LONDON & TE2100

10 December 2009

Tim Reeder
Environment Agency

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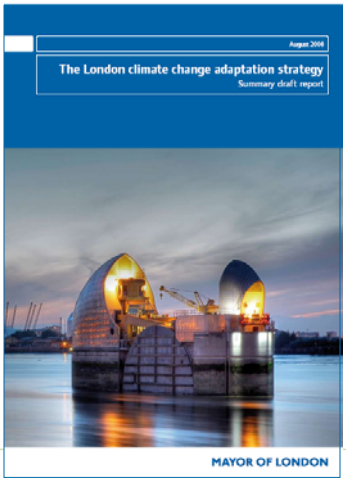
How is London vulnerable to CC ?

- Flooding
- Overheating
- Water resources
- Air Quality
- Subsidence and heave
- Wind storms
- Global climate events



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What is TE2100?

A Project to provide a plan demonstrating how **flood risk** can be managed in the **Thames Estuary** over this **century** in response to:

- **a changing climate**

- **a changing estuary**

- **ageing flood defences**

The 100th Thames Barrier Closure

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Thames Estuary 2100 Plan Area

- >1.25million people
- £160bn Property
- International Habitats & Species
- Port of London generates £2.7bn/yr.

- 400 Schools, 16 Hospitals
- 30 Mainline Railway Stns
- 68 Underground & DLR Stns
- 8 Power Stations

- At Risk
- The Current Defences
- Future Scenarios
- New Barriers
- Controlled Inundation
- Restoration of the Floodplain
- Spatial Planning

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Climate Change & TE2100

- Climate Change critical issue for flood risk
- Main driver of physical flood risk sources in order of uncertainty at project start :-

Uncertainty

- Waves
- Fluvial Flow
- Sea Level Rise
- Surge
- Joint Probability

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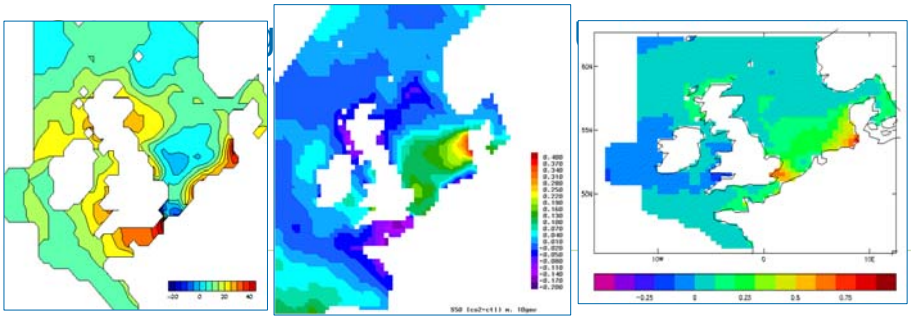
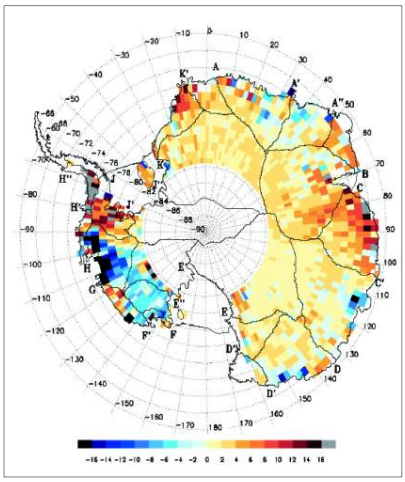
Science before TE2100

- River flow - DEFRA guidance – 20 % increase
- Mean SLR – IPCC 3rd Assessment Report, UKCIP02



Latest Satellite Altimeter Results

- East Ant : - 0.12mm/y msl
- West Ant : + 0.16mm/y msl
- Marine ice sheet zones
  - major discharges :
    - Pine Island –Thwaites in West Antarctica
    - Totten and Cook in East Antarctica



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TE2100 Programme & Approach

- MOHC POL CEH studies provide probabilistic scenarios for Thames Estuary for Storm Surge, Sea Level Rise, Fluvial Flow,
- Storm Surge and Sea Level Rise benefit to UKCIP 09
- Climate Change Critical Factor – TE2100 input to IPCC 4th Assessment Report, Stern
- Structured project around uncertainty and decision testing

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TE2100 – Planning for an uncertain future

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Thames Estuary 2100 Project

- To achieve the project objectives we have based our programme of studies around a Decision-Making Framework that has largely been piloted by ESPACE…

