Considering climate change in controlled waters[1] risk assessment

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SoBRA Sub-group– Climate Change and Controlled Waters

[1] Equivalent term in Scotland is the Water Environment. NIEA use both terms.

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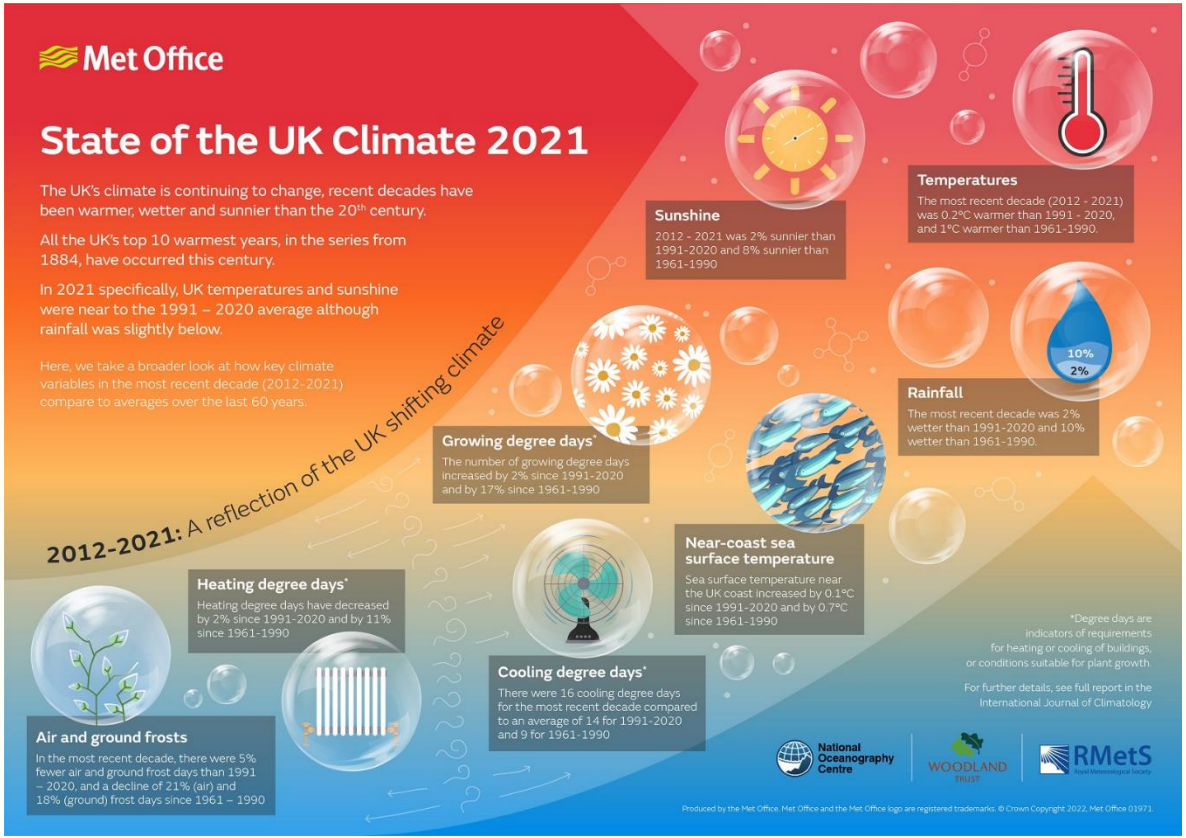
The sub-group

Climate change in UK – general overview



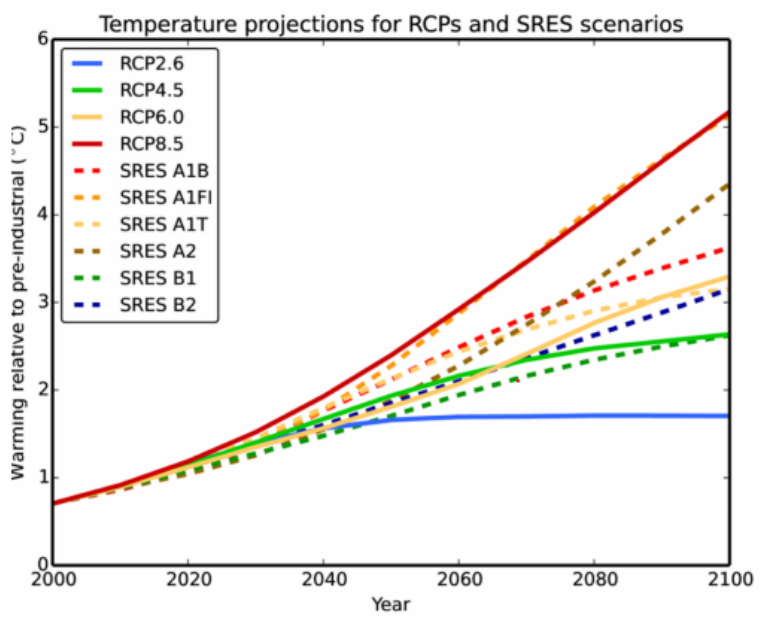
Climate change is the large-scale, long-term shift in average weather patterns and average temperatures and is assessed by averaging data over a 30-year period.

