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CESER
Centre for Earth Systems Engineering Research

Climate risks and adaptation of UK infrastructure

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Examples of climate impacts on UK infrastructure

UK infrastructure provides services essential to improving quality of life

Infrastructure assets	Annual usage
55 major airports	228m passengers
2,537 railway stations	1.3bn rail journeys (GB)
245,000 miles of road	>6,500 miles per person (GB)
52 major ports	507m tonnes cargo
>100 drinking water reservoirs	53,000 litres drinking water per person
>9,000 waste water treatment plants	
25,400 miles of flood defence (England)	748,000 properties with a 1-in-100 annual chance of flooding or greater(England)
510 landfill sites	48 million tonnes waste received
460 power stations	361 TWh electricity
15,500 miles high voltage overhead power lines (GB)	
Almost 500,000 distribution network overhead lines and cables (GB)	
>52,500 mobile phone base stations	134 bn minutes call time
3.5million m^2 data centres	22.6m broadband connections

Observed changes in climate

- **Temperature**
- Central England Temperature has risen by 0.9-1^{o}C since 1980.
- All ten of the warmest years on record in the UK have occurred since 1990. 2014 was the warmest years on record in the UK.

- **Rainfall**
- Increased average rainfall in recent decades but no clear long-term trend for England and Wales since records began in 1766
- Seasonal rainfall is highly variable
- Over the past 50 years, there is evidence that more rain is falling as heavy events during winter [in some regions]

- **Sea level**
- Sea level around the UK rose 1-2mm/year during the 20th century
- Over 3mm/year in the past decade
- Peak sea levels during extreme events rising at a similar rate.

- **Windstorms**
- Severe windstorms have become more frequent in the past few decades, although long-term trend unclear