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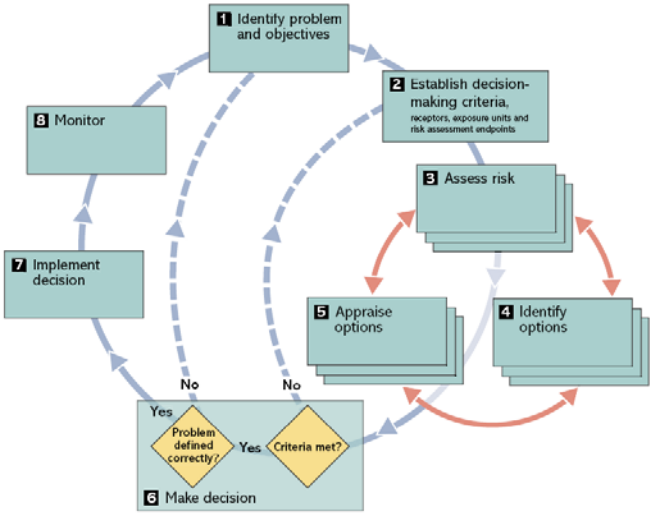
- Helps deliver policies and projects that are robust in the face of an uncertain future climate

www.ukcip.org.uk

Eight-stage decision-making framework



TE2100 Techniques

- Scenario neutral analysis – thresholds for responses
- Led to decision pathways and adaptable options
- Monitoring - links with BAS, at cutting edge of ice melt science – essential for adaptable plan - with critical lead times

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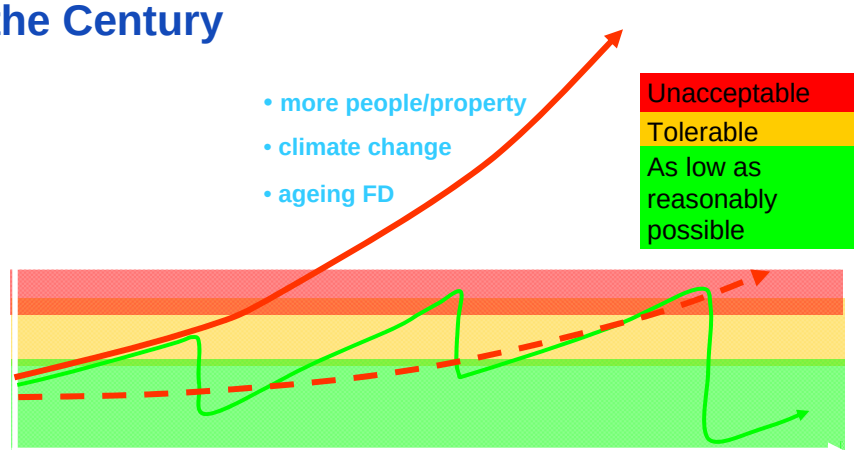
Managing Flood Risk through the Century