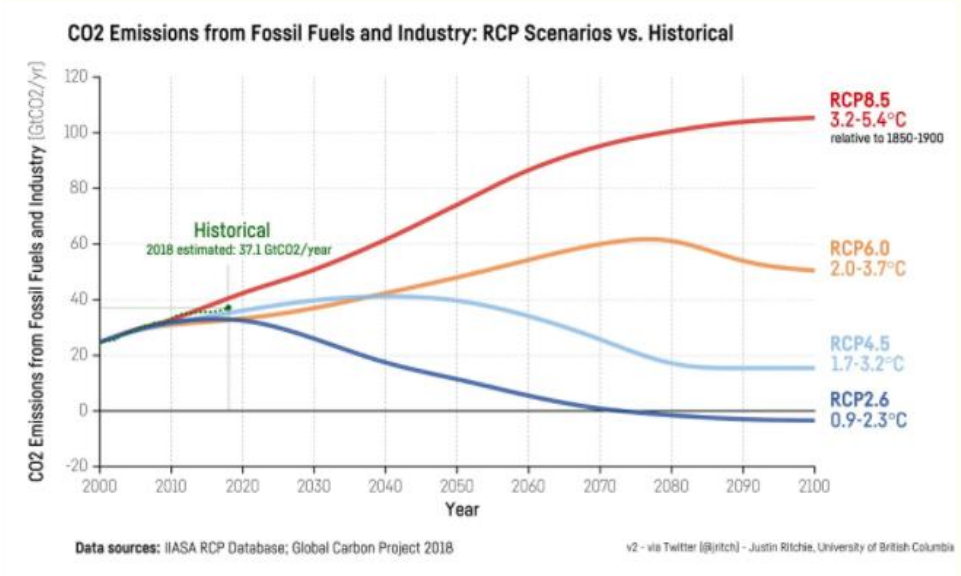
Future UK climate change projections

Intergovernmental Panel on Climate Change (IPPC)

Global greenhouse Emission Standards (SRES > RCP > SSPs)

UK Climate Projections (UKCP18)





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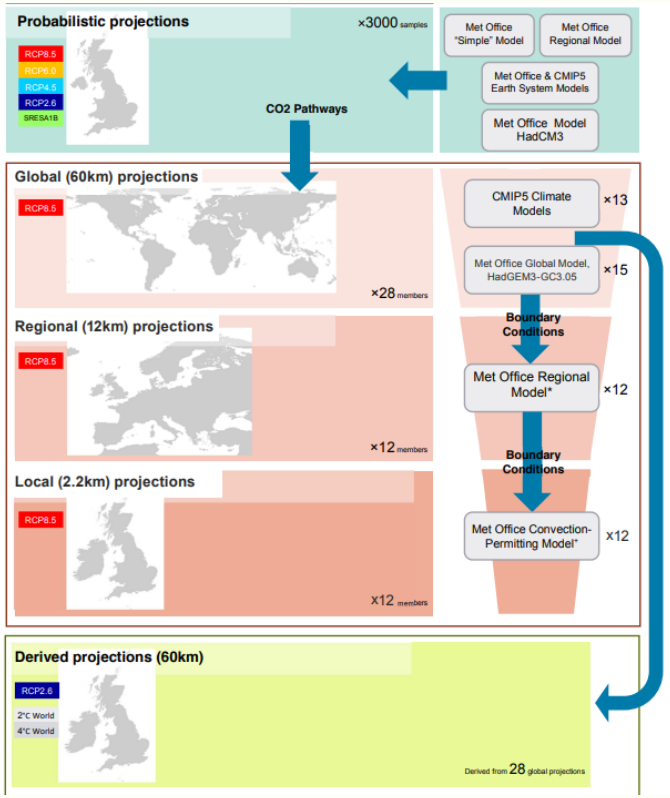
Future UK climate change projections

Scale		Global (60 km)	Regional (12 km)	Local (2.2 km)
Baseline period		1961 – 1990 1981 – 2000 1981 - 2010	1981 – 2000 1981 - 2010	1981 - 2000
Projection time period		2010 – 2100 (20yr timeslices)	2010 –2080 (20yr timeslices)	2021 – 2040 2061- 2080
Projections		28	12	12
Emissions Scenario	RCP8.5 (4.3 °C)	√	√	√
	RCP6.0 (2.8 °C)			
	RCP4.5 (2.4 °C)			
	RCP2.6 (1.6 °C)	√		



