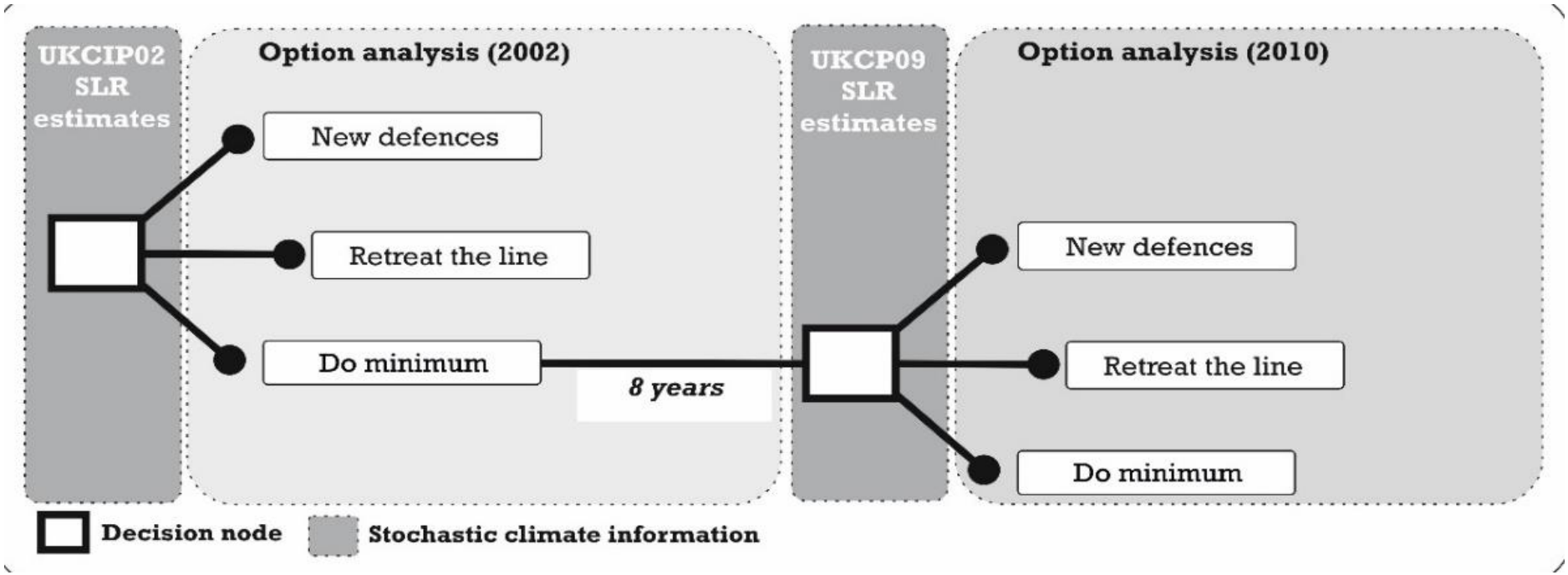
Adaptation decisions in 2002 (UKCIP02) and 2010 (UKCP09)



- Real option analysis: 8 years apart using updated climate projections (sea level)
- What is the value of new 'improved' projections?

Small print: Many additional assumptions (discount factors, capital cost, etc.)!!!