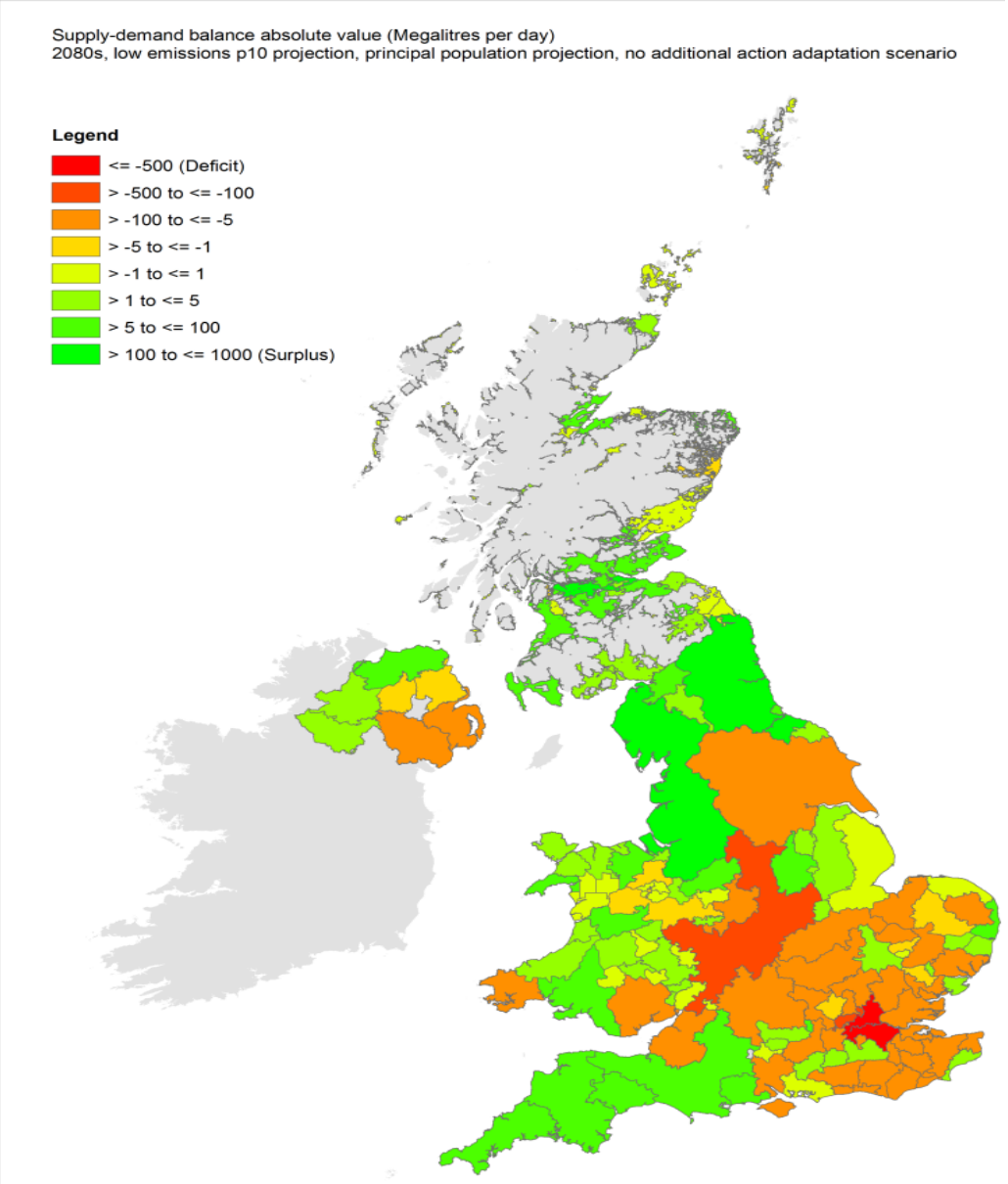
Headline risks

- ***Flood damage and disruption to infrastructure***
- ***Droughts and low water availability for public water supplies and energy generation***
- ***Impacts of extreme heat on rail and energy infrastructure***
  - The 2003 heat wave cost £2.5 million in repairs to the rail network,
  - Frequency of rail buckling events is expected to be four times higher under a low climate change scenario
  - Increases in mean temperature reduce line rating by 1.4-19% by the 2080s, whilst load growth of 1.5-2% per year reported in many regions.
- ***Storm damage and disruption***
  - 90 weather related faults on the transmission network and over 9,000 on the distribution network between April 2008 and March 2009, causing 1.9 million interruptions
  - lightning strike disruptions to the energy network may increase by up to 36%
  - No statistically significant change in wind
- ***Geohazards***
  - 8% of the UK's road and rail network is at medium-high risk of landslide disruption
  - 622 km electricity cable, significant proportions of the gas transmission network, and water pipes, are located in areas susceptible to swell-shrink subsidence

Droughts and low water availability for public water supplies and energy generation

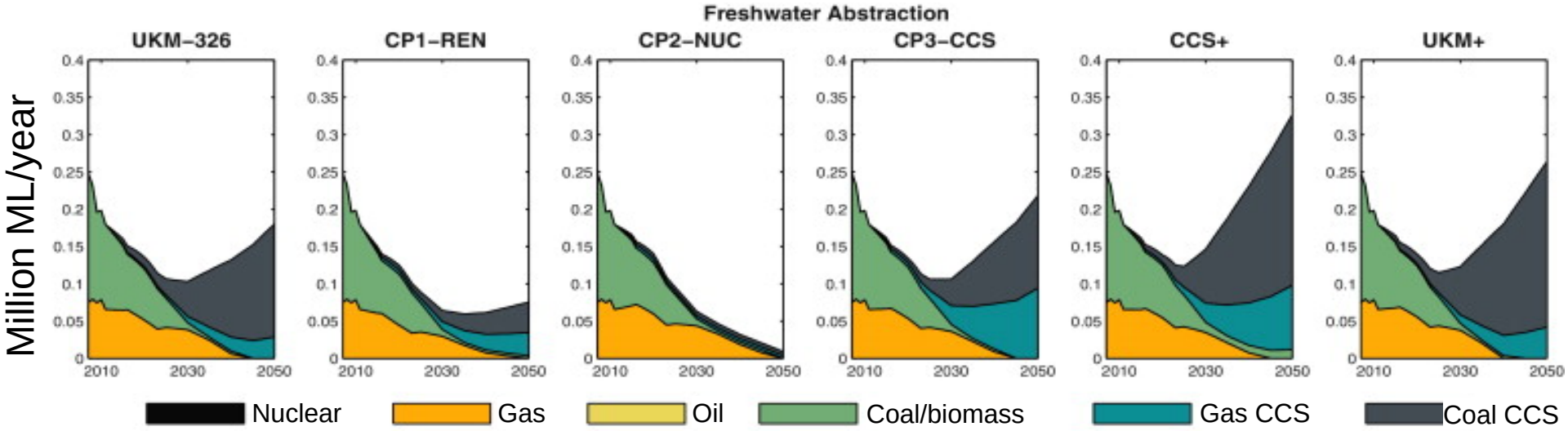
Currently a supply/demand surplus of water of around 2,000 Ml/day. But deficits will be widespread by the 2050s – particularly in the SE England and