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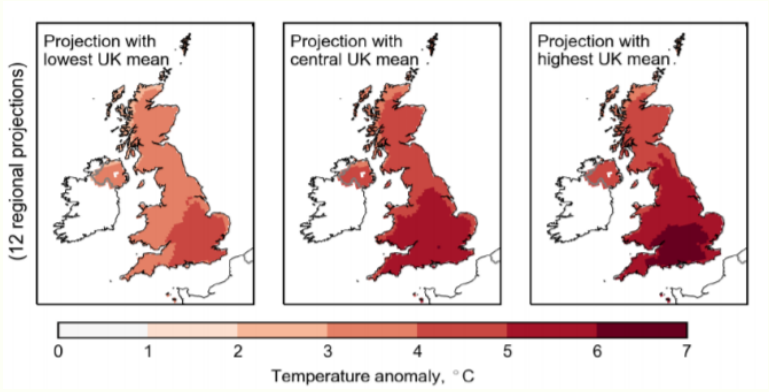
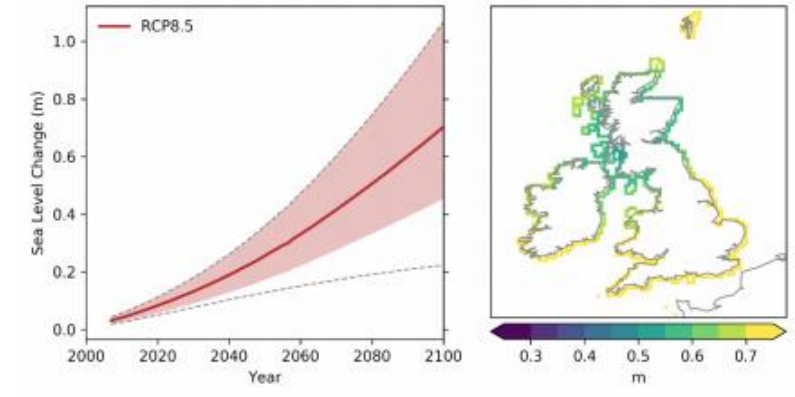
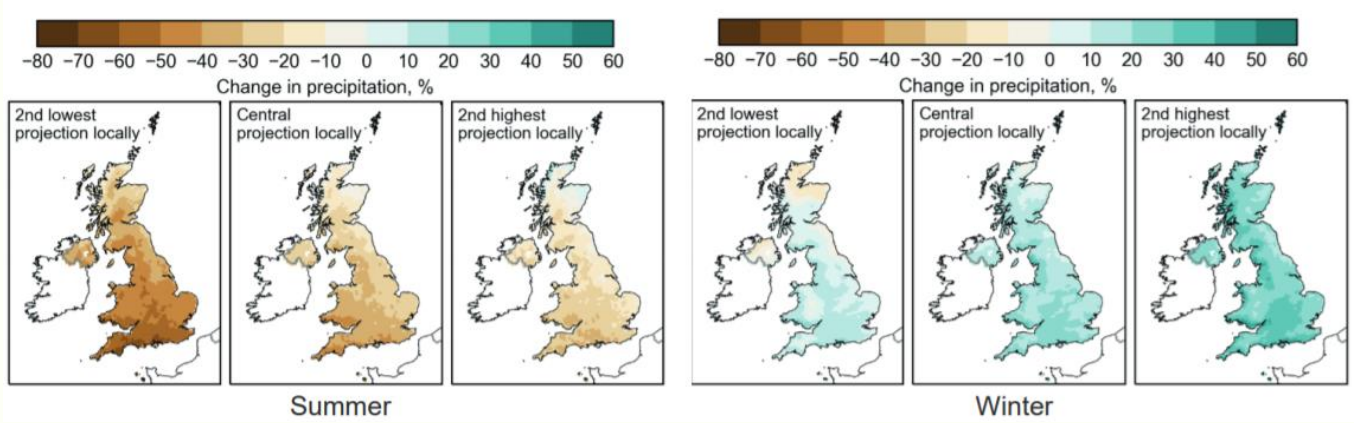
Climate change in UK – regional variation







