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2014 TCCIP: International Workshop on Climate Change

The application of climate change projections to national assessments of flood risk: Case studies from the UK.

13th January 2014

Steven Wade, Ben Gouldby, Mike Panzeri and Chris Counsell. HR Wallingford.

Outline

- Managing climate risks in the UK and the role of research
- UK Climate Change Projections 2009
  - Approaches to downscaling
  - Probabilistic projections
  - Estimates of extreme sea level rise (H++) and storm surge
- Case studies for national risk assessment
  - Hydrological research to estimate changes in peak river flows
  - National Flood Risk Assessment (NaFRA) modelling tools
  - The UK Climate Change Risk Assessment 2012 – flood risks
- Conclusions ~ lessons learned from our experience

UK approach to climate adaptation and use of climate information

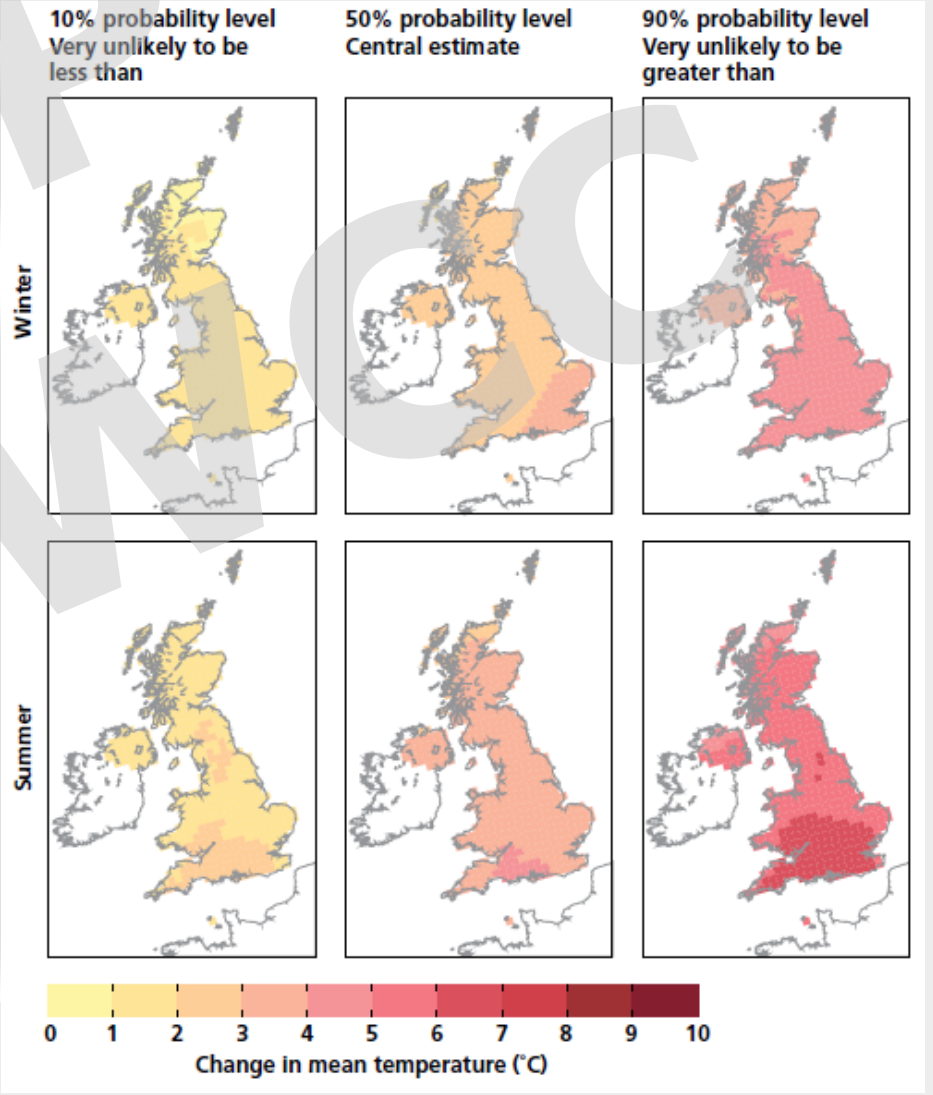
National policy and programmes

- Climate Change Act 2008
- Met Office Hadley Centre, UKCP09
- RCUK research programmes
- UK Climate Change Risk Assessment and National Adaptation Plan
- ***Needs robust scientific evidence to inform policy***, including monitoring, national and case study risk assessment and to inform long term investment etc..