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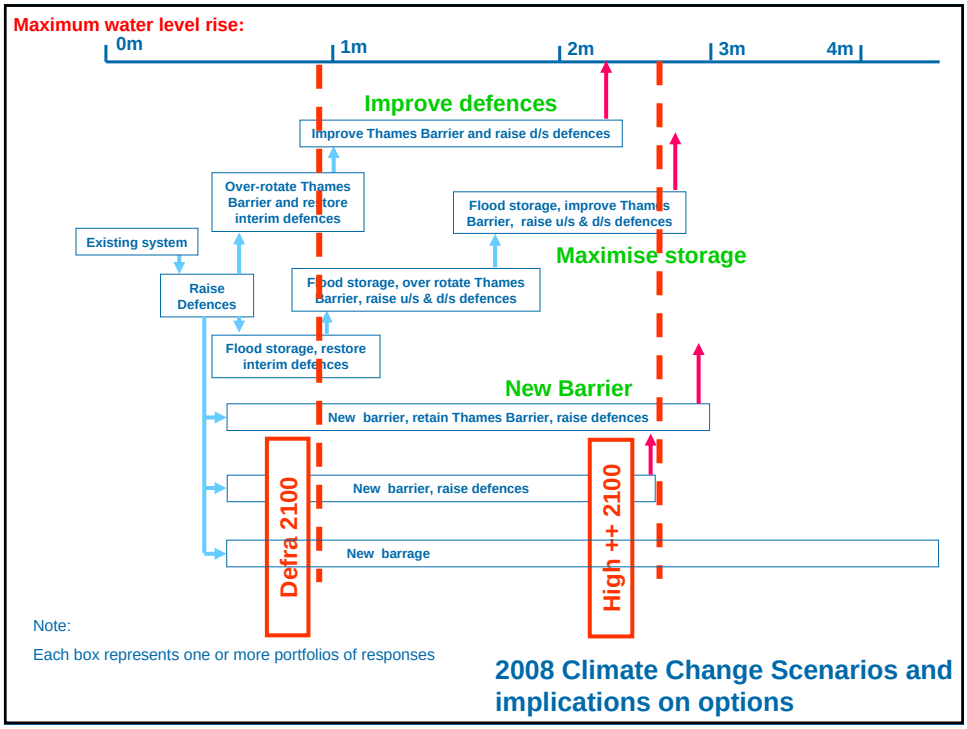
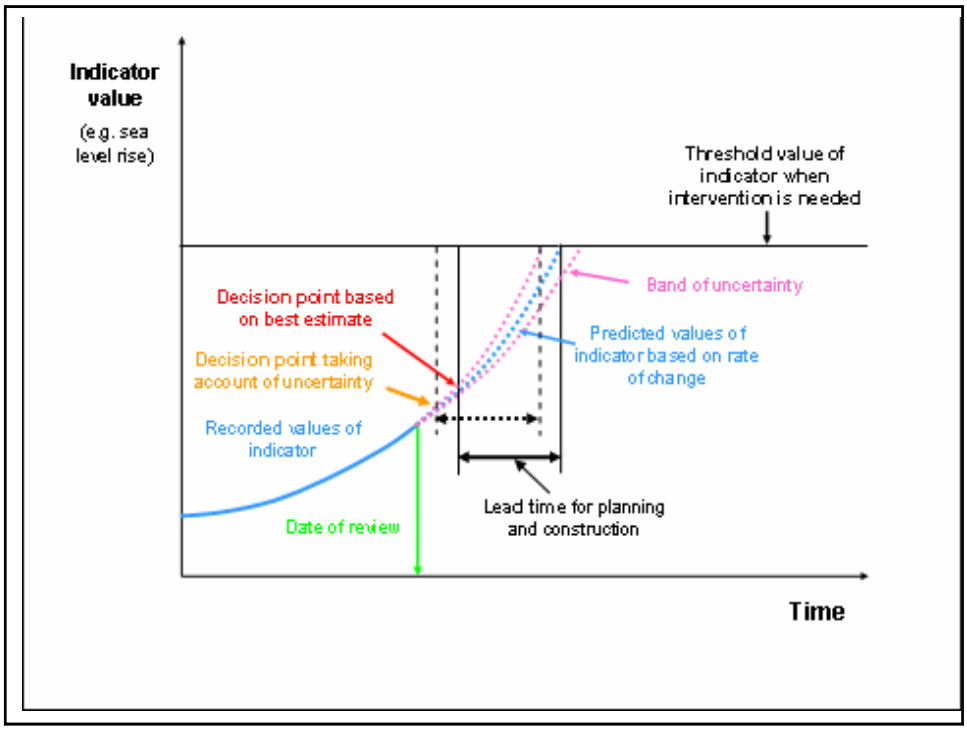

Maximum water level rise:
0m
1m
2m
3m
4m
Improve defences
Improve Thames Barrier and raise d/s defences
Over-rotate Thames Barrier and restore interim defences
Flood storage, improve Thames Barrier, raise u/s & d/s defences
Existing system
Maximise storage
Raise Defences
Flood storage, over rotate Thames Barrier, raise u/s & d/s defences
Flood storage, restore interim defences
New Barrier
New barrier, retain Thames Barrier, raise defences
New barrier, raise defences
New barrage
Defra 2100
High ++ 2100
Note:
Each box represents one or more portfolios of responses
2008 Climate Change Scenarios and implications on options


Indicator value
(e.g. sea level rise)
Threshold value of indicator when intervention is needed
Band of uncertainty
Decision point based on best estimate
Predicted values of indicator based on rate of change
Decision point taking account of uncertainty
Recorded values of indicator
Lead time for planning and construction
Date of review
Time

TE2100 – Driving the science

Feeding into UKCP09

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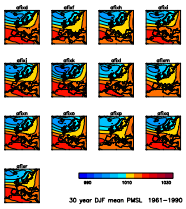
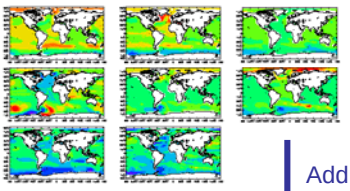
Ensemble climate change projections

Met Office Hadley Centre

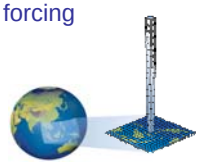
Uncertainty in large scale atmospheric forcing

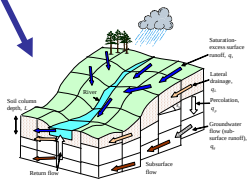




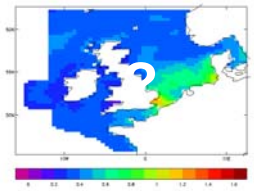
Add in ice melt uncertainty

Downscale to get uncertainty in Regional scale atmospheric forcing





Run surge model simulations to estimate uncertainty range in local extreme water levels