Source-Pathway-Receptor (SPR) Pollutant Linkages

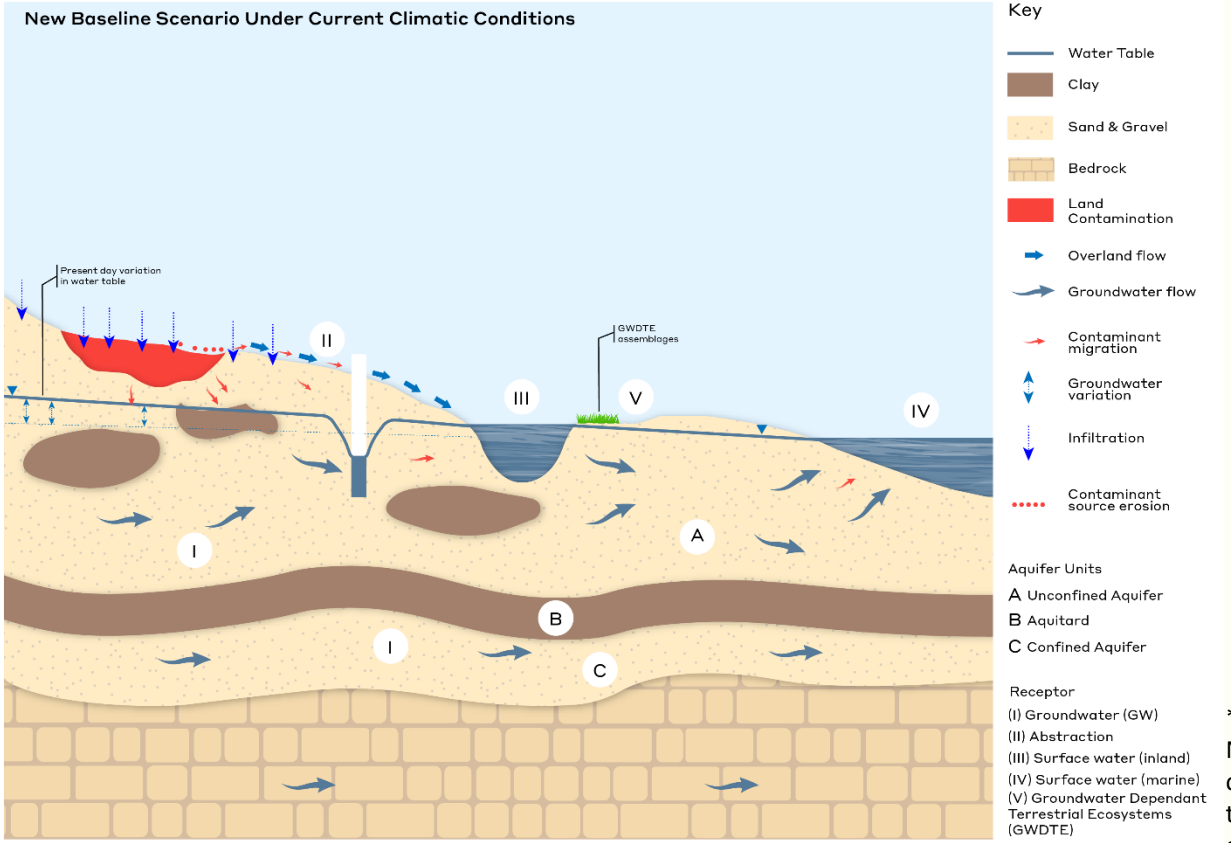


*Figure adapted from SEPA, Nov. 2020. Land contamination and impacts on the water environment consultation.