Applying ROA @ Dawlish

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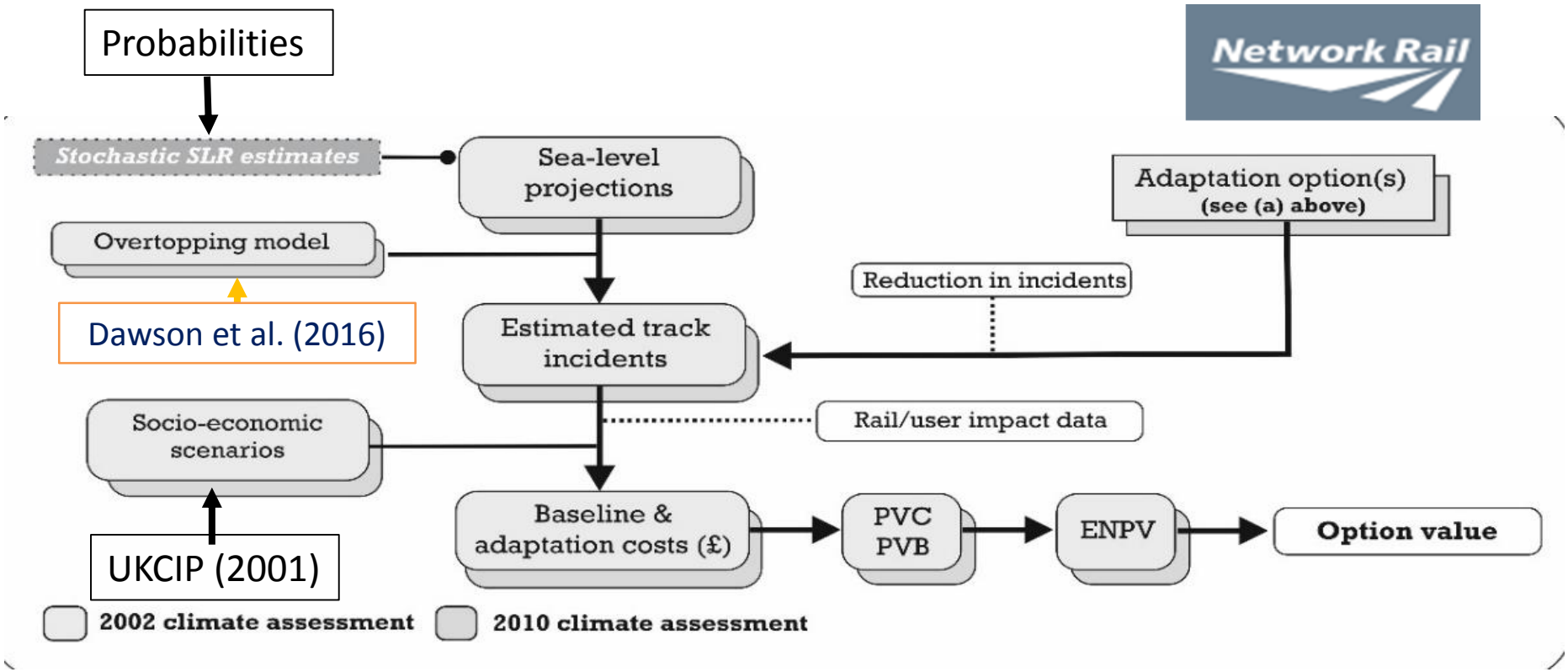

- Tested various scenarios will equal probability
- Difference between the **Expected Net Present Value** (ENPV) is the option value (of updated sea-level data).

Results of test…

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- Low BCRs for each of the options – capital costs are large compared to the calculated economic impacts
- Update resulted in additional economic value impacts of £115 - £157 million
- <40% of the capital cost of adaptation investment
- New information: £34 million per km (between Dawlish-Teignmouth)…