The south-east of England and the large conjunctive use zones in the north of England are particularly susceptible, but deficits are projected in other parts of the UK as well.



HR Wallingford et al. (2015) Water availability projections for the UK

Droughts and low water availability for public water supplies and energy generation



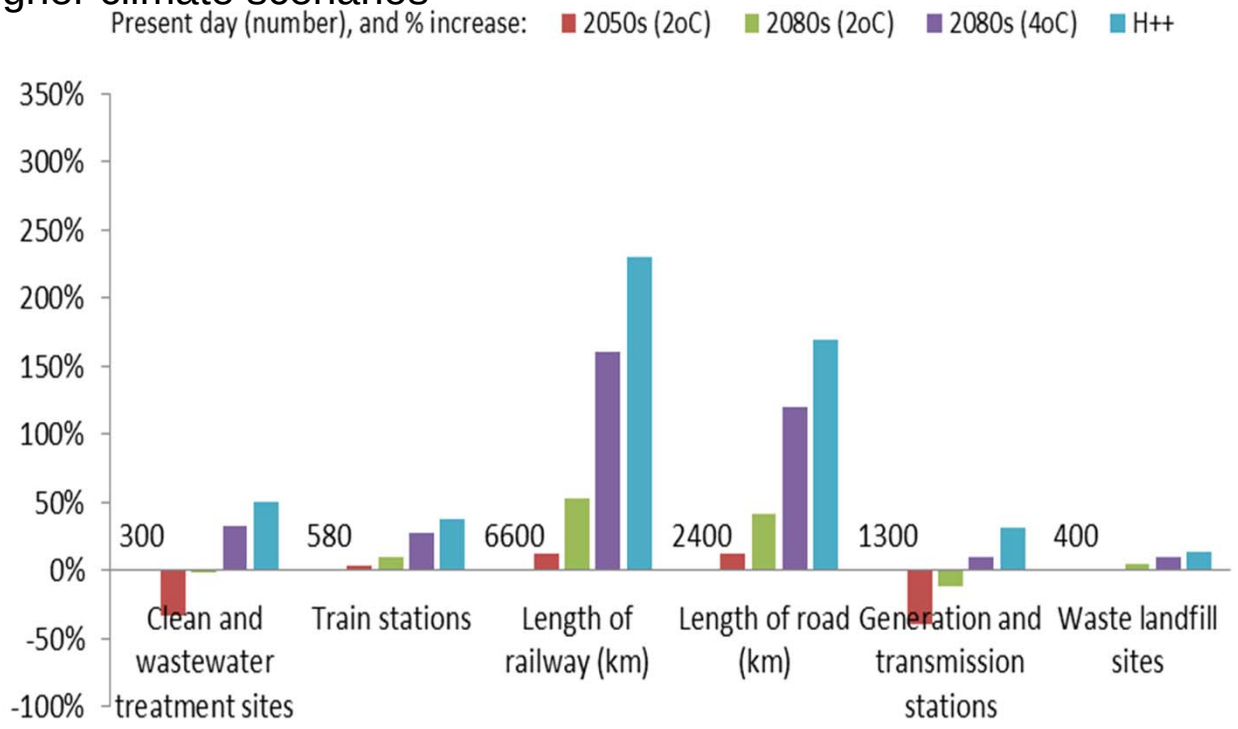
Byers et al. (2014) Electricity generation and cooling water use: UK Pathways to 2050. Global Environmental Change 25 16-30.