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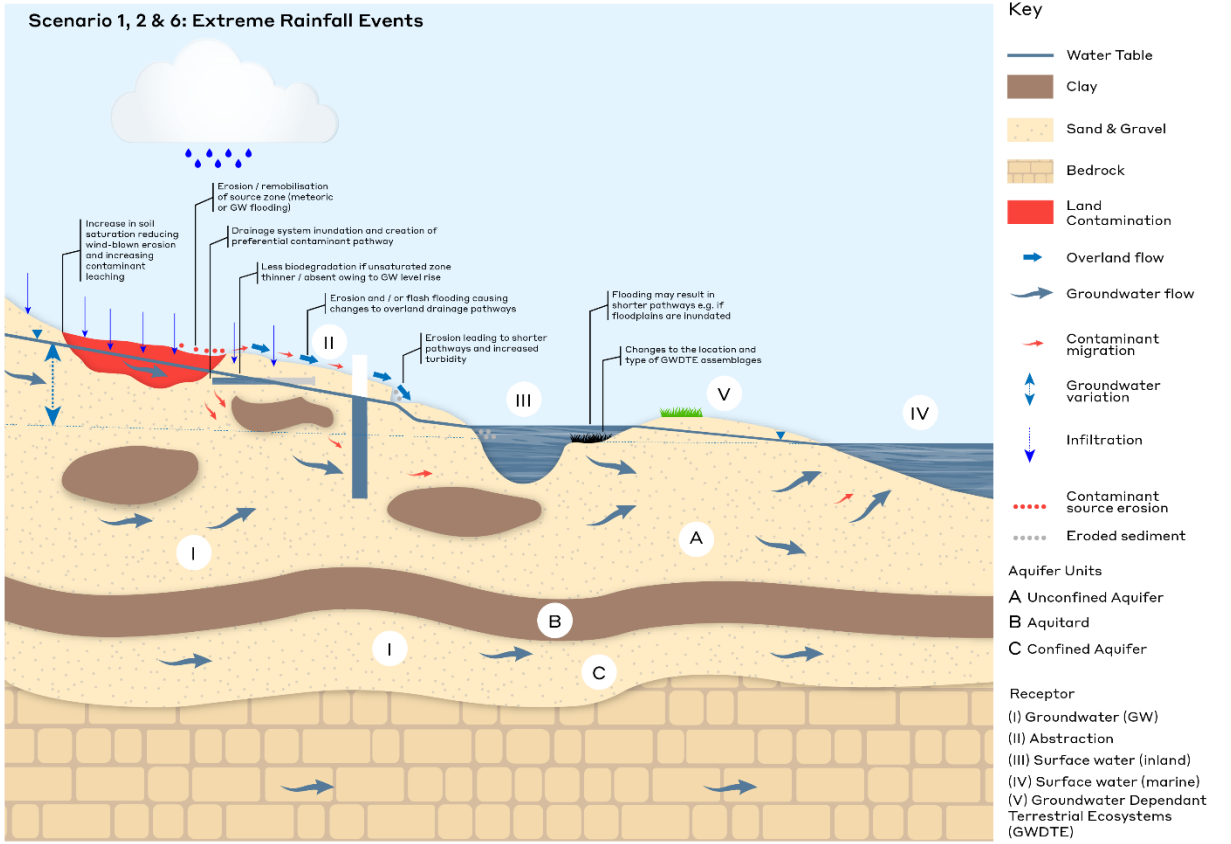
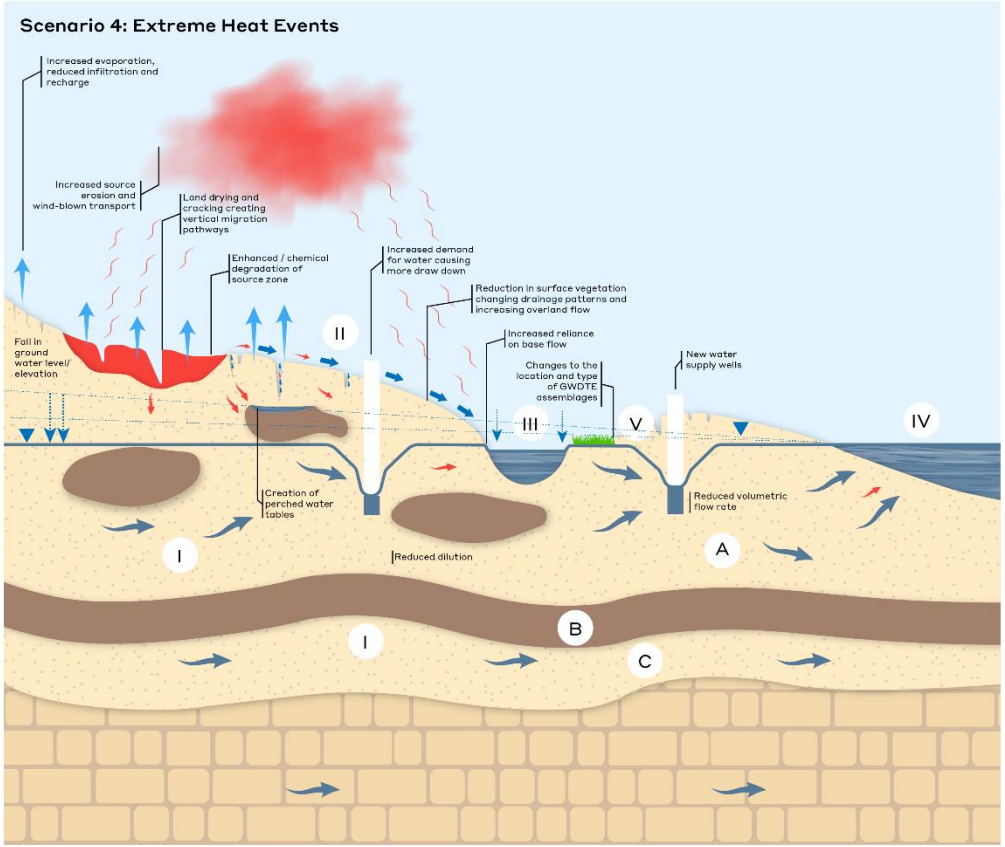
CSM considerations – extreme rainfall events



- Increase in precipitation (inc. extreme weather events)
- Rise in groundwater levels causing groundwater flooding
- Increase in precipitation causing land based erosion or changes to the geomorphology of surface waters (changes to S-P-R)
- Long term/seasonal changes to groundwater levels

CSM considerations – extreme heat events



- Fall in groundwater levels
- Desiccation
- Abstraction Changes
- Changes to contaminant properties:
  - Solubility
  - DO
  - Volatility
  - NAPL viscosity
  - Microbial activity
  - Reaction kinetics