Local climate adaptation

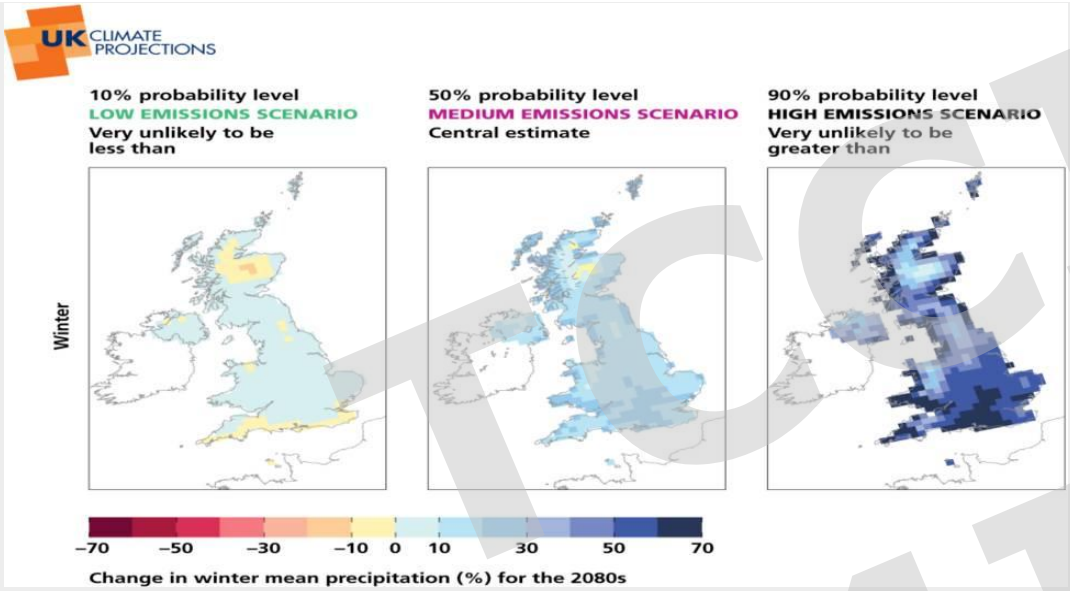
- Catchment flood risk studies, detailed flood mapping, warning
- Water resources management plans
- Catchment drought plans
- ***Requires headline messages on climate change and simple tools***
- ***Plus more detailed assessments for major infrastructure development***

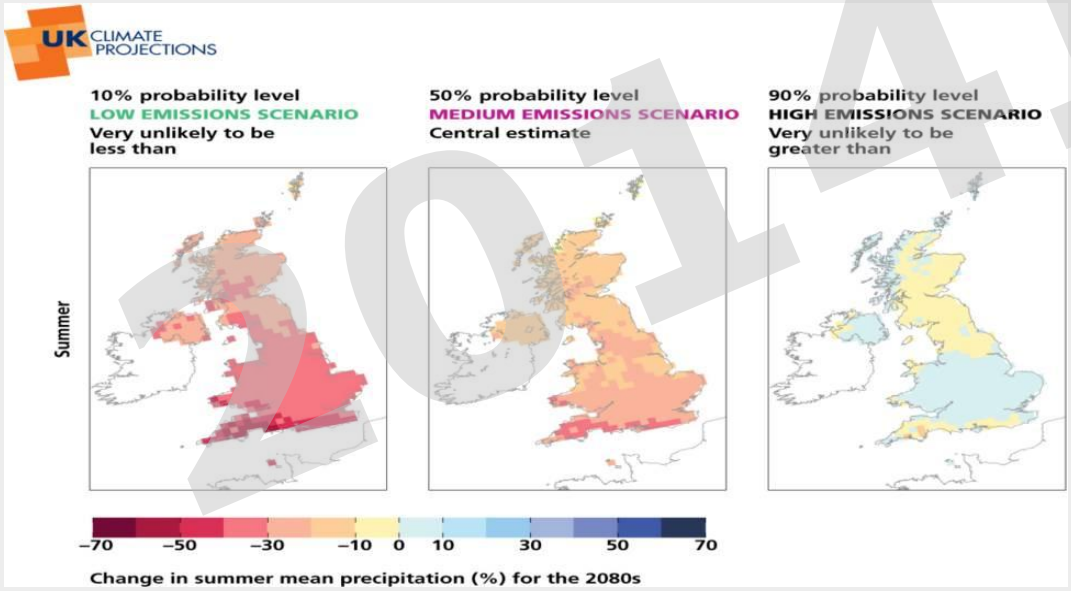
UK Climate Projections 2009



http://ukclimateprojections.defra.gov.uk/

Climate projections (2020s, 2050s, 2080s and High, Medium and Low Emissions)





