

# What are the most pressing issues for adaptation to a changing climate



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# Overview



- Adaptation definition and principles

## Global

- IPCC Global Risk Analysis (from the 6<sup>th</sup> Assessment Report, AR6)

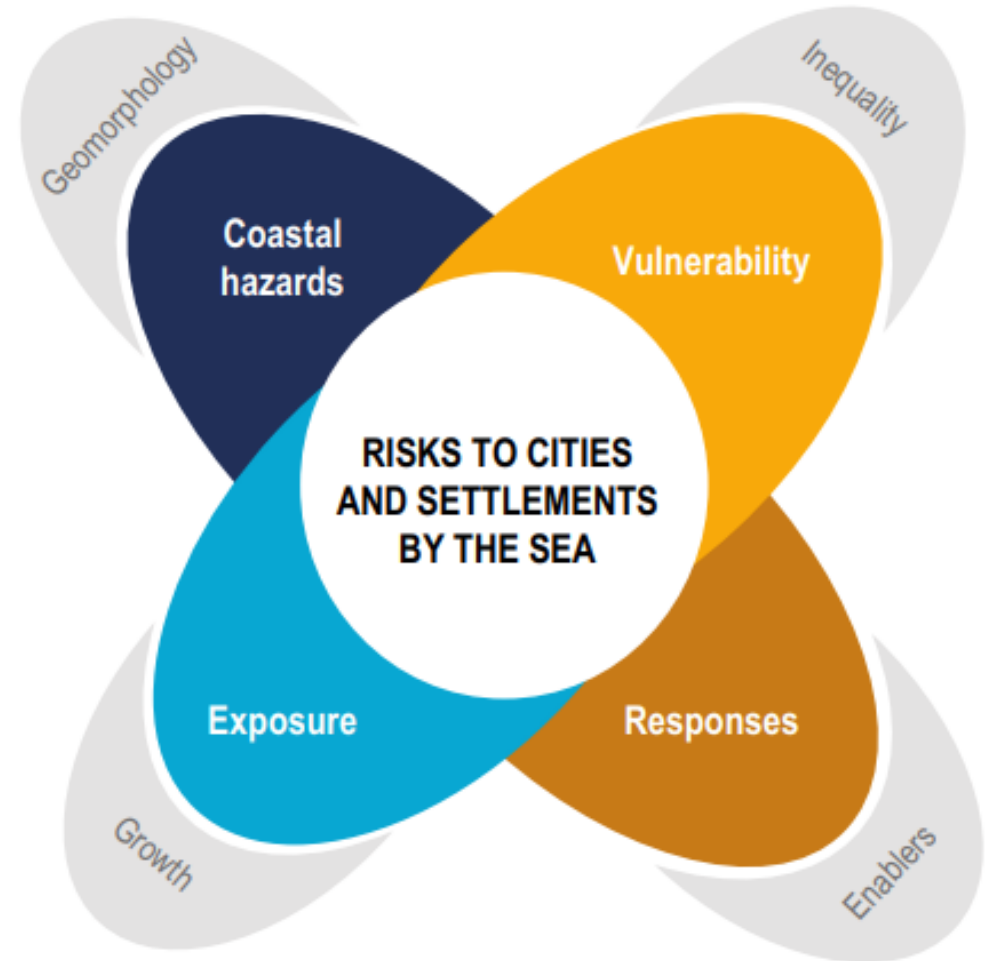
## UK

- Climate Change Risk Analysis (from the 3<sup>rd</sup> CCRA)
- Adaptation Progress (from the Climate Change Committee's 2023 Progress Report)

- Challenges in monitoring adaptation

# Adaptation

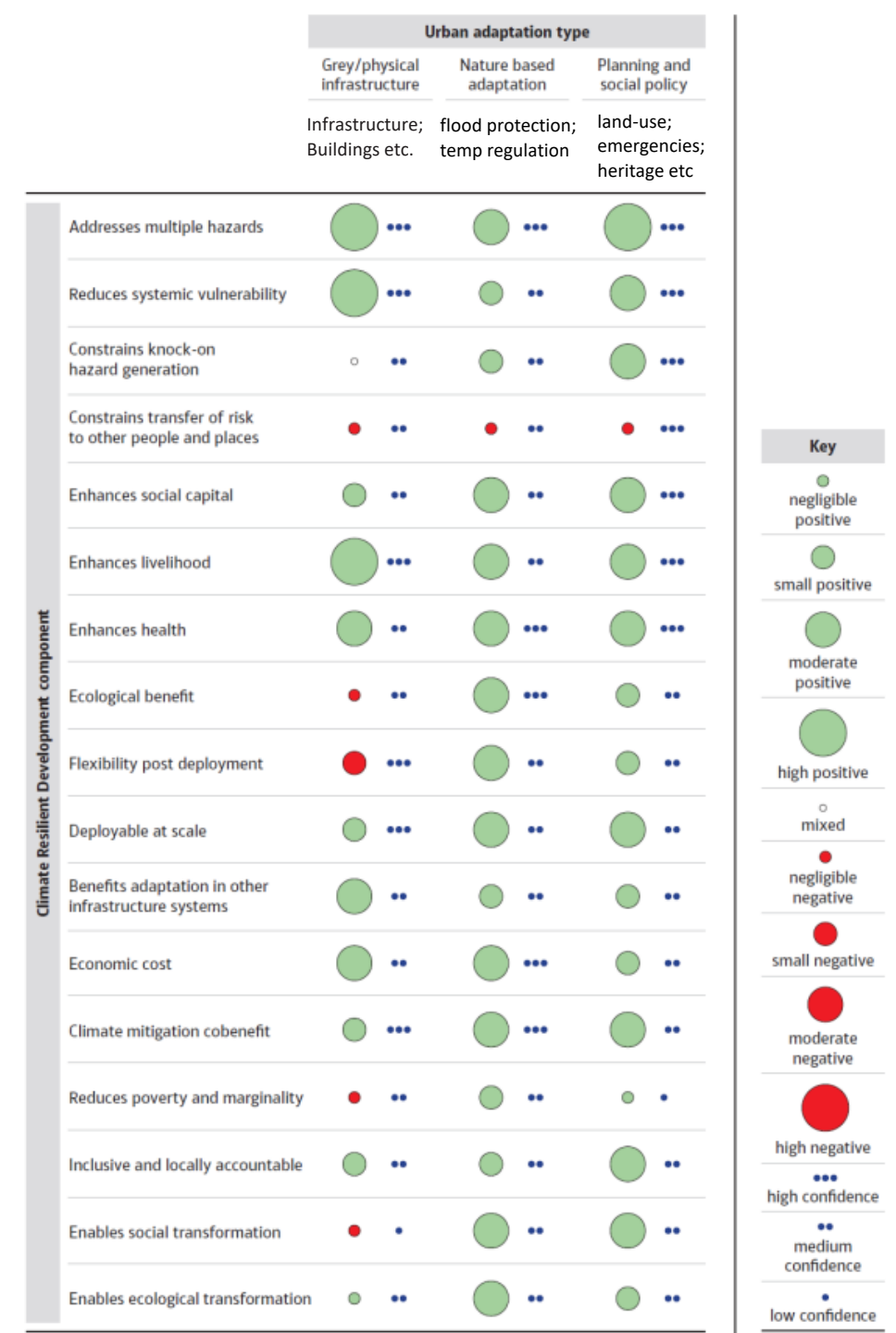
- **Adaptation**
- In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.
- In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.



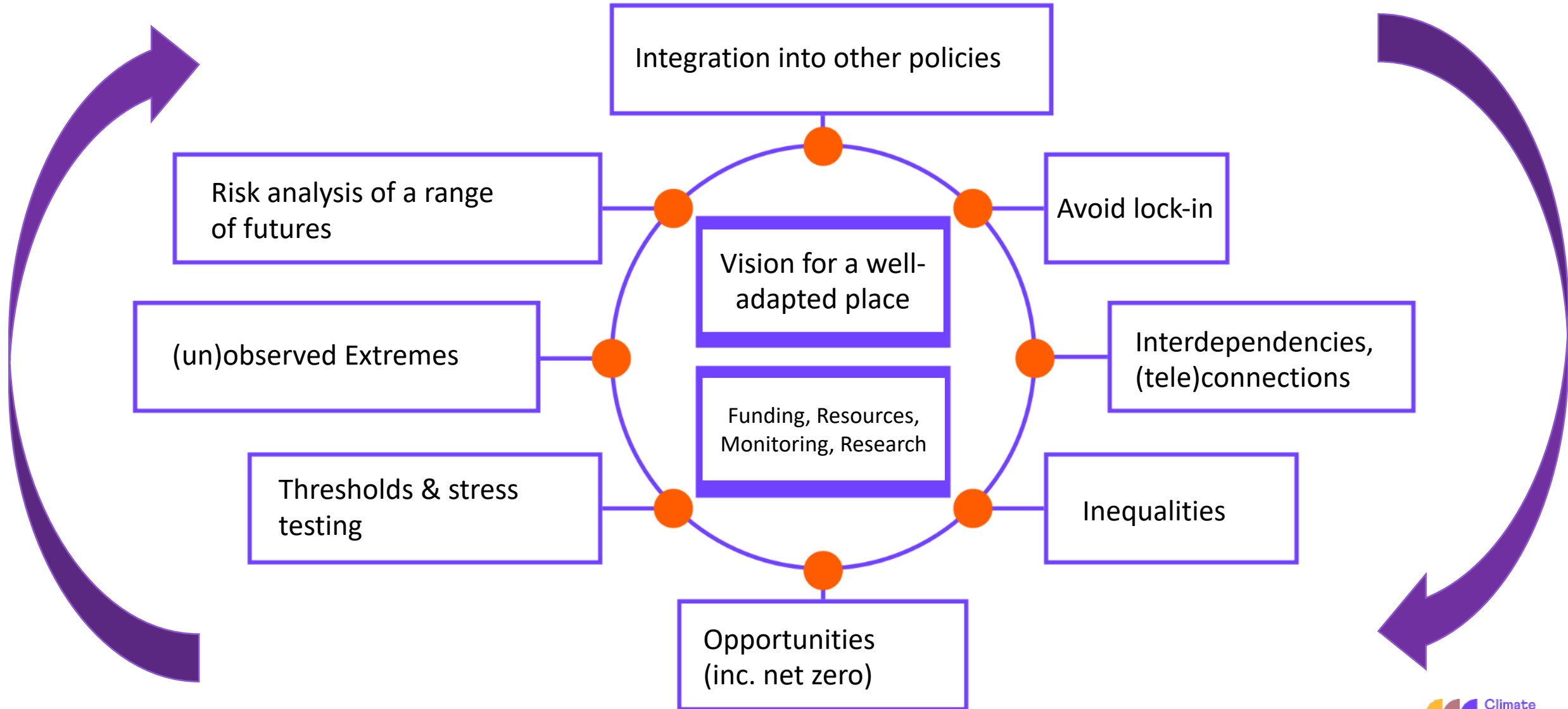
IPCC (2022) [Cities and Settlements by the sea](#),  
6<sup>th</sup> Assessment Report