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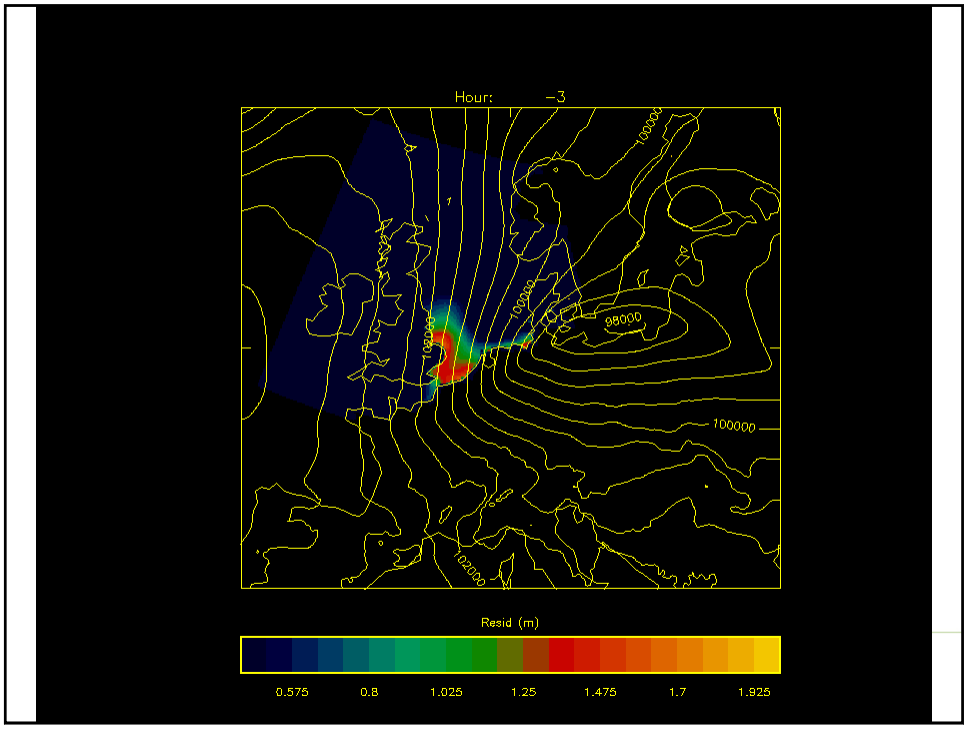
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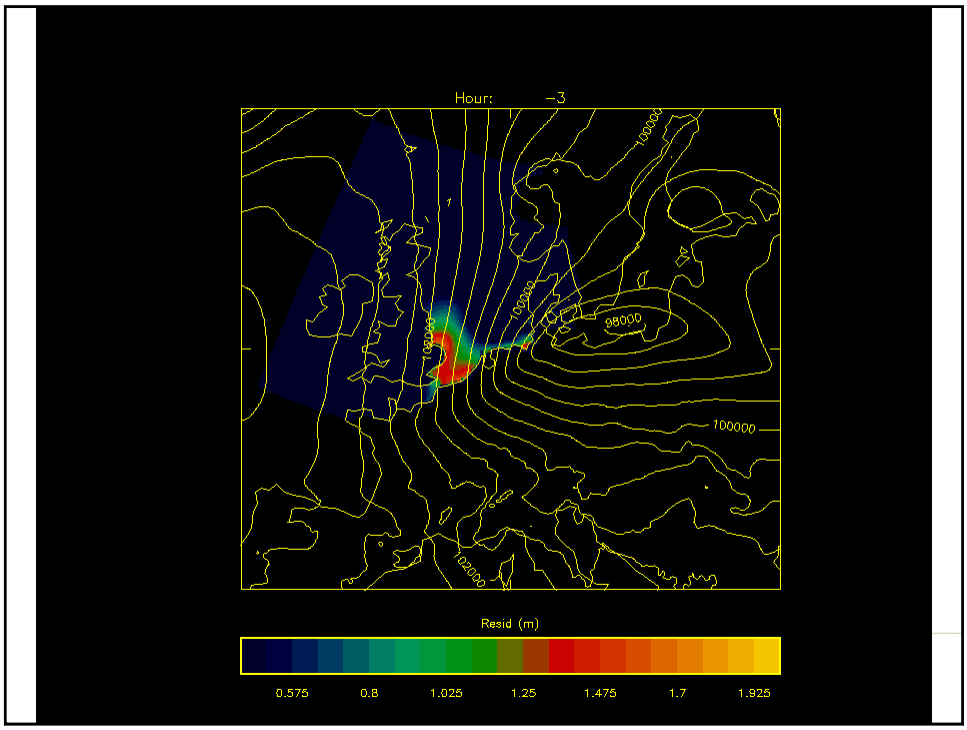
100000
98000
100000
100000
Resid (m)
0.575
0.8
1.025
1.25
1.475
1.7
1.925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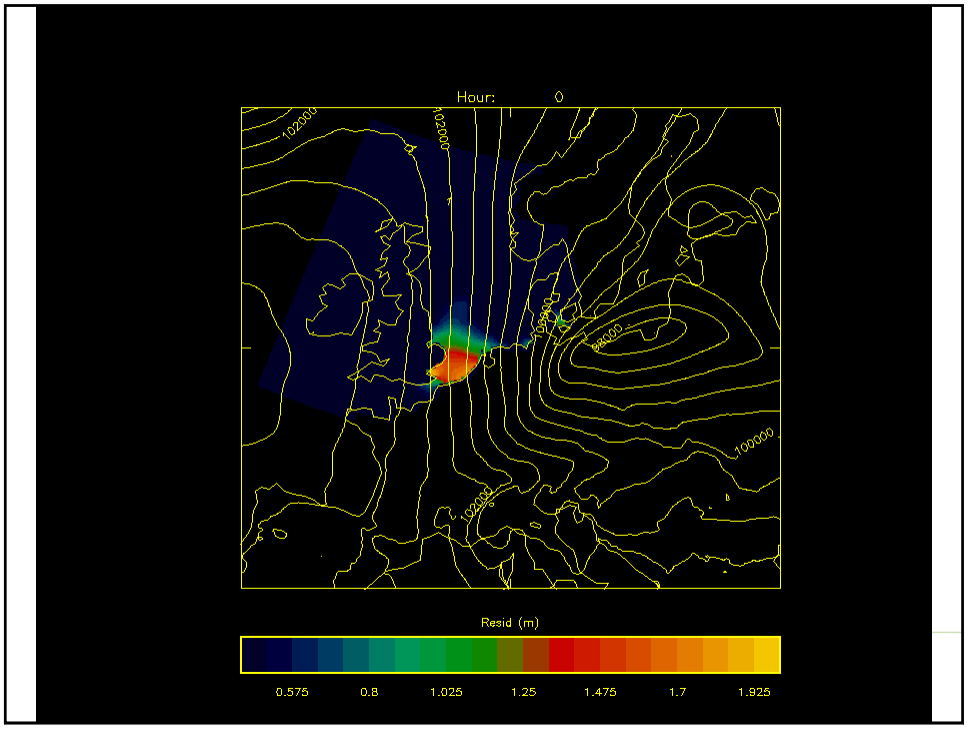