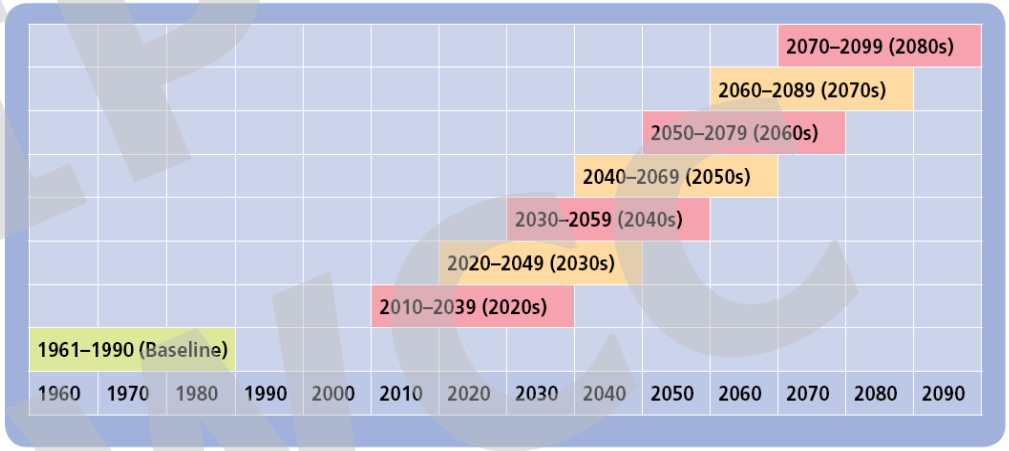
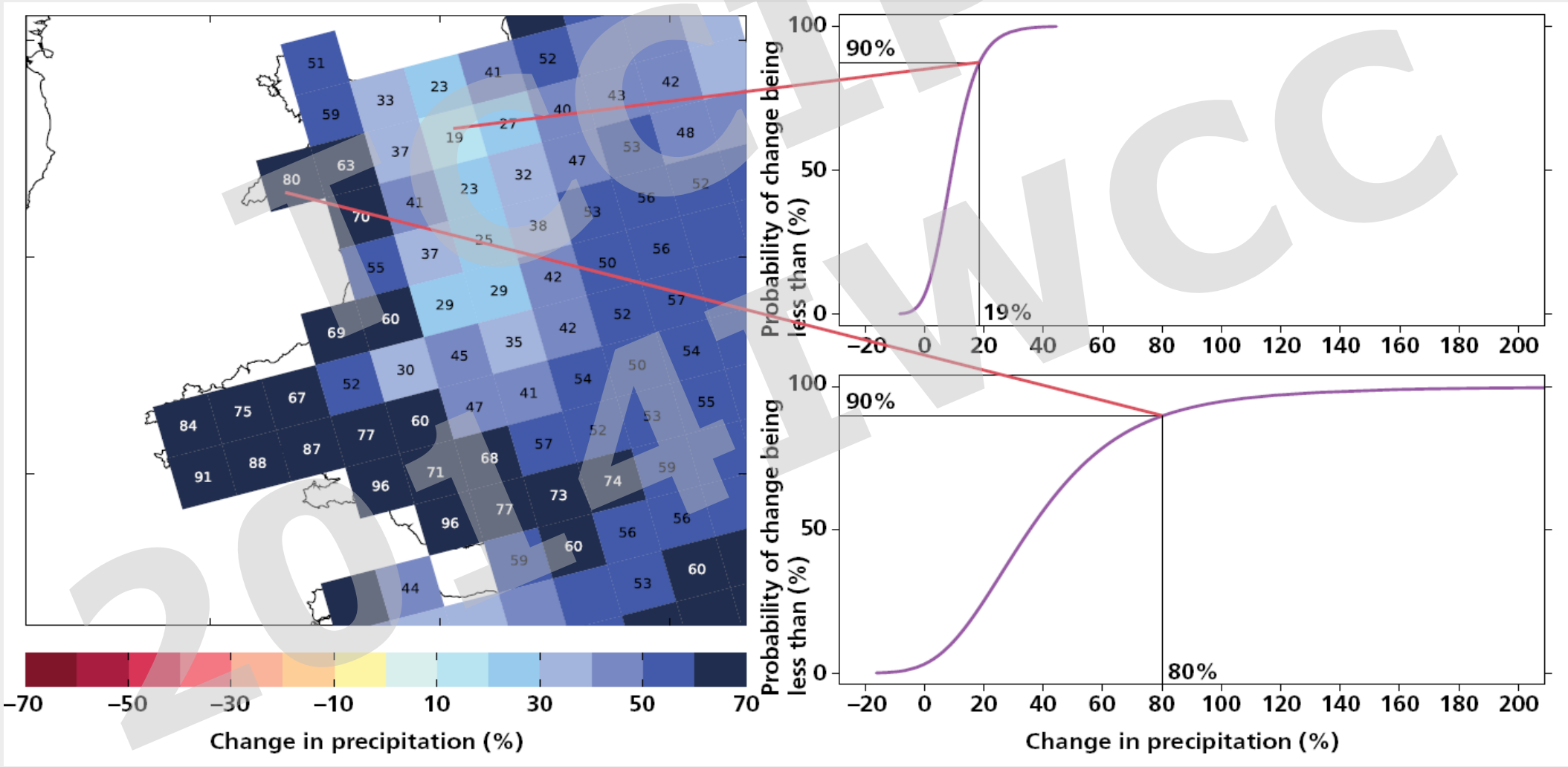