# Adaptation

- **Adaptation**
- In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.
- In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.
- **Adaptation options**
- The array of strategies and measures that are available and appropriate for addressing adaptation.
- They include a wide range of actions that can be categorised as structural, institutional, ecological or behavioural.



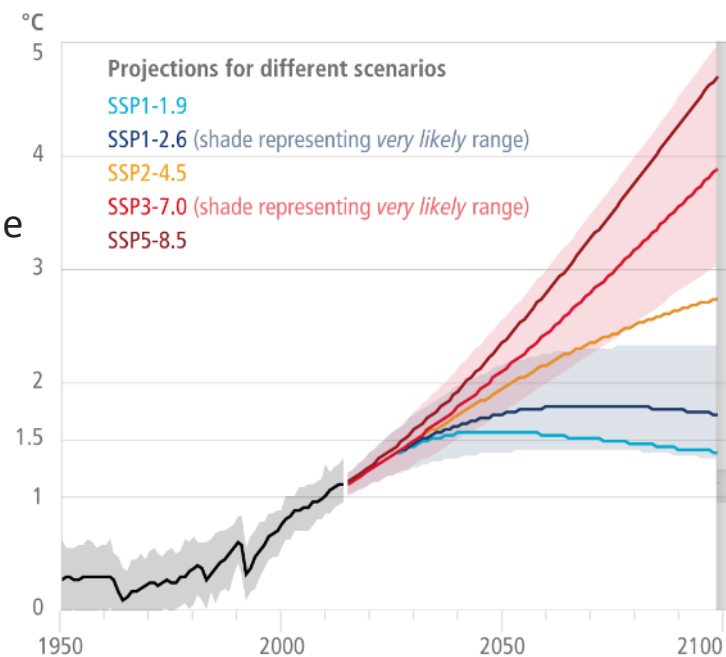
# Principles for good adaptation



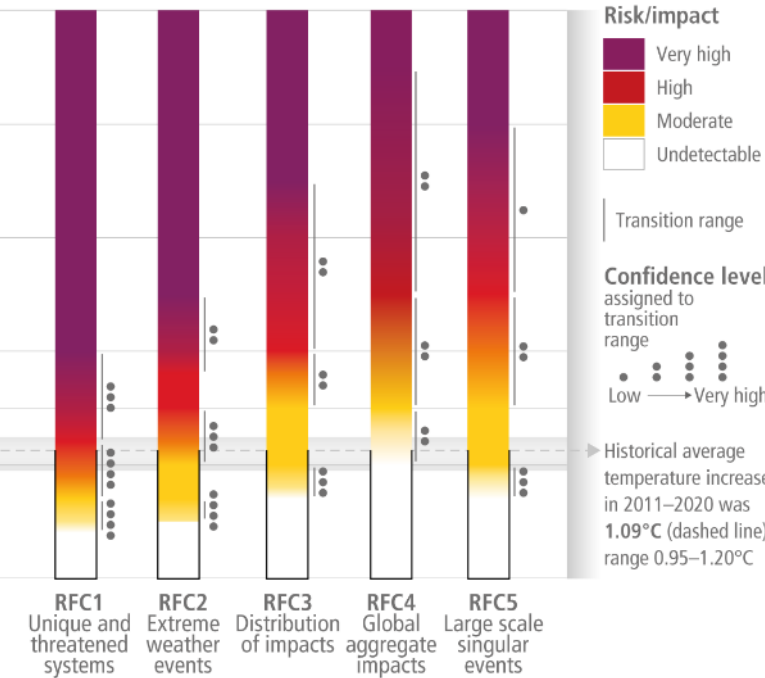
# IPCC Global risks for increasing global warming levels

- RFC1: e.g. coral reefs, the Arctic and its Indigenous Peoples, mountain glaciers and biodiversity hotspots.
- RFC2: e.g. risks/impacts to human health, livelihoods, assets and ecosystems from extreme weather events such as heatwaves, heavy rain, drought and associated wildfires, and coastal flooding.
- RFC3: e.g. disproportionately affect particular groups due to uneven distribution of physical climate change hazards, exposure or vulnerability.
- RFC4: impacts to socio-ecological systems that can be aggregated globally into a single metric, such as monetary damages, lives affected, species lost or ecosystem degradation at a global scale.
- RFC5: e.g. ice sheet disintegration or thermohaline circulation slowing.

(a) Global surface temperature change  
Increase relative to the period 1850–1900



(b) Reasons for Concern (RFC)  
Impact and risk assessments assuming low to no adaptation





# IPCC Key risks

120 Risks identified, clustered into 8 Representative Key Risks

Type and level

<b>C</b> Climate (warming)	<b>H</b> High
<b>EV</b> Exposure and Vulnerability	<b>M</b> Medium
<b>A</b> Adaptation	<b>L</b> Low
	<b>H</b> High
	<b>L</b> Low
	<b>NA</b> Not fully assessed

Scope

- \* Broadly applicable (risks are severe pervasively and even globally)
- \*\* Specific (risks are to particular areas, sectors or groups of people)


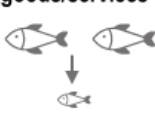
Confidence levels

- High
- Medium
- Low

## (a) Low-lying coastal systems

* <b>C</b> <b>EV</b> <b>A</b> ●●	Nat. coastal protection & habitats	Loss of lives, livelihoods & well-being	Disruption of transport systems
** <b>C</b> <b>EV</b> <b>A</b> ●●●			
** <b>C</b> <b>EV</b> <b>A</b> ●●			

## (b) Terrestrial and marine ecosystems

* <b>C</b> <b>EV</b> <b>A</b> ●●	Change structure/functioning	Loss ecosystem goods/services
* <b>C</b> <b>EV</b> <b>A</b> ●● / ●●●		
* <b>C</b> <b>EV</b> <b>A</b> ●●●		

## (c) Critical infrastructure, networks and services

* <b>C</b> <b>EV</b> <b>A</b> ●●●	Damage & disruption	Impacts of failure on lives, livelihoods, economies
** <b>C</b> <b>EV</b> <b>A</b> ●●		

## (d) Living standards




Aggregate economic impacts	* <b>C</b> <b>EV</b> <b>A</b> ●●	Increased poverty	Nat. coastal protection & habitats	Loss of biodiversity
	** <b>C</b> <b>EV</b> <b>A</b> ●●			
		* <b>C</b> <b>EV</b> <b>A</b> ●●		

## (f) Food security

* <b>C</b> <b>EV</b> <b>A</b> ●●●	Decline provis. ecosystem services
* <b>C</b> <b>EV</b> <b>A</b> ●●	Increased hunger
* <b>C</b> <b>EV</b> <b>A</b> ●●	
	

Loss of livelihoods	* <b>C</b> <b>EV</b> <b>A</b> ●●
	** <b>C</b> <b>EV</b> <b>A</b> ●●●



## (e) Human health

Heat-related mortality	Vector-borne diseases	Waterborne diseases
		
* <b>C</b> <b>EV</b> <b>A</b> ●●●	** <b>C</b> <b>EV</b> <b>A</b> ●●	** <b>C</b> <b>EV</b> <b>A</b> ●●

## (g) Water security

Water scarcity	Water-related disasters	Indig. & trad. cultures & ways of life
		
* <b>C</b> <b>EV</b> <b>A</b> ●●●	* <b>C</b> <b>EV</b> <b>A</b> ●●●	** <b>C</b> <b>EV</b> <b>A</b> ●●