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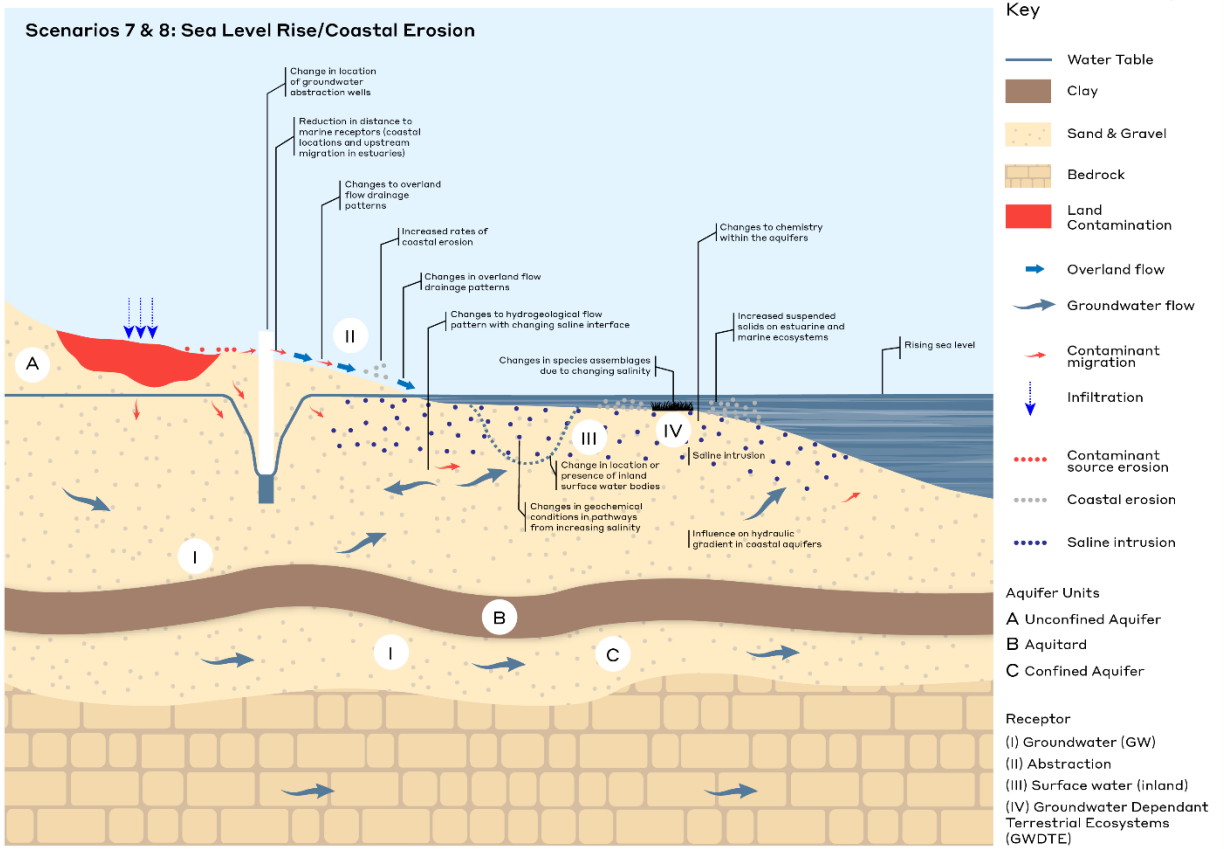
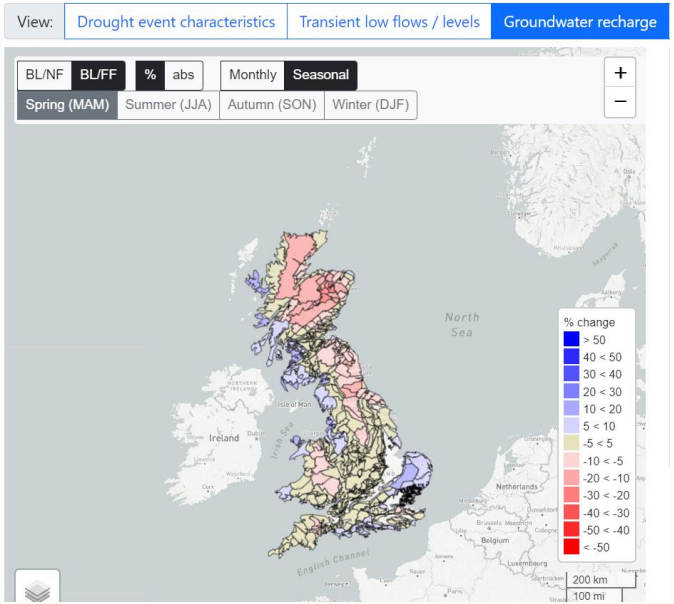
CSM considerations – Sea Level Rise / Coastal Erosion



- Tidal limit on estuaries/rivers moves upstream
- Influence on hydraulic gradients in coastal aquifers
- Increased risk of coastal/tidal flooding
- Increased rates of coastal erosion
- Saline intrusion