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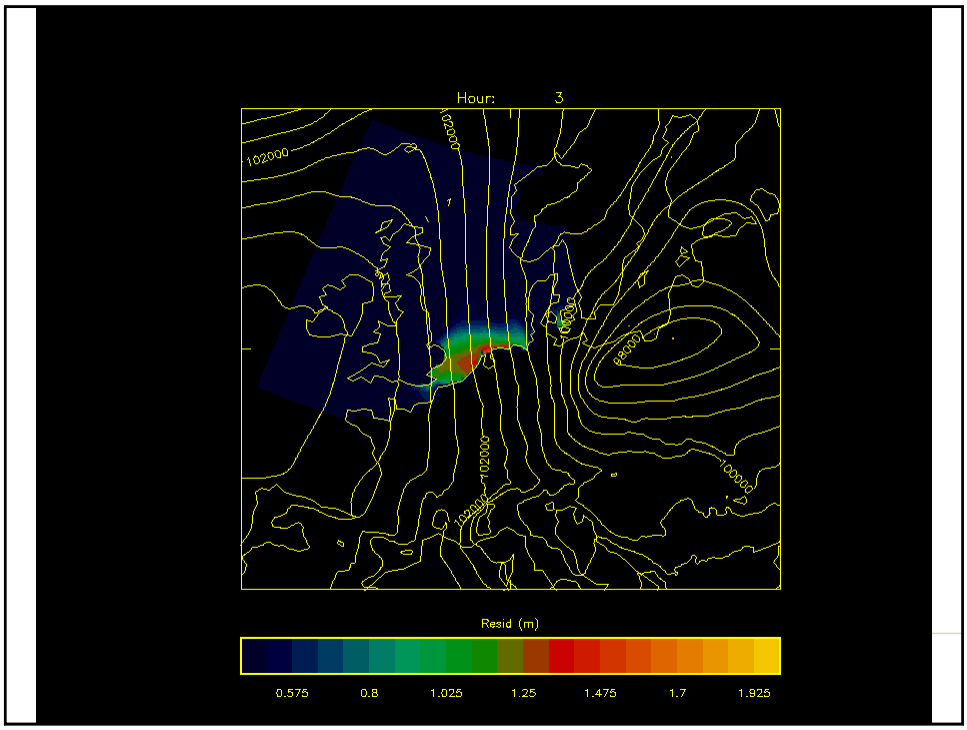
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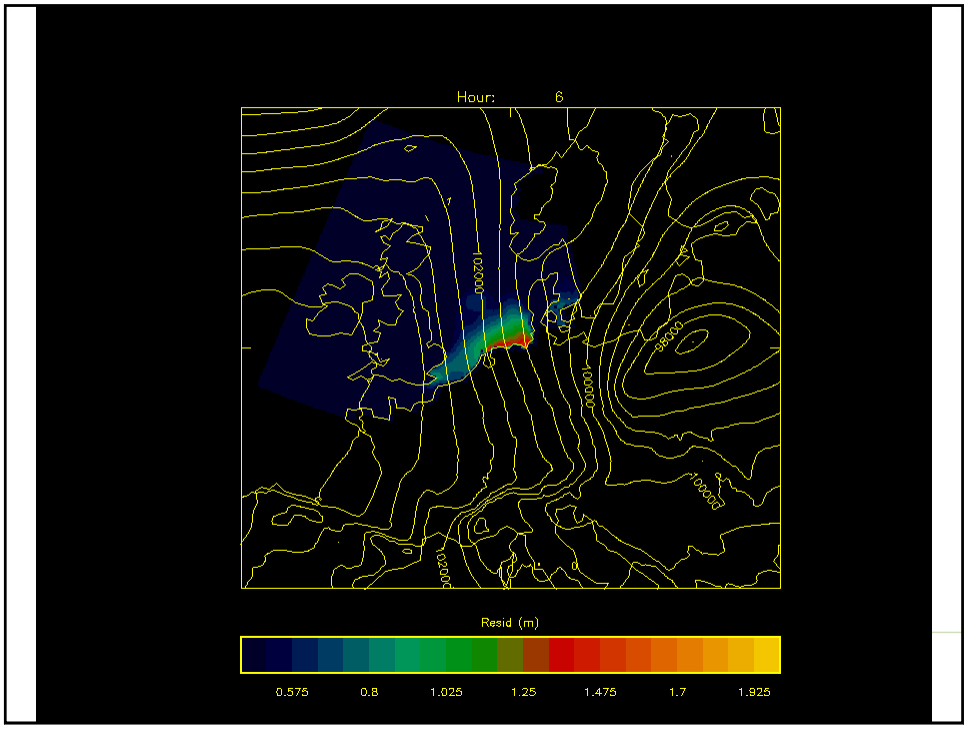
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100000
102000
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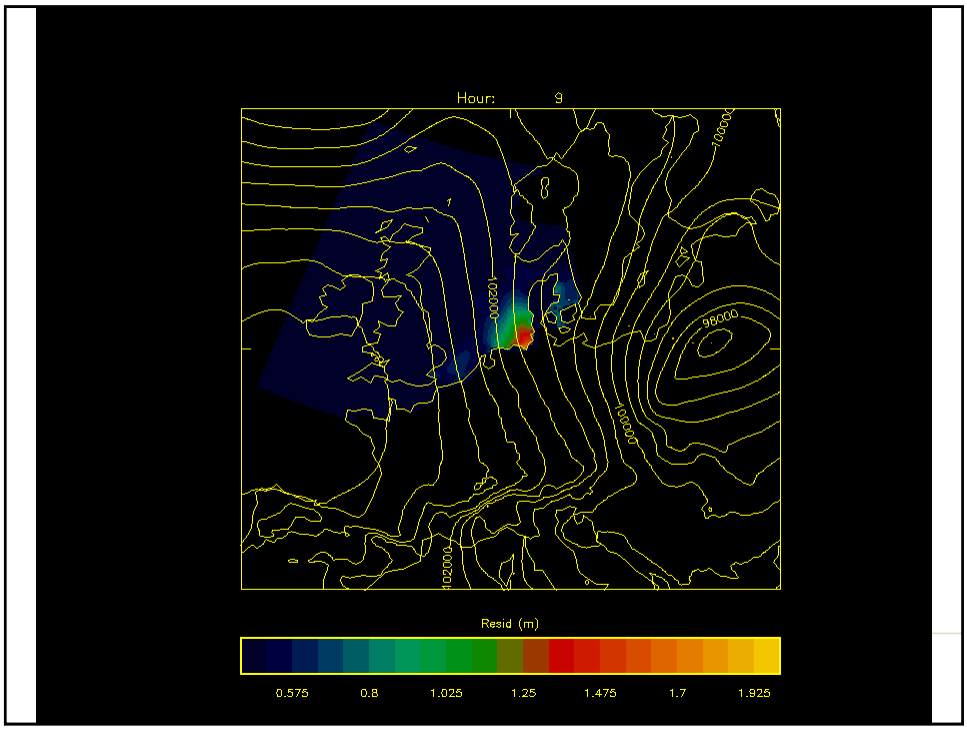
0.8
1.025
1.25
1.475
1.7
1.925