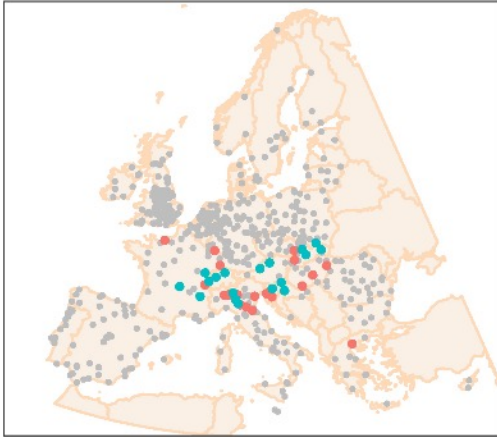
## (h) Peace & mobility

Armed conflicts	Involuntary (im)mobility
	
* <b>C</b> <b>EV</b> <b>A</b> ●	* <b>C</b> <b>EV</b> <b>A</b> ●●
	** <b>C</b> <b>EV</b> <b>A</b> ●● / ●●●

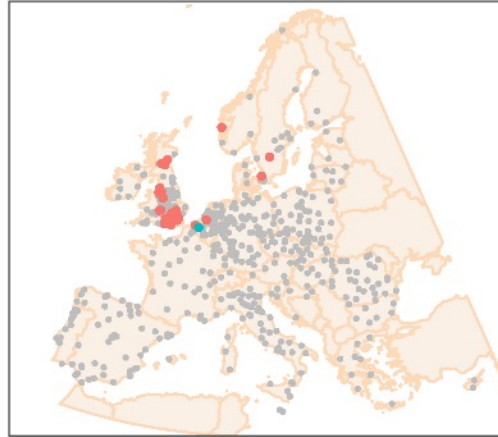
# Inequalities

## Hazards

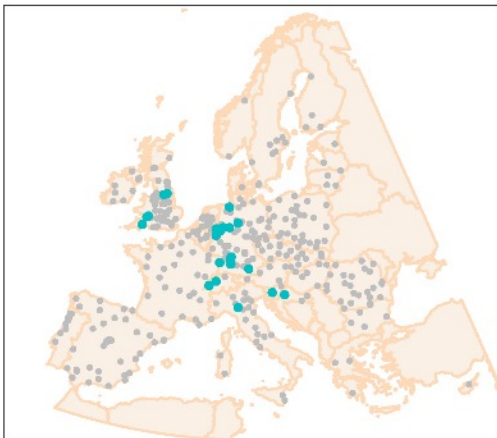
a) Top 50% for all indices



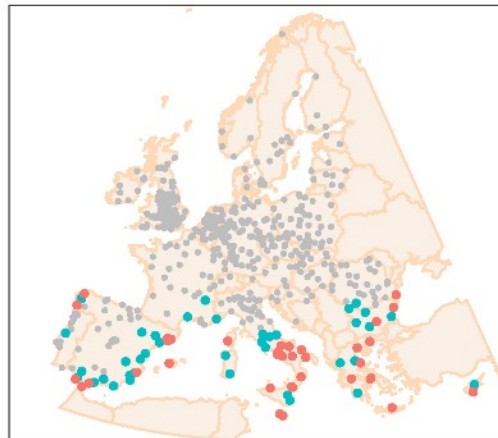
d) Bottom 50% for all indices



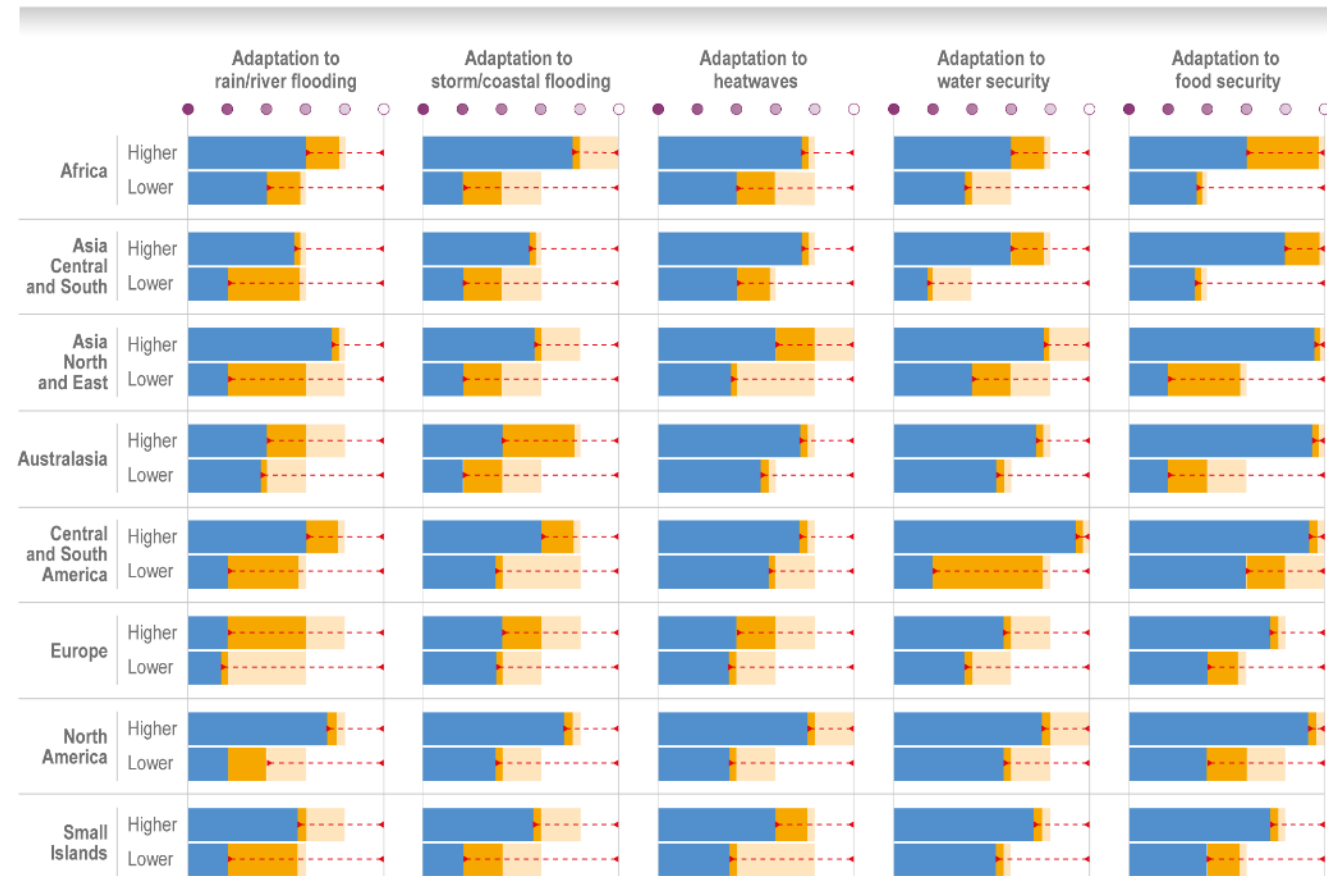
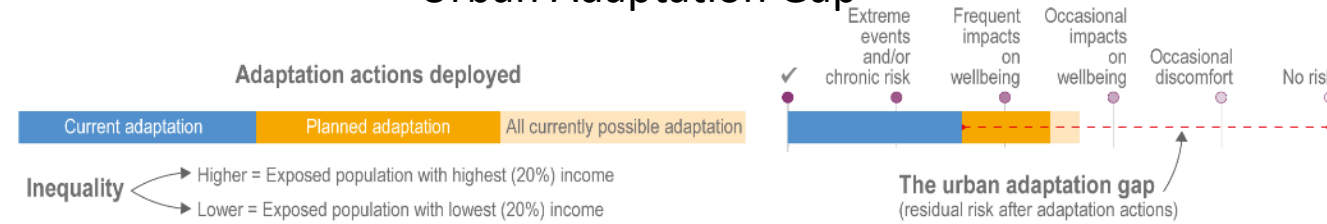
c) Top 25% for floods and HW Tmax