- Extended periods of low rainfall will limit freshwater abstractions to cool power plants – with inland power capacity in England most at risk.

- Energy mixes with nuclear and carbon capture technologies most significant
- High CCS scenarios double freshwater consumption by the 2050s
- Clustering generation capacity compounds these issues further.

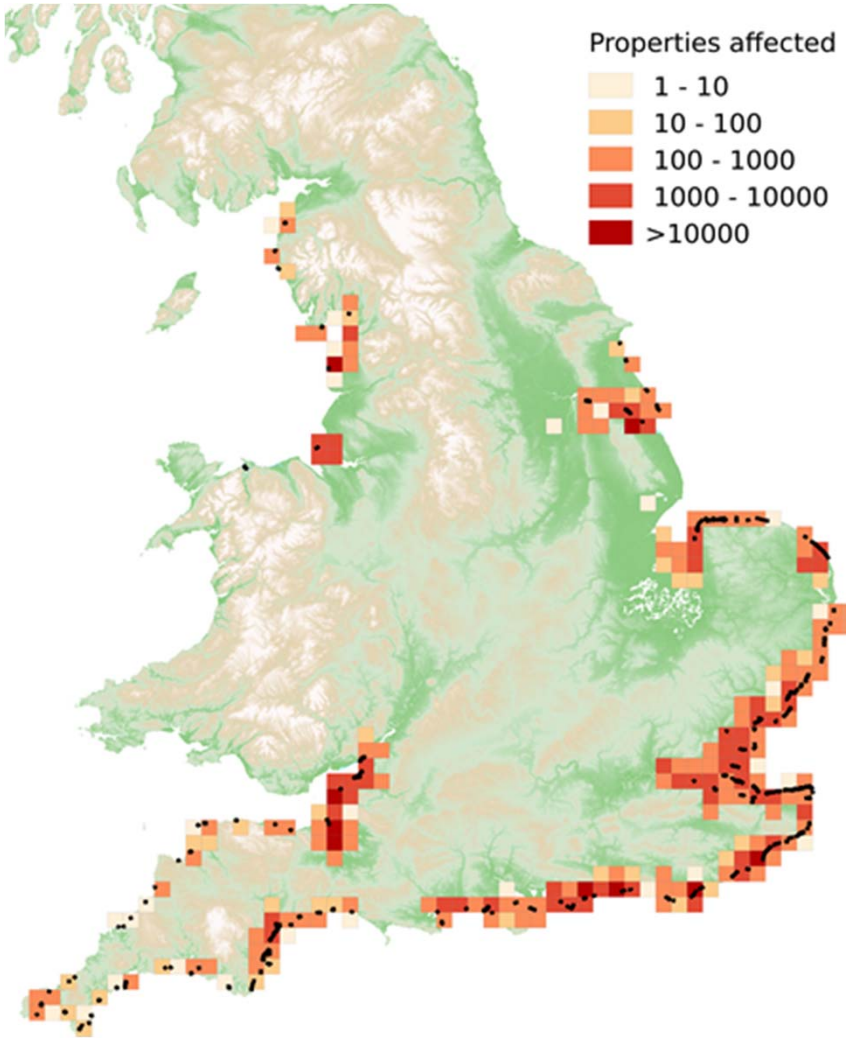
Flood damage and disruption to infrastructure

- Number exposed infrastructure assets increases 30-200% by the 2080s
- Residential properties at risk of 1 in 75 year event will almost double to 1.7million
- Adaptation (e.g. for electricity substations) to a 1:200 year return period standard will reduce risk for the 2020s and 2050s
- Projected to increase across the UK, and even the most ambitious current adaptation plans will be unable to handle higher climate scenarios