Hour: 9
100000
102000
98000
100000
102000
Resid (m)
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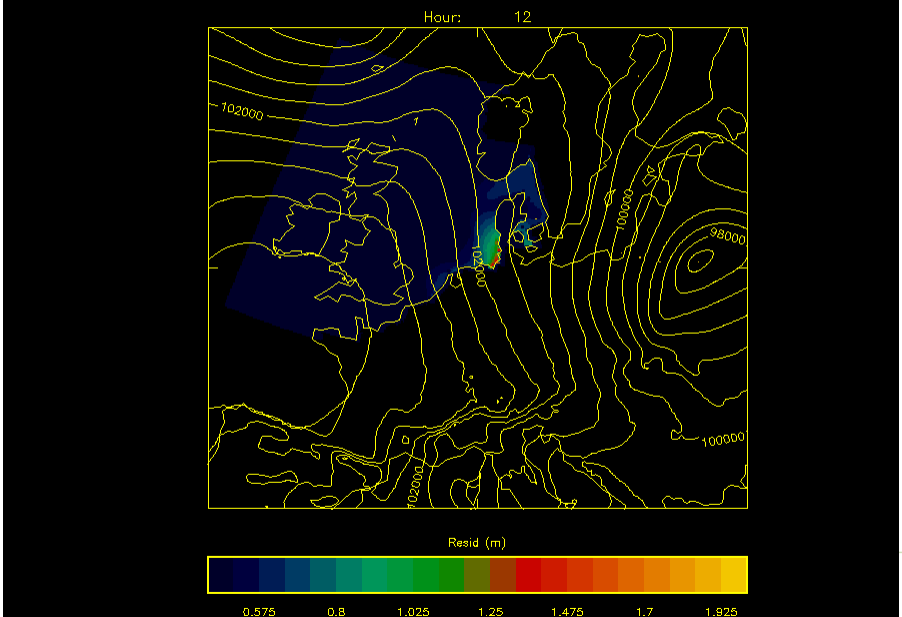
0.8
1.025
1.25
1.475
1.7
1.925