Figure 1.3: The seven 30-yr future time periods over which projections are averaged, relative to the baseline period.

UK Climate Projections 2009 - UKCP09

http://ukclimateprojections.defra.gov.uk/

UKCP09 Precipitation changes - 2080s High Emissions 90% probability level



UKCP09 Marine projections for relative sea level rise, surge and H++

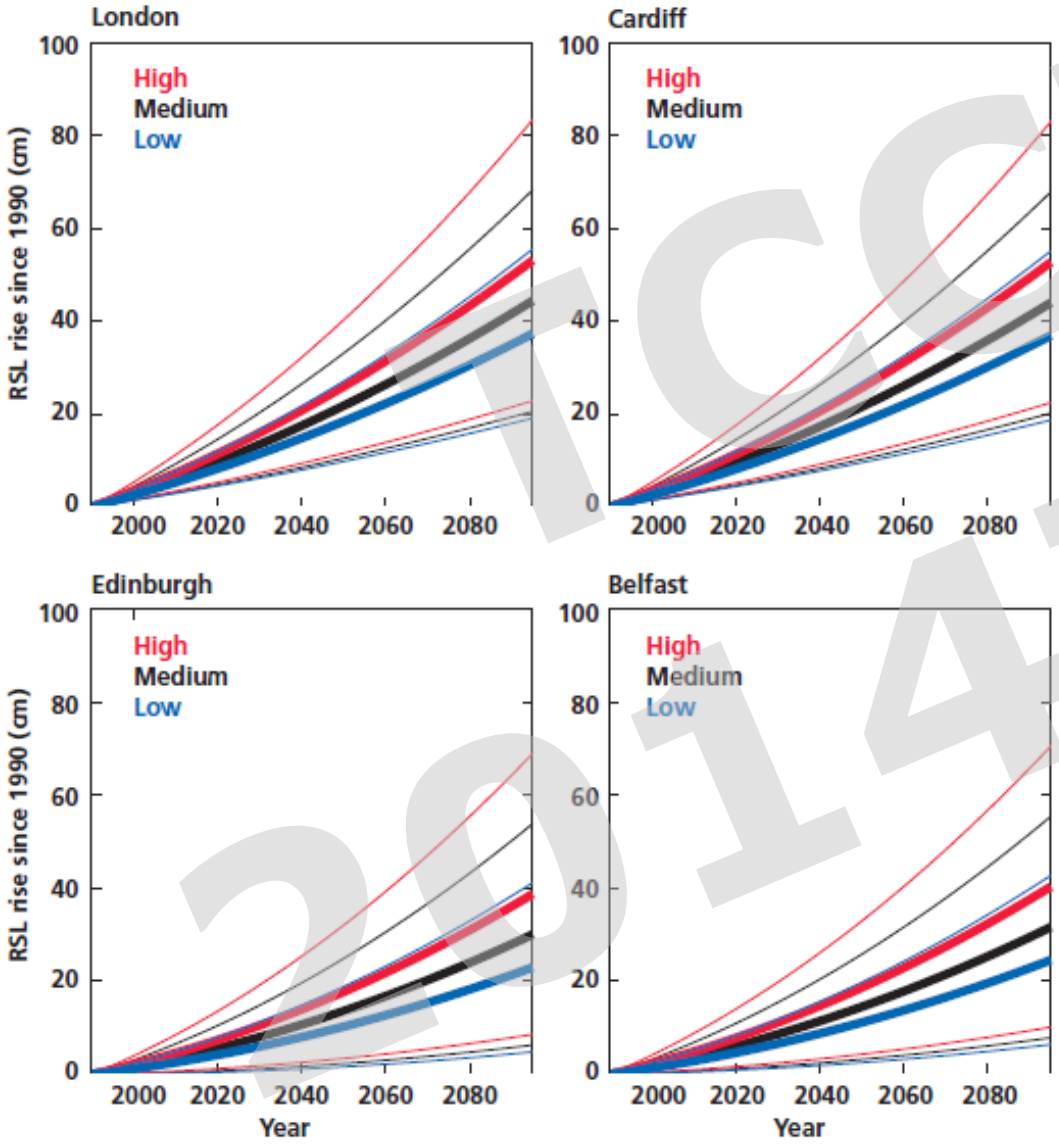