Value of climate information

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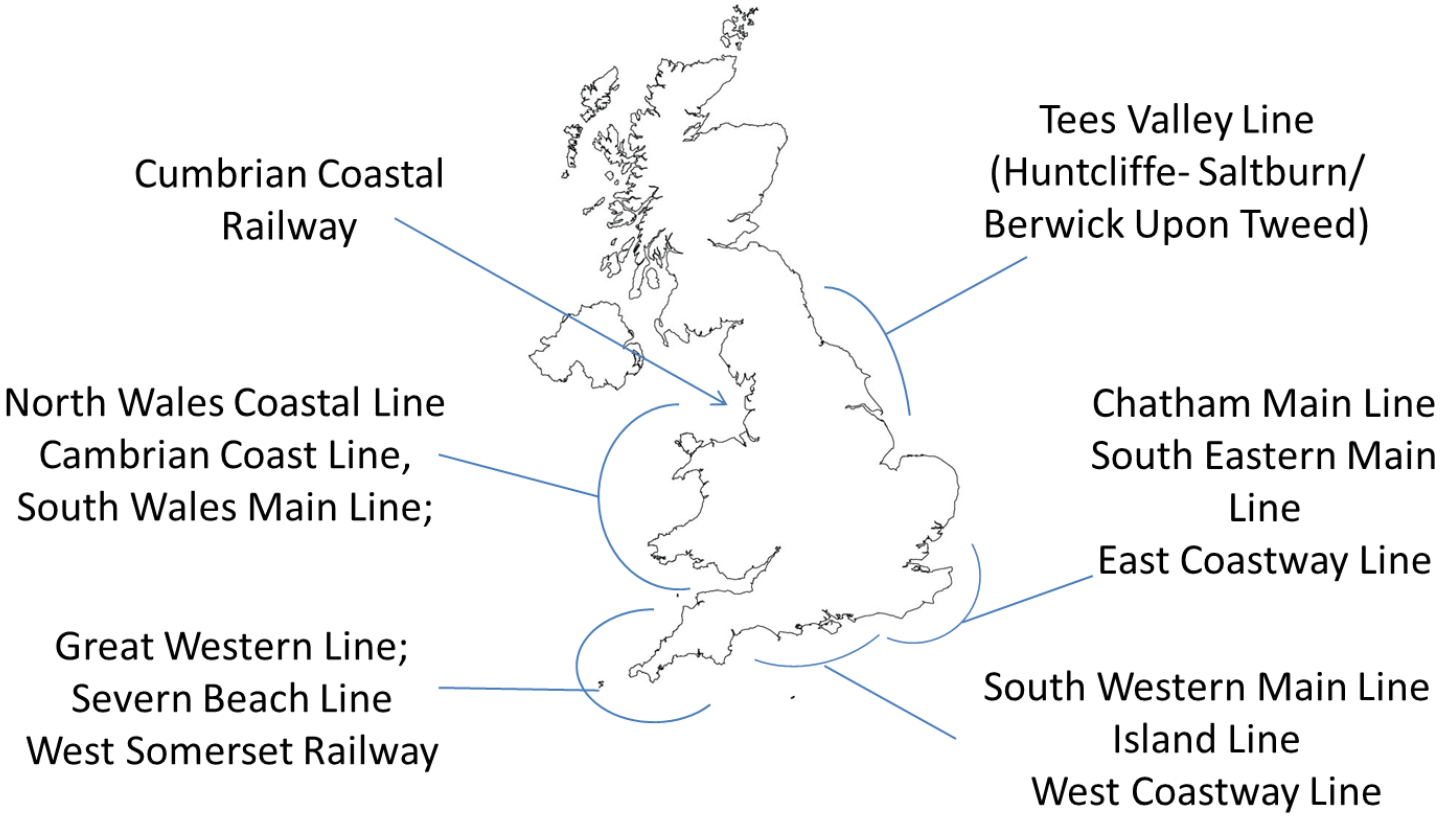
To coastal rail adaptations (pinch of salt):



800 km of **coastal railway networks** in UK in flood risk areas

Value of climate data = £3.4 billion in additional impacts

Resilience Study 2014

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West of Exeter Route Resilience Study

Summer 2014

NetworkRail

''from a transport economic appraisal point of view, ***all the alternative route options represent poor value for money… we have not taken account of wider social and economic benefits*** *that might have been forgone during the closure of the railway in February''*

"66% contingency to 'deal' with future uncertainties"

Our approach BCRs: 0.13 & 0.21

Route Option	Capital Cost (£m)	Journey Time	BCR
A	875	+14	0.14
B	470	+7	0.29
C1	3100	-5	0.08
C2	2510	-6	0.12
C3	2250	-6	0.13
C4	1560	-5	0.17
C5	1490	-3	0.15

Conclusion / Comments

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- Climate change will increase the impacts of disruption to infrastructure
- Adaptation costs will likely be greater than the impacts – other options?
- Climate information has a 'real' economic value in adaptation investment decisions
- 'Real options' can be done simply to provide information for decision making and long-term planning
- UKCP18: will continue will probabilistic data, supporting this type of analysis

UK CLIMATE PROJECTIONS

UKCP18 Project