b) Top 25% for droughts and HW days



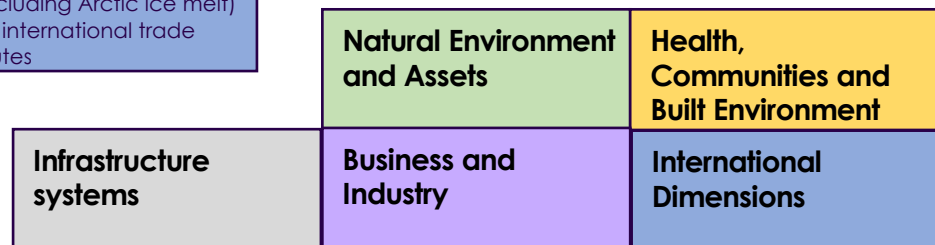
## Urban Adaptation Gap





# UK CCRA: 61 Risks and Opportunities

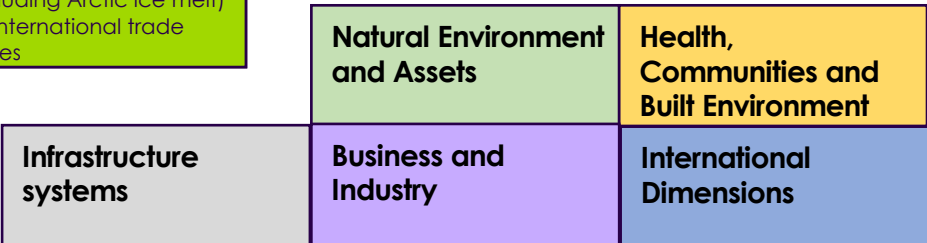
N1 Risks to terrestrial species and habitats	N2 Risks to terrestrial species and habitats from pests, pathogens and INNS	N4 Risk to soils from changing conditions, including seasonal aridity and wetness	N5 Risks to natural carbon stores and sequestration from changing conditions	N6 Risks to and opportunities for agricultural and forestry productivity	N7 Risks to agriculture from pests, pathogens and INNS	N8 Risks to forestry from pests, pathogens and INNS	N11 Risks to freshwater species and habitats
N12 Risks to freshwater species and habitats from pests, pathogens and INNS	N14 Risks to marine species, habitats and fisheries	N16 Risks to marine species and habitats from pests, pathogens and INNS	N17 Risks and opportunities to coastal species and habitats	I1 Risks to infrastructure networks from cascading failures	I2 Risks to infrastructure services from river and surface water flooding	I5 Risks to transport networks from slope and embankment failure	N1 Risks to terrestrial species and habitats
I12 Risks to transport from high and low temperatures, high winds, lightning	H1 Risks to health and wellbeing from high temperatures	H3 Risks to people, communities and buildings from flooding	H4 Risks to people, communities and buildings from sea level rise	H6 Risks and opportunities from summer and winter household energy demand	H8 Risks to health from vector-borne diseases	H11 Risks to cultural heritage	H12 Risks to public water supplies from reduced water availability
H13 Risks to education and prison services	B1 Risks to business sites from flooding	B2 Risks to business locations and infrastructure from coastal change	B6 Risks to business from disruption to supply chains and distribution networks	ID1 Risks to UK food availability, safety, and quality from climate change overseas	ID5 Risks to international law and governance from climate change overseas that will impact the UK	ID4 Risks to the UK from international violent conflict resulting from climate change	ID9 Risk to UK public health from climate change overseas
ID7 Risks from climate change on international trade routes	ID10 Risk multiplication from the interactions and cascade of named risks across systems and geographies	N3 Opportunities from new species colonisations in terrestrial habitats	N9 Opportunities for agricultural and forestry productivity from new species	N10 Risks to aquifers and agricultural land from sea level rise, saltwater intrusion	N15 Opportunities for marine species, habitats and fisheries	N18 Risks and opportunities from climate change to landscape character	I3 Risks to infrastructure services from coastal flooding and erosion
I4 Risks to bridges and pipelines from flooding and erosion	I6 Risks to hydroelectric generation from low or high river flows	I7 Risks to subterranean and surface infrastructure from subsidence	I9 Risks to energy generation from reduced water availability	I10 Risks to energy from high and low temperatures, high winds, lightning	I13 Risks to digital from high and low temperatures, high winds, lightning	H2 Opportunities for health and wellbeing from higher temperatures	H5 Risks to building fabric
H7 Risks to health and wellbeing from changes in air quality	H9 Risks to food safety and food security	H10 Risks to health from poor water quality and household water supply interruptions	B3 Risks to businesses from water scarcity	B5 Risks to business from reduced employee productivity- infrastructure disruption and higher	B7 Opportunities for business - changing demand for goods and services	N13 Opportunities to marine species, habitats and fisheries	I11 Risks to offshore infrastructure from storms and high waves
B4 Risks to finance, investment, insurance, access to capital	ID8 Risk to the UK finance sector from climate change overseas	ID2 Opportunities for UK food availability and exports	ID3 Risks to the UK from climate-related international human mobility	ID6 Opportunities (including Arctic ice melt) for international trade routes			



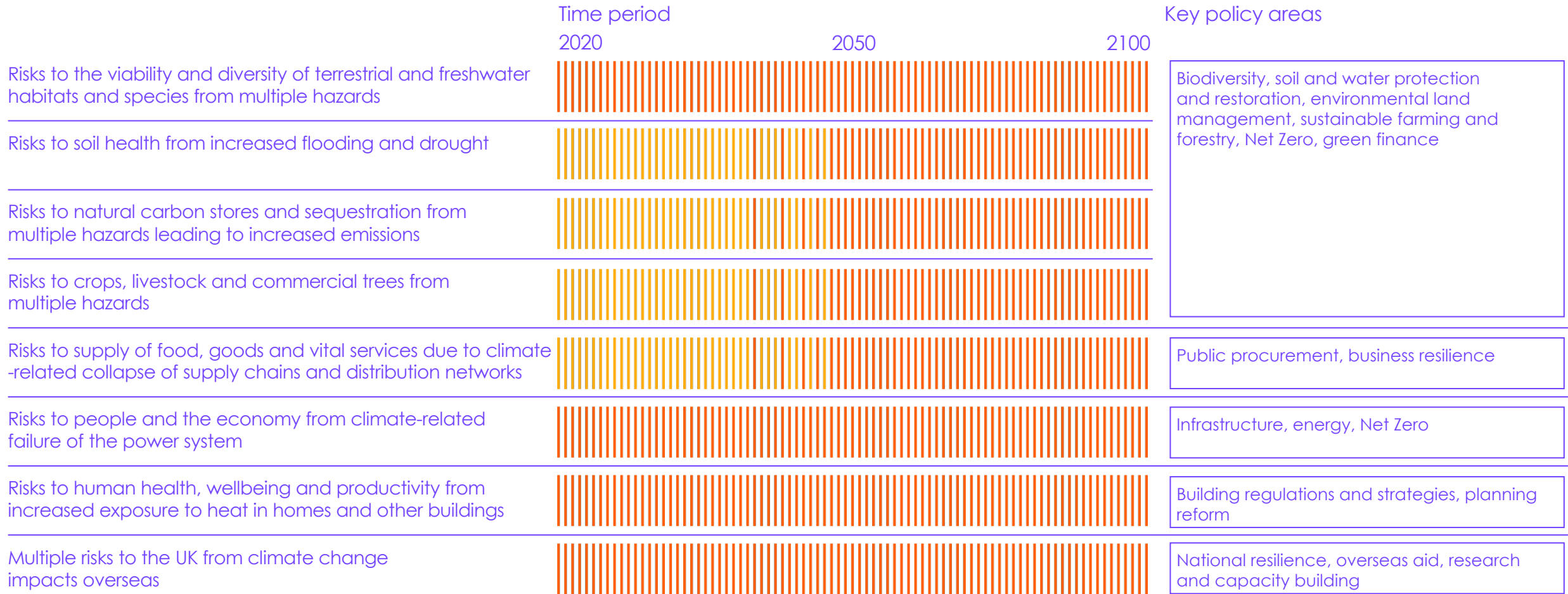
# UK CCRA: 61 Risks and Opportunities

<b>N1</b> Risks to terrestrial species and habitats	<b>N2</b> Risks to terrestrial species and habitats from pests, pathogens and INNS	<b>N4</b> Risk to soils from changing conditions, including seasonal aridity and wetness	<b>N5</b> Risks to natural carbon stores and sequestration from changing conditions	<b>N6</b> Risks to and opportunities for agricultural and forestry productivity	<b>N7</b> Risks to agriculture from pests, pathogens and INNS	<b>N8</b> Risks to forestry from pests, pathogens and INNS	<b>N11</b> Risks to freshwater species and habitats
<b>N12</b> Risks to freshwater species and habitats from pests, pathogens and INNS	<b>N14</b> Risks to marine species, habitats and fisheries	<b>N16</b> Risks to marine species and habitats from pests, pathogens and INNS	<b>N17</b> Risks and opportunities to coastal species and habitats	<b>I1</b> Risks to infrastructure networks from cascading failures	<b>I2</b> Risks to infrastructure services from river and surface water flooding	<b>I5</b> Risks to transport networks from slope and embankment failure	<b>N1</b> Risks to terrestrial species and habitats
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● More Action Needed
 ● Further Investigation
 ● Sustain Current Action, Watching Brief



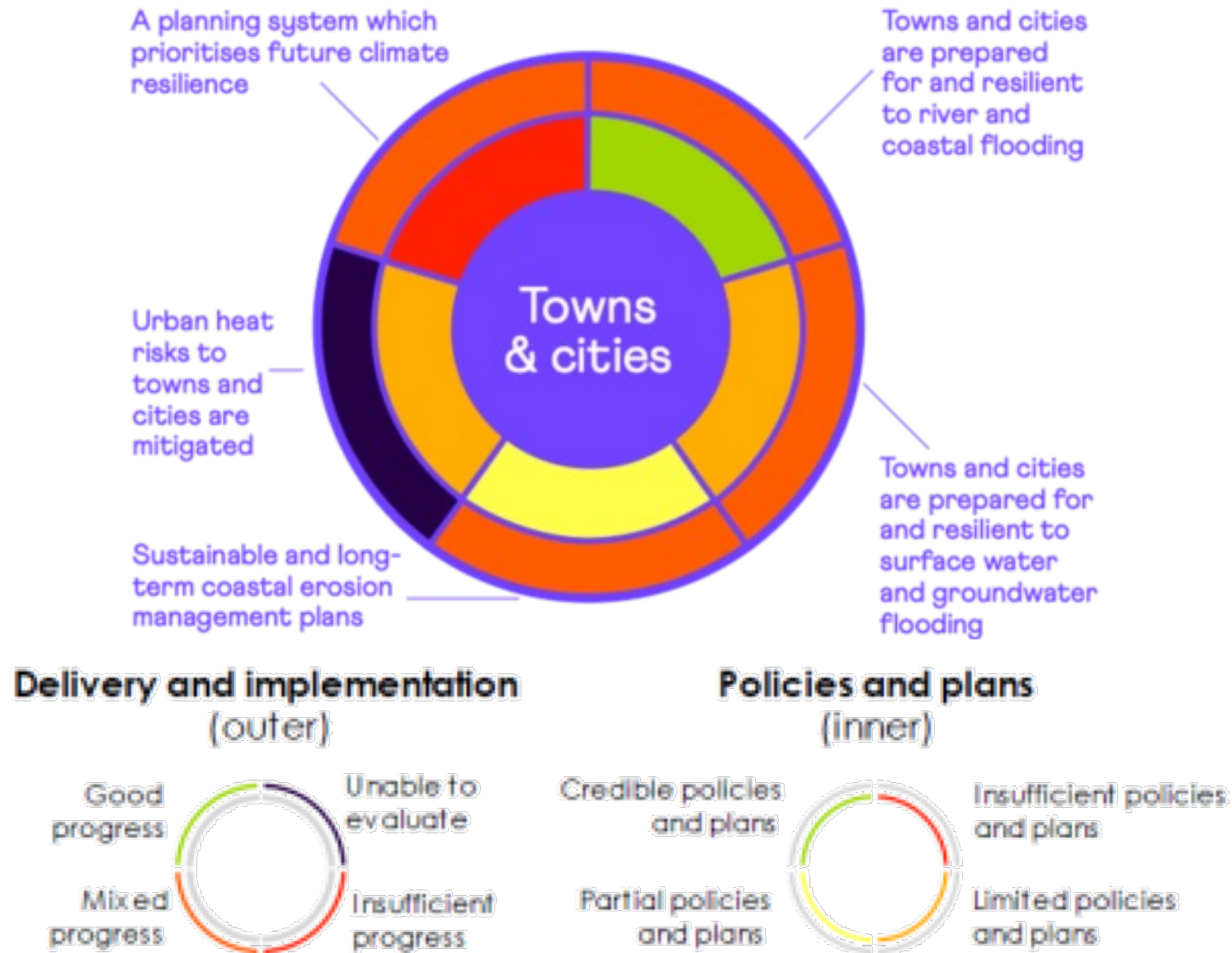
# UK CCC's Priority risks for urgent further action