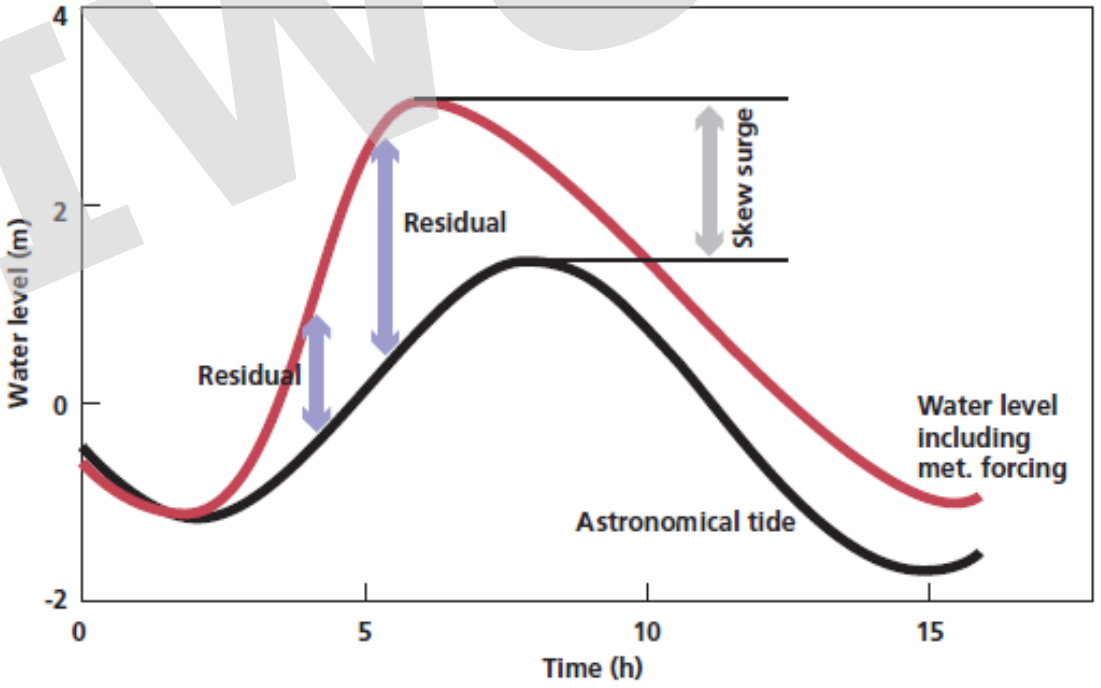


Figure 3.6: Relative sea level (RSL) rise over the 21st century showing central estimate values (thick lines) and 5th and 95th percentile limits of the range of uncertainty (thin lines) for four sample locations around the UK. Values are relative to 1990. Central estimates for each decade are given in Table 3.4.