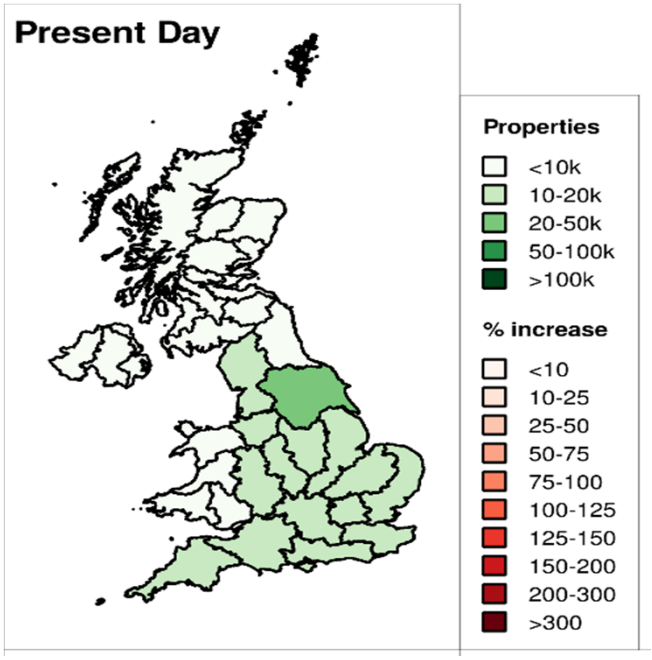
0.5m sea level rise will nearly double length of vulnerable coastal flood defence

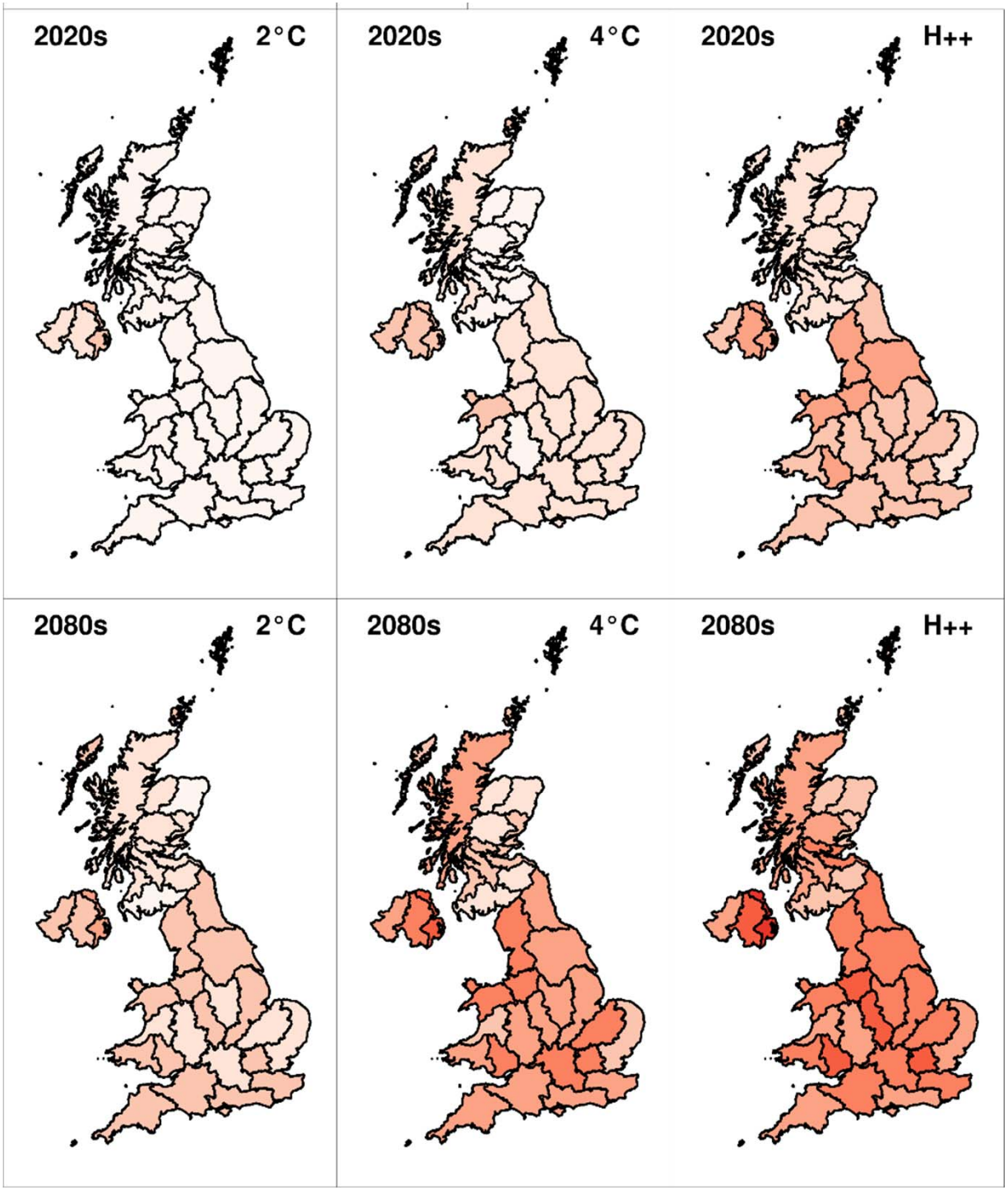
Sea level rise will increase the annual cost of maintaining coastal defences by 150-400%.