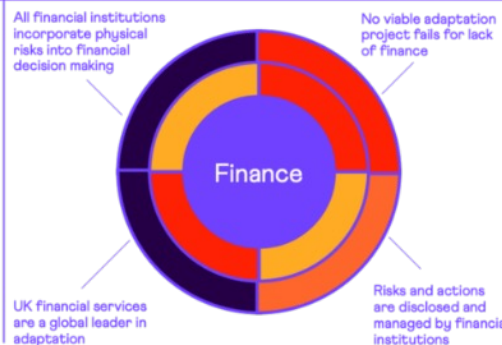
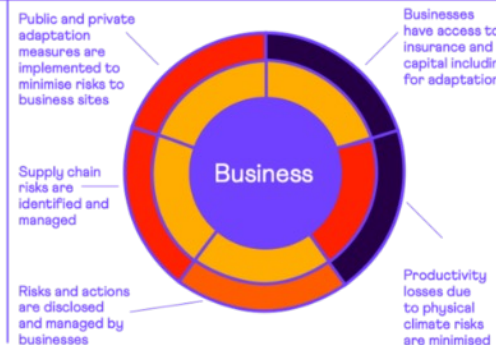
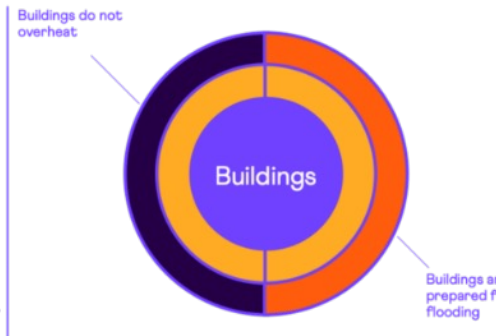
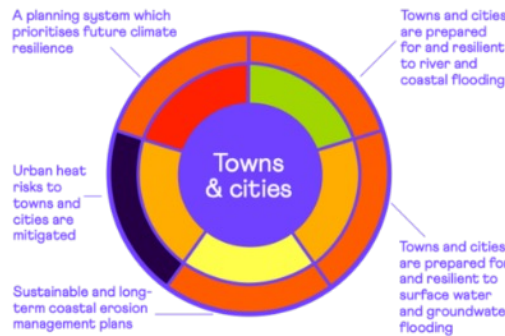
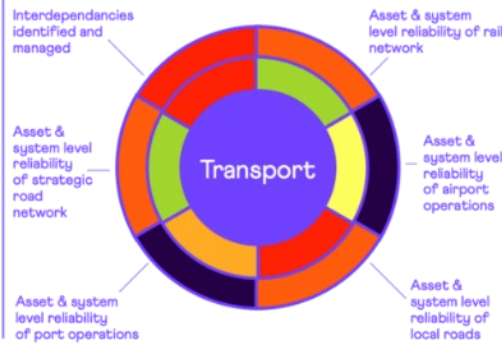
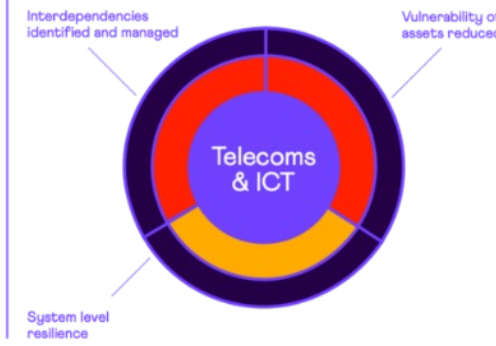
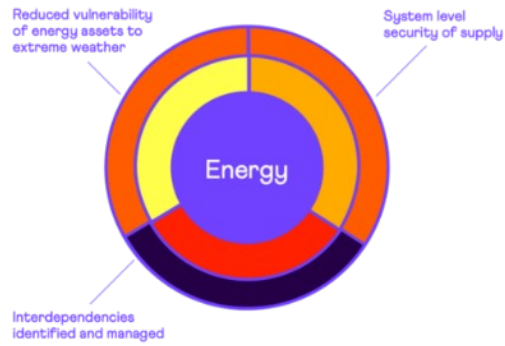
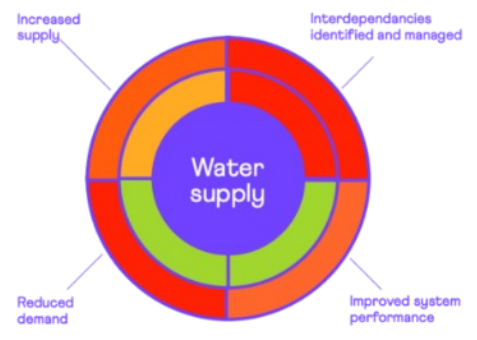
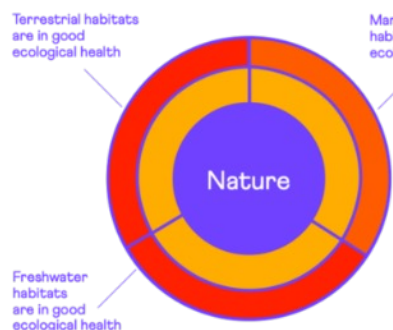
Magnitude of risk



# 2023 Adaptation Progress Report









# Monitoring progress

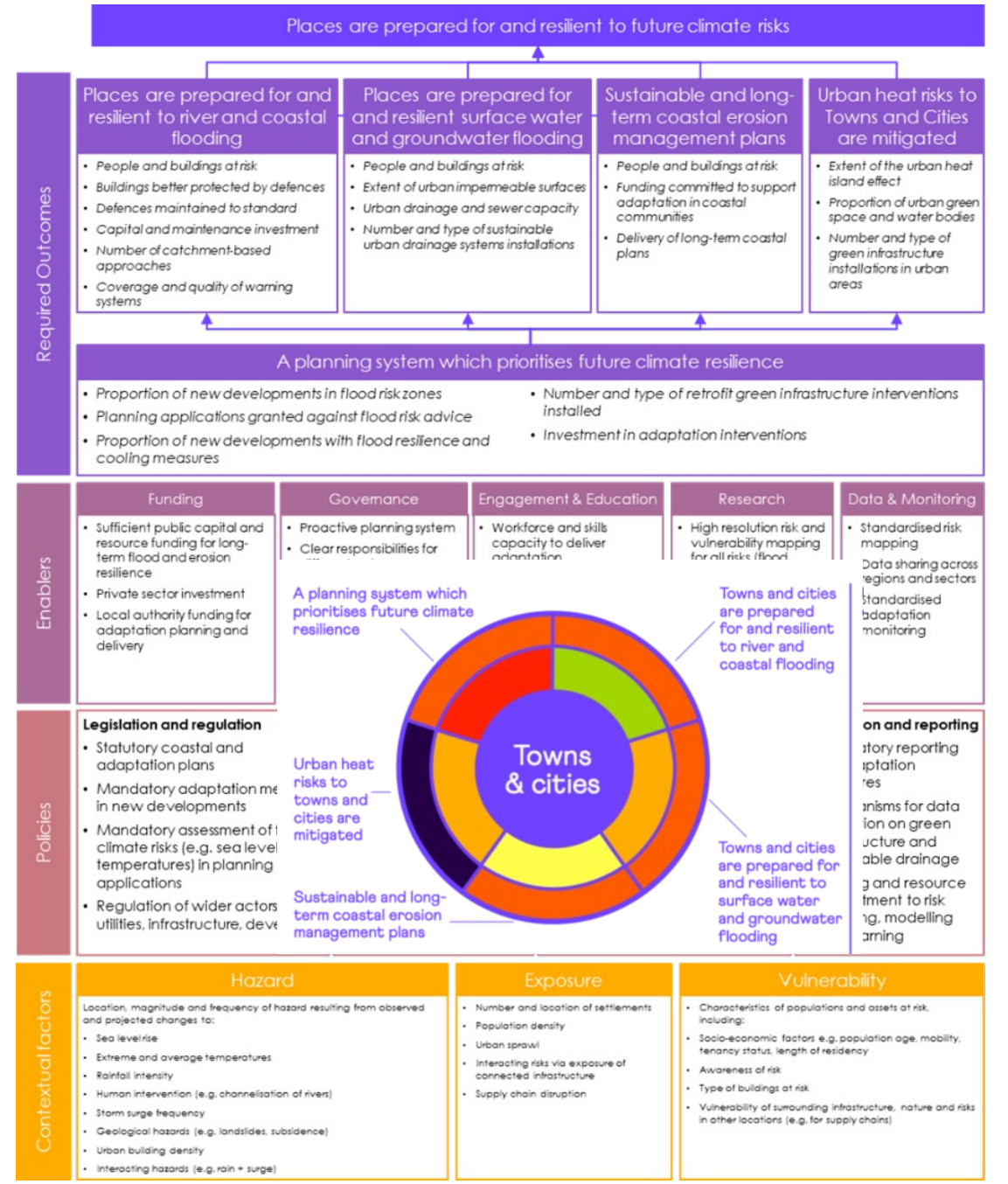
## Sustainable and climate-resilient working land and seas