What about the trends?

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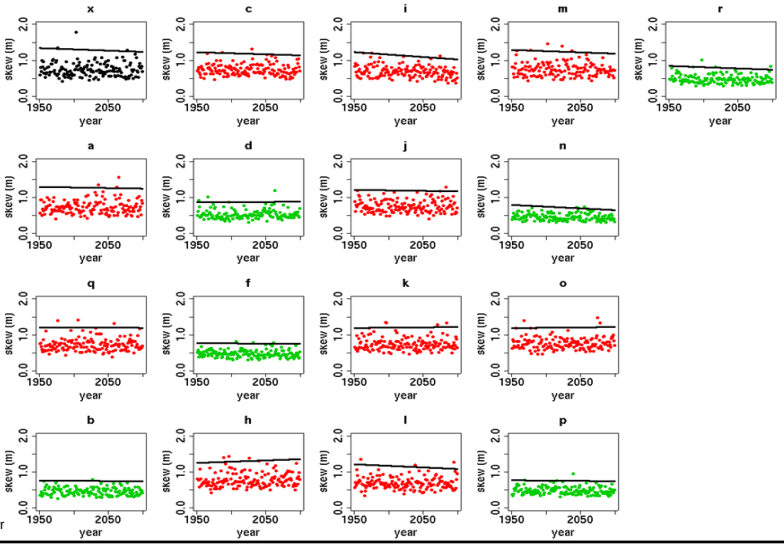
Hadley Centre



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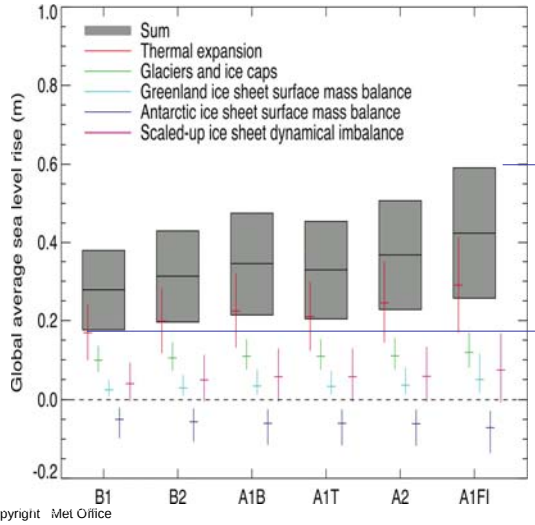
IPCC AR4 mean sea level Projections



+additional contribution from ice sheet ???????

Does the UK experience the global mean?

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Adding it all together

- Global mean
- UK ocean deviation
- Vertical land movement
- No significant trend in surges

Including emissions uncertainty We project 20cm to 90cm increase in extreme SL by 2100.

This value is VERY close to the current Defra guidance, which is based on the IPCC TAR

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Is 90cm the upper limit?