Sayers et al. (2015) Climate Change Risk Assessment 2017: Projections of future flood risk in the UK, Download from

Properties at risk





Sayers et al. (2015) Climate Change Risk Assessment 2017: Projections of future flood risk in the UK

Interdependencies

- Infrastructures are increasingly reliant on each other – for power, control (via ICT), access for deliveries or servicing.
- Most sectors identify failure of another infrastructure sector as a risk, but these are typically not quantified.
- Led by the Cabinet Office, there has been effort in recent years to encourage infrastructure operators to work together and address vulnerabilities.
- Commercial and security sensitivities remain barriers to routine data sharing and co-operation.

Relationship between climate hazards and infrastructure

	Sea level rise				Rainfall						Temperature						Other factors				
	Damage or disruption from coastal flooding	Tidelocking	Saline intrusion	Coastal erosion	Damage or disruption from river flooding	Damage or disruption from pluvial flooding	Droughts and low precipitation	Altered capacity or efficiency	Biological processes and/or disease	Stability of earthworks	Severe heat	Severe cold, snow and ice	Altered capacity or efficiency	Subsidence and/or dessication	Biological processes and/or disease	Demand for service	Lightning strike	Humidity	Solar radiation	Fog	Storminess and wind damage
Rail transport	x			x	x	x	x	x		x	x	x	x	x		x	x	x			x
Road transport	x			x	x	x		x		x	x	x	x	x		x		x		x	x
Inland waterway transport	x	x			x	x	x			x	x	x	x	x		x					
Ports & marine transport	x	x		x		x					x	x	x							x	x
Potable water	x		x	x	x	x	x	x	x		x	x	x	x	x	x					x
Waste water & sanitation	x	x	x		x	x	x		x		x	x	x	x	x						
Flood & coastal erosion management	x	x		x	x	x				x	x			x	x						x
Information & communication technology	x				x	x	x	x			x	x	x				x	x			x
Solid waste	x			x	x	x	x	x	x		x		x		x						x
Nuclear, coal, oil & gas energy	x			x	x	x	x			x	x	x	x								x
Renewable energy generation	x				x	x	x	x					x						x		x
Power systems, transmission & distribution	x				x	x					x		x				x				x
Energy demand	x				x	x	x				x	x				x			x		