<b>Climate resilient agricultural production</b> <ul style="list-style-type: none"> <li>Livestock mortality (%) and crop failure (per hectare) due to climate impacts.</li> <li>Abundance and diversity of pollinators and pest predators</li> </ul>	<b>Climate resilient commercial forestry sector</b> <ul style="list-style-type: none"> <li>Area of commercial forestry under sustainable adaptive management meeting UK Forestry Standard</li> <li>Area of commercial forestry planted with climate appropriate and ecologically suitable tree species (avoiding invasive or water-hungry species and damage to native biodiversity)</li> <li>Genetic diversity and species diversity of trees in commercial forests</li> </ul>	<b>Climate resilient commercial fisheries and aquaculture sector</b> <ul style="list-style-type: none"> <li>UK fish stocks maintained at healthy status</li> <li>UK aquaculture stocks healthy and resilient</li> <li>Freshwater, marine and estuarine waters achieve good quality</li> <li>Water temperatures controlled</li> </ul>
<b>Take up of sustainable farming measures</b> <ul style="list-style-type: none"> <li>Area of arable land under cover crops, reduced tillage, addition of compost or manure</li> <li>Area of agroforestry, hedgerows, buffer strips and species-rich field margins</li> <li>Reduced use of pesticides/synthetic fertilisers</li> <li>Greater on-farm water storage capacity /lower abstraction</li> <li>Appropriate slurry store /silage clamp engineering</li> <li>Overgrazing/stocking rates</li> </ul>		
<b>Healthy soils</b> <ul style="list-style-type: none"> <li>Soil erosion rates (t/ha/yr)</li> <li>Increase in soil organic carbon, natural soil biota diversity /abundance and soil infiltration</li> </ul>		
<b>Effective wildfire planning in place</b> <ul style="list-style-type: none"> <li>Prevalence of local wildfire response plans and sufficient fire-fighting equipment /personnel levels</li> <li>Management of vegetation and fuels (but minimising adverse biodiversity impacts)</li> <li>For carbon offsets, plant sufficient area to account for risk of reversal due to fires etc.</li> </ul>		
<b>Responsible practices</b> <ul style="list-style-type: none"> <li>Sustainable harvesting of UK fish stocks in line with scientific evidence</li> <li>Sustainable adaptive management of aquaculture production</li> <li>Restrict /ban bottom trawling activities</li> </ul>		
<b>Climate resilient operations</b> <ul style="list-style-type: none"> <li>Safe and secure vessel and aquaculture operations</li> <li>Reduced vulnerability of vessels and ports</li> </ul>		

<b>Manage and reduce the impacts from pest, diseases and invasive non-native species</b> <ul style="list-style-type: none"> <li>Geographical spread of</li> <li>Number of high priority species</li> </ul>	<b>Climate resilient commercial fisheries and aquaculture sector</b>	<b>Climate resilient commercial forestry sector</b>
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<b>Funding &amp; Investment</b> <ul style="list-style-type: none"> <li>Agric-environment schemes</li> <li>Payments for ecosystem services</li> <li>R&amp;D funding for agroecological adaptation</li> <li>Small port resilience initiatives</li> <li>Public-private partnerships</li> </ul>	<b>Research</b> <ul style="list-style-type: none"> <li>Appropriate species research</li> <li>Biomass crop productivity</li> <li>Changing ocean temperature impacts on fisheries' productivity</li> <li>Agroforestry R&amp;D impacts by location</li> </ul>
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<b>Climate resilient agricultural production</b> <ul style="list-style-type: none"> <li>Improved land management standards</li> <li>Flexible fisheries management arrangements</li> <li>Better protection for Marine Protected Areas (as nurseries to replenish fish stocks)</li> </ul>	<b>Fisheries Act provisions</b> <ul style="list-style-type: none"> <li>Support delivery of climate objectives outlined in UK Fisheries Act</li> </ul>
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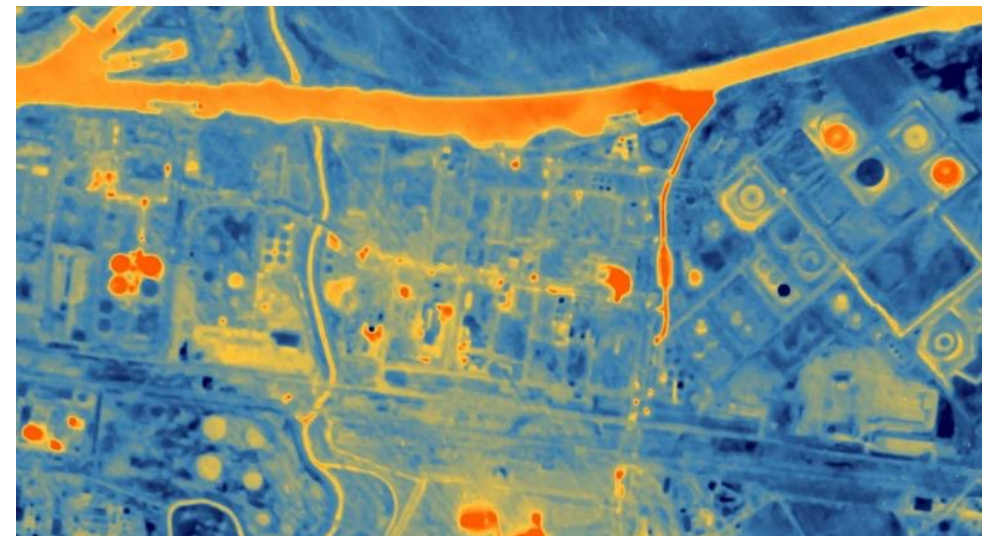




# Spatial resolution



Urban flood management features  
(from Hidrologias Ostenible)



HotSat-1, (from Satellite Vu)