Met Office Hadley Centre

- Probably not less than than zero
- Probably not more than 12m
- 4m – based on Lenton et al., 2008 (based on Hansen, 2005)
- 1.6±0.8m – Rohling et al., 2008 (based on Red Sea observations)
- 2m - various personal comms with ice sheet "experts"
- 2m – Pfeffer et al., 2008

- **We present two scenarios to 2100**
  - **The 0.20m to 0.90m as the LIKELY range, with no trend in surges.**
  - **H++ range of 1m to 2m for mean sea level rise for sensitivity testing. With our H++ surge scenario the full H++ range extends to 2.7m for a 5-year period event.**
  - **We think the upper end of this range is VERY UNLIKELY to occur by 2100**

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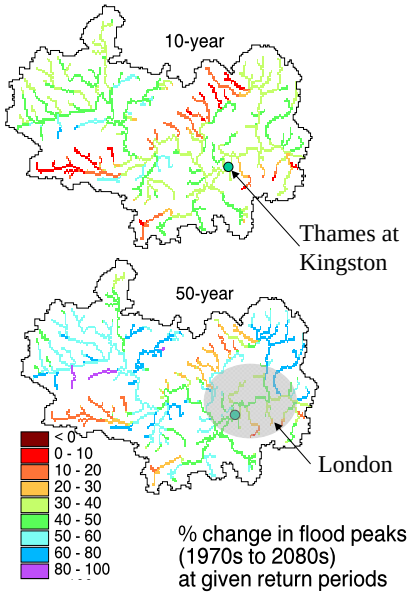
Results averaged over 11 RCM ensembles



Modelled percentage changes in flood peaks at different return periods for the Thames at Kingston

Ensemble member	Return Period (years)		
	5	20	50
Minimum	*3.4*	*-11.1*	*-22.0*
Maximum	*53.5*	*68.2*	*77.1*
Mean	***29.0***	***36.4***	***43.0***

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

TE2100 Science Key Findings

- Sea level rise in the Thames over the next century due to thermal expansion of the oceans, melting glaciers and polar ice is likely to be between 20cm and 90cm.
- There is still much uncertainty over the contribution of polar ice melt to sea level rise. At the extreme it may further raise sea levels up to 2m (including thermal expansion) - although this is thought highly unlikely.
- Although still uncertain, climate change is less likely to increase storm surge height and frequency in the North Sea than previously thought.
- Future peak freshwater flows for the Thames are also uncertain. At Kingston they could increase by around 40% by 2080.
- To reduce the uncertainty over the potential effect of polar ice melt on sea level rise, further research and monitoring is needed.

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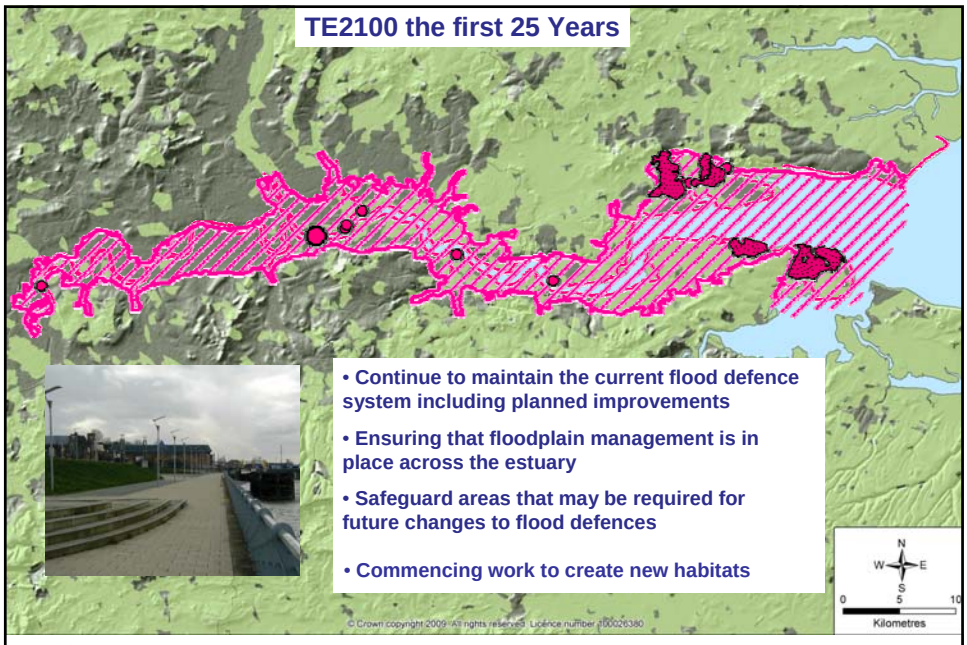

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From 2070, moving into the 22nd century

- Replacing and upgrading defences upstream and downstream of the barrier
- Working with regional and local planning authorities
- Take informed decision on building a new barrier at Long Reach or other end of the century option

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Kilometres

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Summary

- **TE2100 is the first major project in the UK to have put climate change adaptation at its core. We have developed a method to test flood risk measures against climate change scenarios. Working with the Met Office Hadley Centre and other key organisations, we have improved our understanding of future climate change impacts in the Thames Estuary. This gives us confidence that our Plan is adaptable to future climate change.**

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