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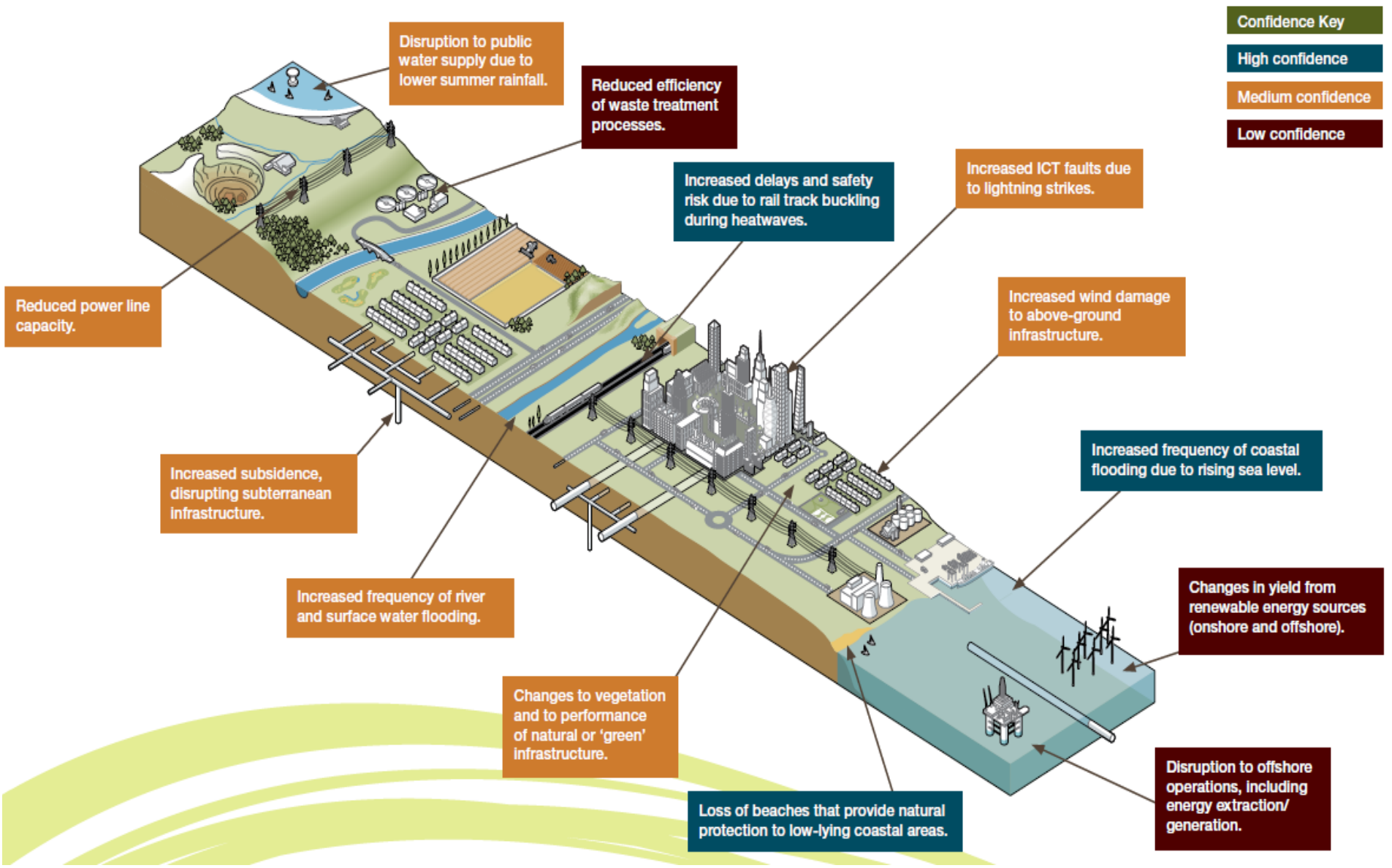

Summary

- Climate change will increase the risk of infrastructure failure and disruption in the UK over the 21st century.
- Over last 5-10 years significant adaptation steps have been implemented, or are underway, across most infrastructure sectors.
- Further action beyond that currently planned is likely to be required to manage risks beyond a few decades.
- Improvements to recording and provision of data on climate risks to infrastructure are needed.
- Good understanding of key sectoral risks, but need to further build capacity to handle interdependent risks.

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Further information

https://www.theccc.org.uk/tag/adaptation-sub-committee/

http://www.nerc.ac.uk/research/partnerships/lwec/