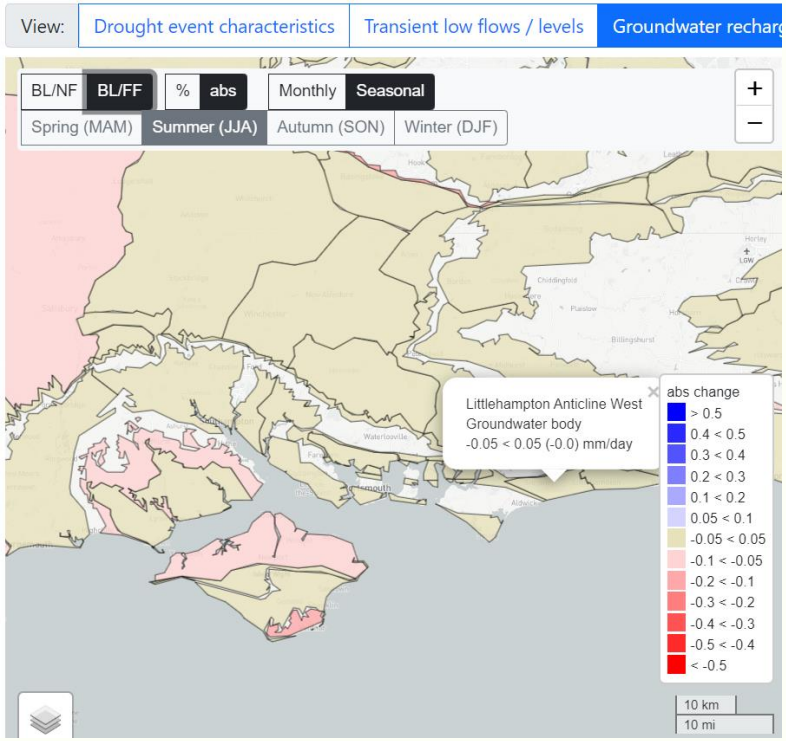
PRA climate change considerations

- Design life of proposed development
- Location and elevation of the site in relation to the sea or tidally influenced rivers
- Projected changes to rainfall, (temperature) and groundwater level for defined time slices (UKCP18, eFLaG)
- The location and elevation of the site in relation to projected increased flooding extents
- **Consider “What-if” Scenarios**

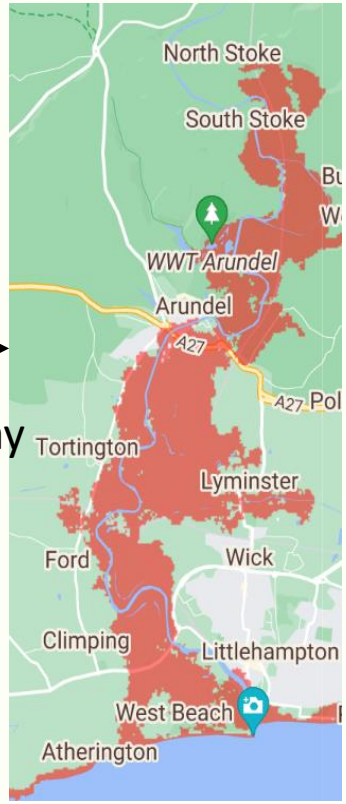


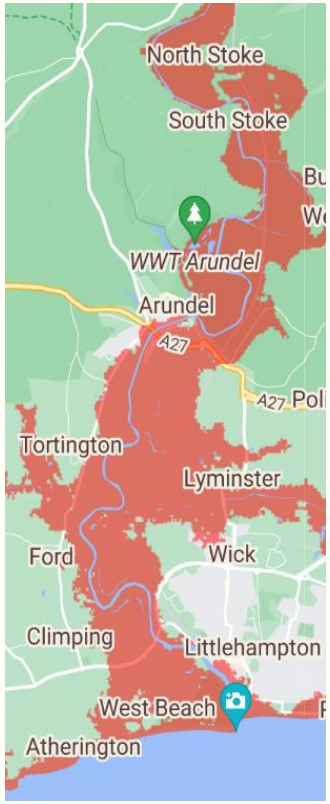
Appendix 4 of the guidance presents a number of worked PRA case-study examples

Does it matter?.....Yes, but not always.



Today





+1m

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Case Studies

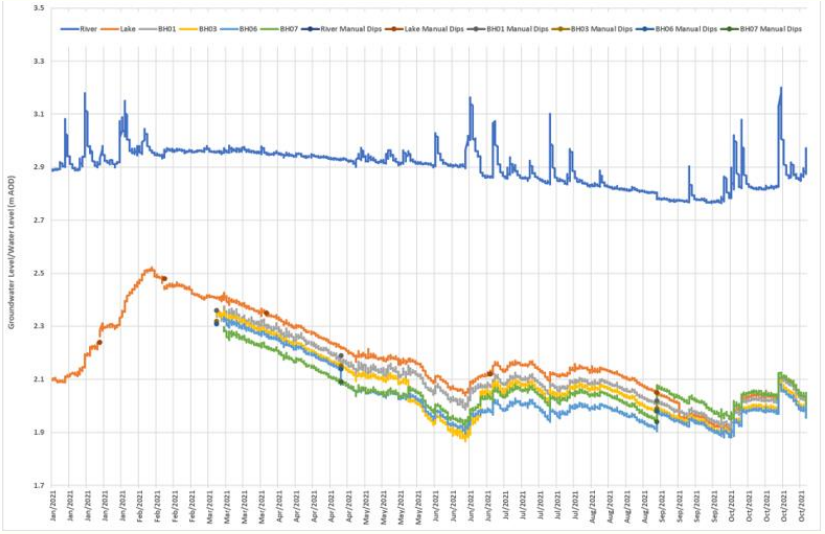
Example 1: Proposed residential development (design life of 60 years) on brownfield site located in Littlehampton, south coast of England.