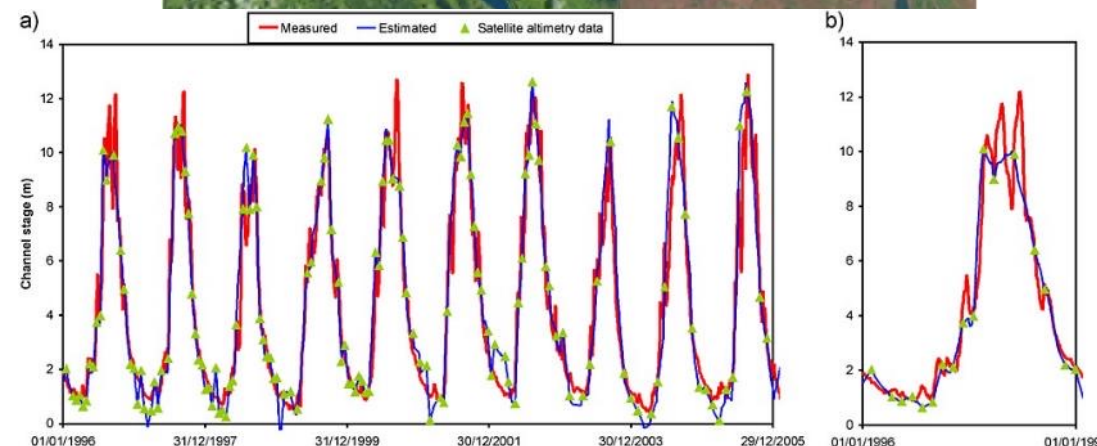
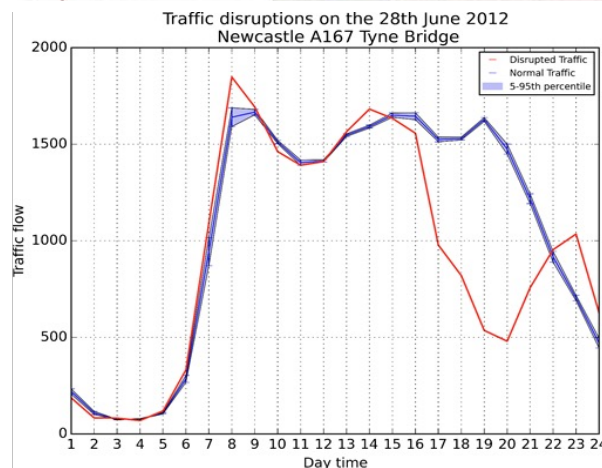
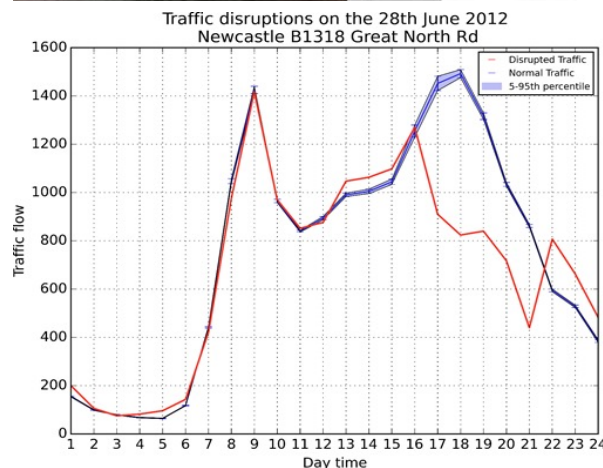
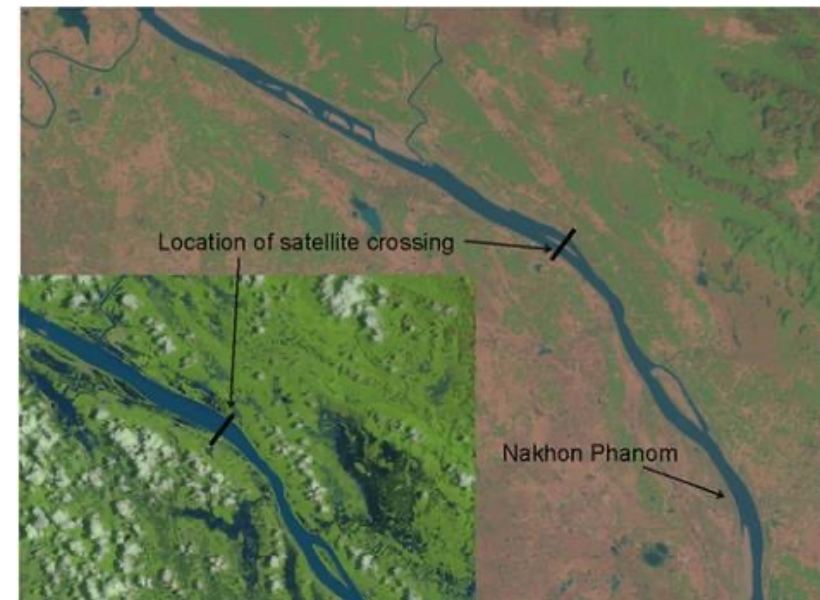
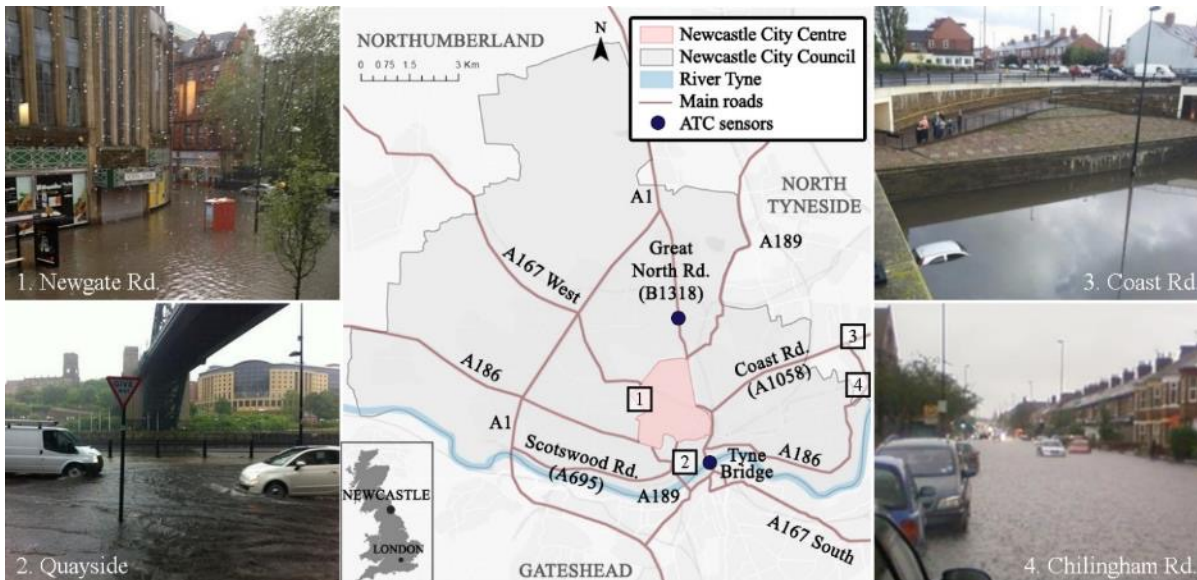
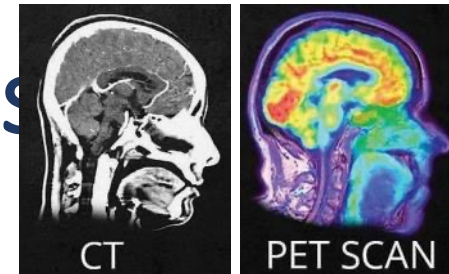


# Spatial resolution



Swales

# From Structure to Function and Process





# Incident management

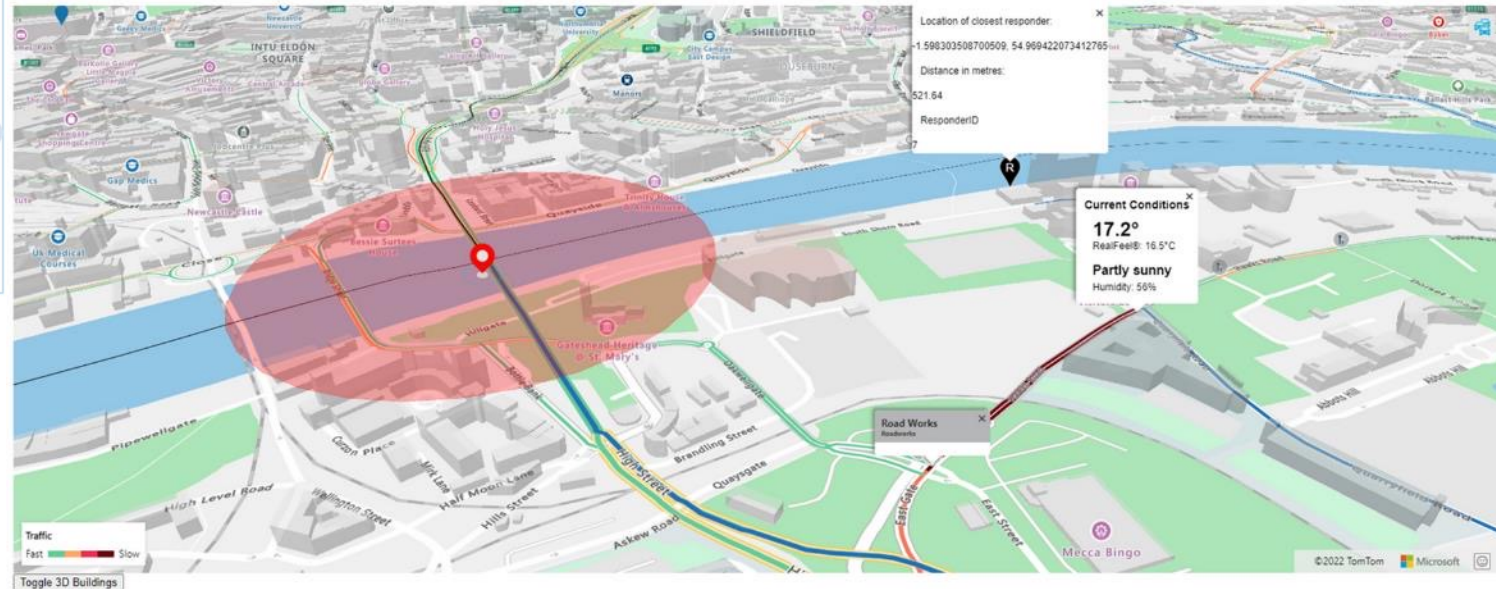
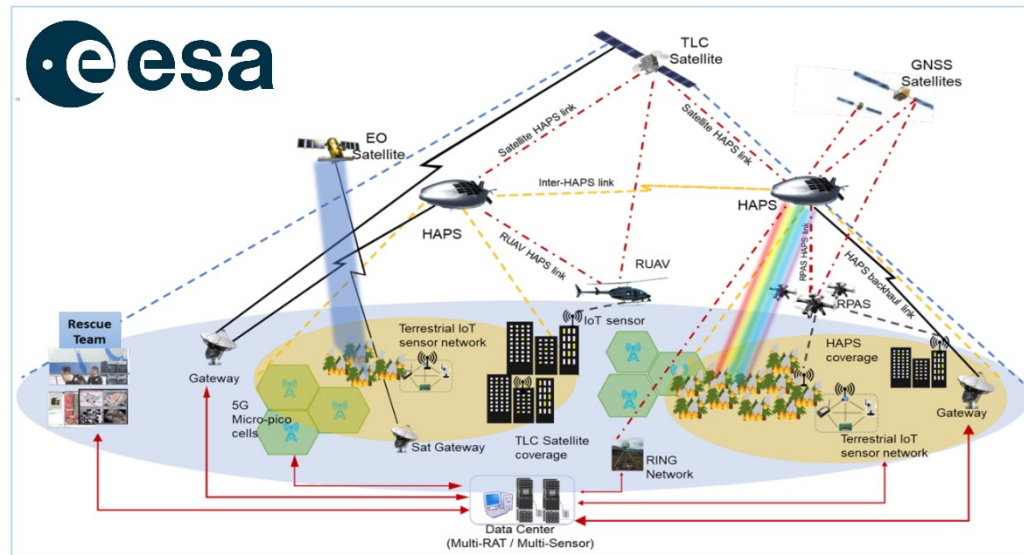
## Output data: Image description