Example 2: Part IIA Assessment of a coastal historical landfill in Eastern England

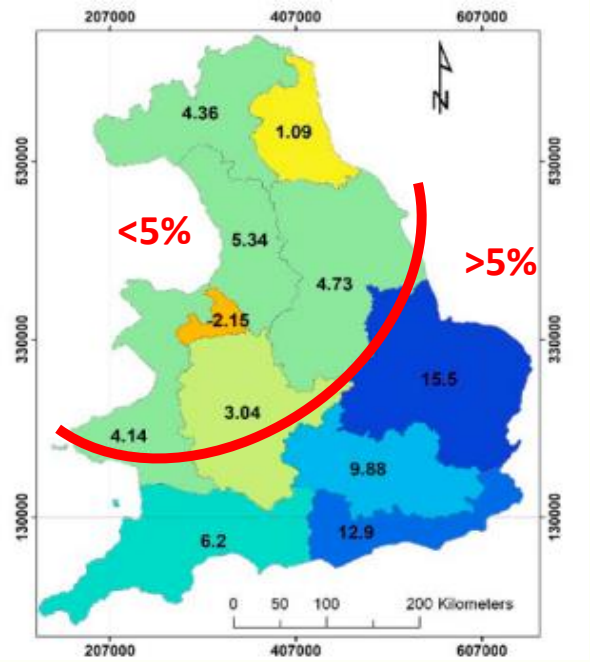
Example 3: Proposed commercial development with basement (design life of 60 years) on former industrial site located in Glasgow, Scotland.

GQRA climate change considerations

- Source delineation (lateral and vertical)
- Preferential flow pathways e.g. subsurface infrastructure
- Understanding of groundwater bodies:
  - unconfined or confined
  - unsaturated zone thickness
  - variation in groundwater level (seasonality)
  - transmissivity
  - hydraulic connection with surface water



DQRA climate change considerations



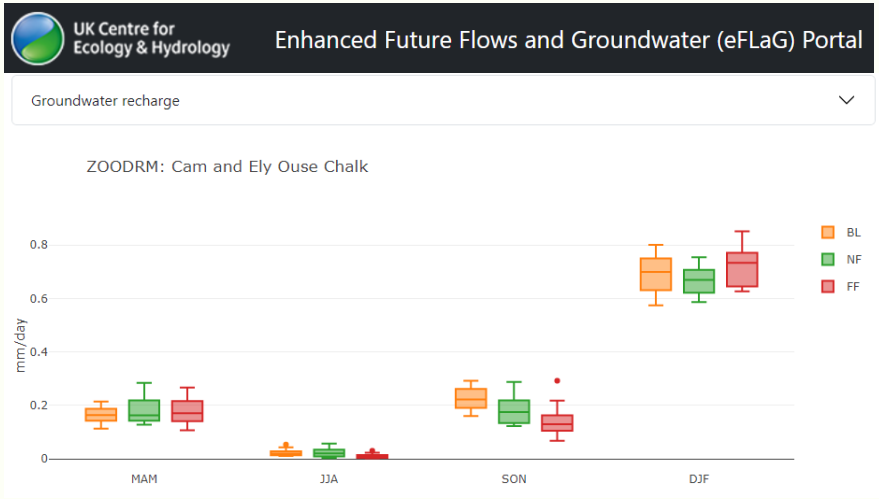
% change in mean recharge 2080s
Source: A Hughes et al Journal of Hydrology 598 (2021)
Scenario: SRES A1B ≈ between RCP4.5 and RCP6.0

- Climate change is transient (median in flux) but commercially available models are not
- Long term changes can be modelled but not extremes
- Sensitive parameters:
  - recharge
  - groundwater elevation => unsaturated/ saturated thickness
  - hydraulic gradient
  - Surface water flow
- Nature of hazard / longevity of risk
- ± 5% change within reasonable uncertainty assumptions for input parameters within DQRA

Useful Data Sources

Section 5.1 of the guidance collates a list of useful data sources - with a selection below:

- UK Climate Projections (UKCP) data - https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/data/index
- eFLaG portal - https://eip.ceh.ac.uk/hydrology/eflag/
- Environmental information data centre - https://eidc.ac.uk/finddata.
- Coastal risk screening tool - coastal.climatecentral.org/map
- National Coastal Erosion Risk Mapping - National Coastal Erosion Risk Mapping (arcgis.com)



Source: eFLAG Portal – showing variation is modelled recharge in the Cam and Ely Ouse Chalk: https://eip.ceh.ac.uk/hydrology/eflag/.

Conclusions

- It's complicated!
- Climate change effects may (*or may not*) fundamentally change the S-P-R linkages being considered:
- source/contaminant behaviour
- active pathways
- proximity to / type of receptor
- Regional variability >>> site specific conditions
- Needs to be considered at outset from PRA stage.

- SoBRA guidance provides a framework to help risk assessors incorporate climate change projections and explore consequences within risk assessments

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SoBRA Guidance https://sobra.org.uk/climate-change/controlled-waters-and-climate-change/