"A couple of men in orange vests standing in a flooded street"



## Output data: Object detection

TAGS:  
 'outdoor' with confidence 99.61%  
 'vehicle' with confidence 99.56%  
 'land vehicle' with confidence 99.31%  
 'person' with confidence 98.33%  
 'car' with confidence 97.90%  
 'clothing' with confidence 97.63%  
 'wheel' with confidence 95.49%  
 'van' with confidence 92.13%  
 'high-visibility clothing' with confidence 89.45%  
 'ford' with confidence 87.05%  
 'emergency service' with confidence 85.32%  
 'water' with confidence 81.52%  
 'wet' with confidence 73.17%  
 'street' with confidence 72.91%  
 'ground' with confidence 57.31%



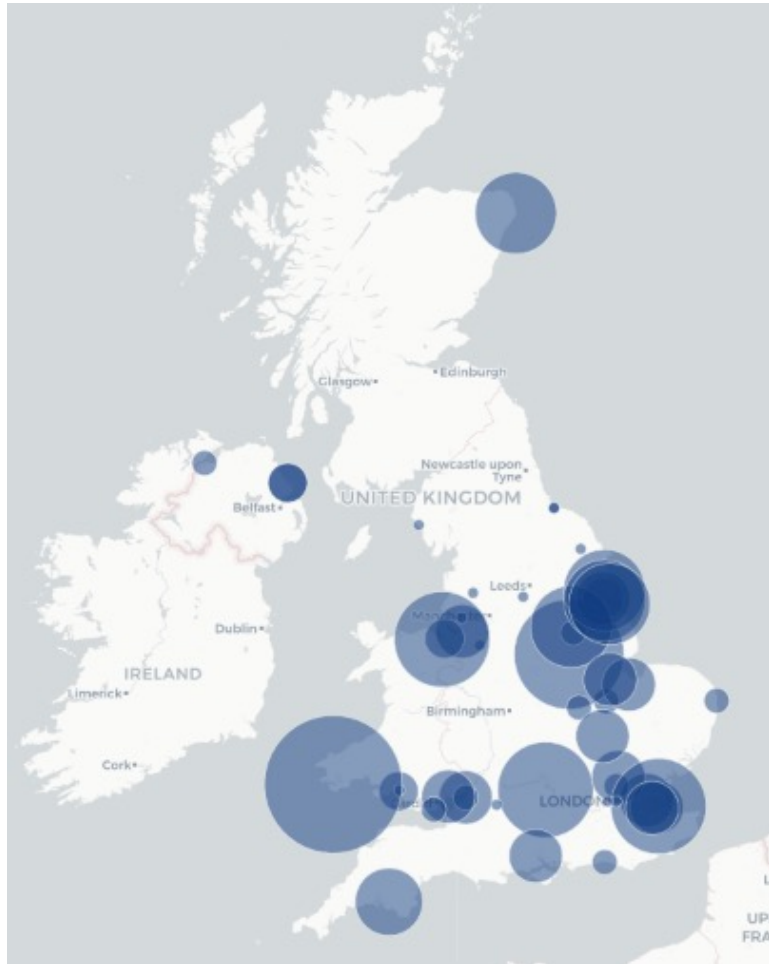
Wolf et al. (2022) Towards a digital twin for supporting multi-agency incident management, <https://doi.org/10.1038/s41598-022-20178-8>



# Exam question...

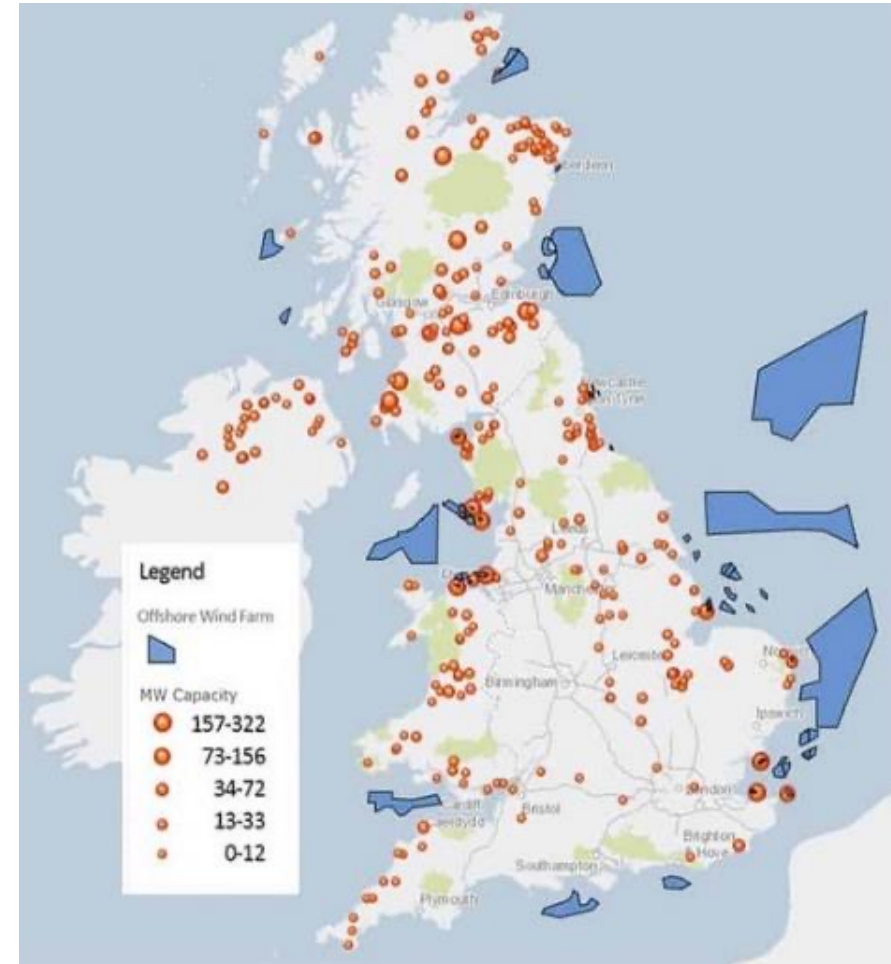
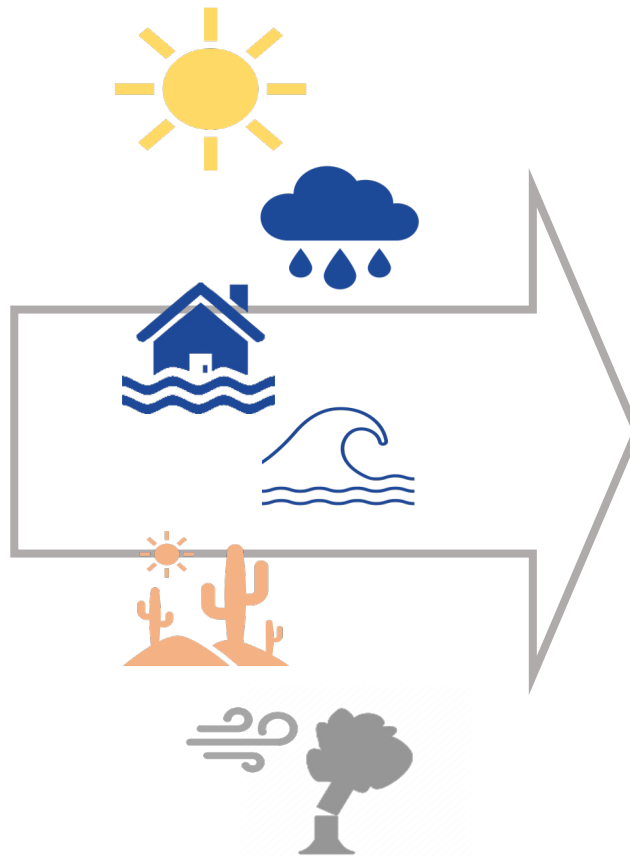
- Food and water security (inc. supporting ecosystems)
- Living standards (inc. buildings and infrastructure services)
- Low-lying coastal systems
  
- Use of remote sensing data well established in many sectors for hazard / risk mapping
- A key general question for all sectors is whether our adaptation is effective
- Conversations between adaptation sectors/CCI expertise needed to explore:
  - Adaptation outcome
  - Measurable variable
  - Spatial x Temporal resolution
  - Data/modelling -> Adaptation insight

# Transition to Net Zero requires fundamentally change of our land, cities, coasts, infrastructure – and risks



**Gas power stations**

Source: [www.carbonbrief.org](http://www.carbonbrief.org)



**Wind generation**

Source: Renewable Energy Hub

Our systems must be resilient after this transition



Or... where will all the Tesla's charge



# What are the most pressing issues for adaptation to a changing climate



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