London by 2100

L->H	20 cm to 83 cm
H++	93 cm to 1.9m



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Case studies

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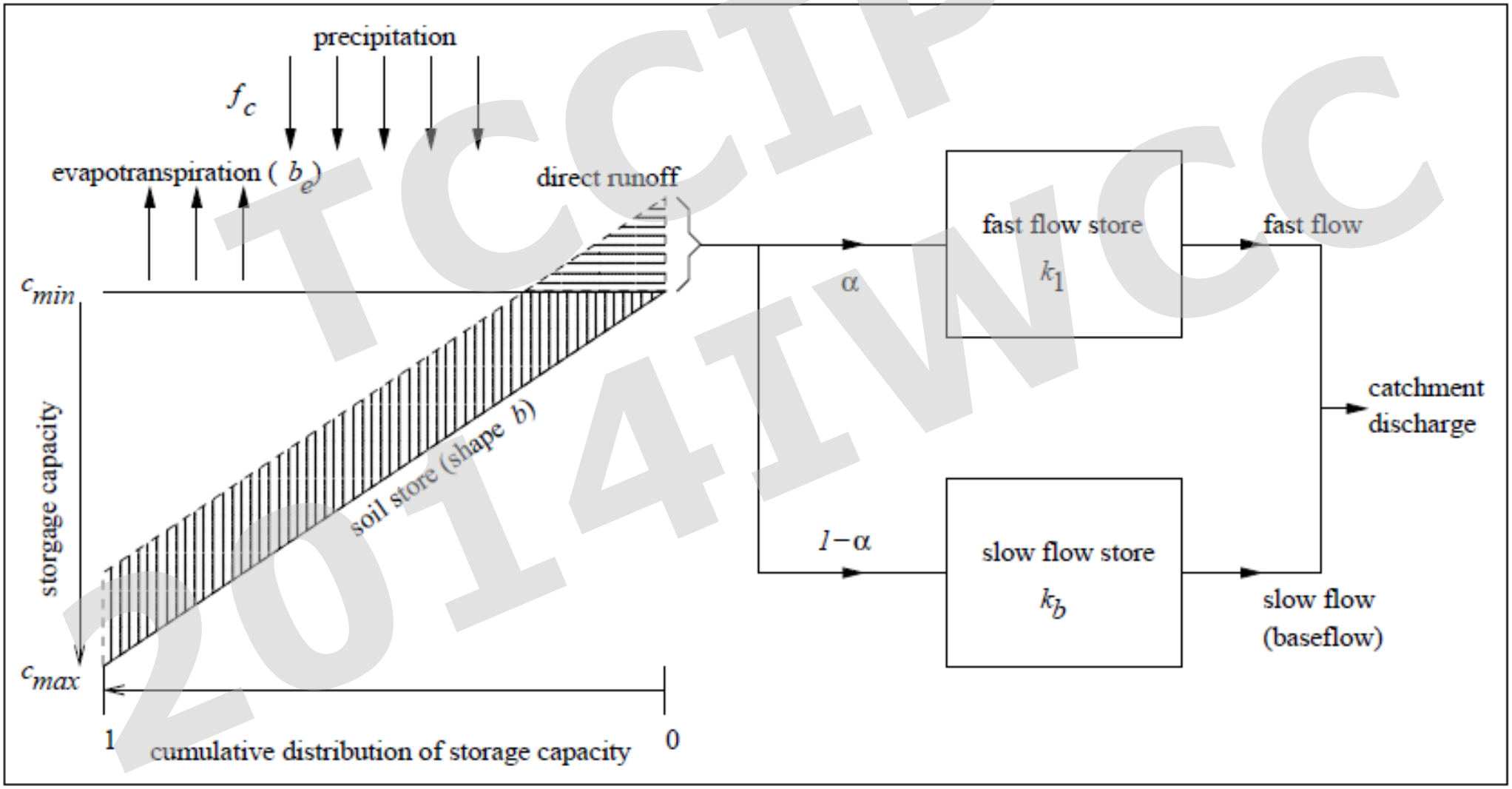
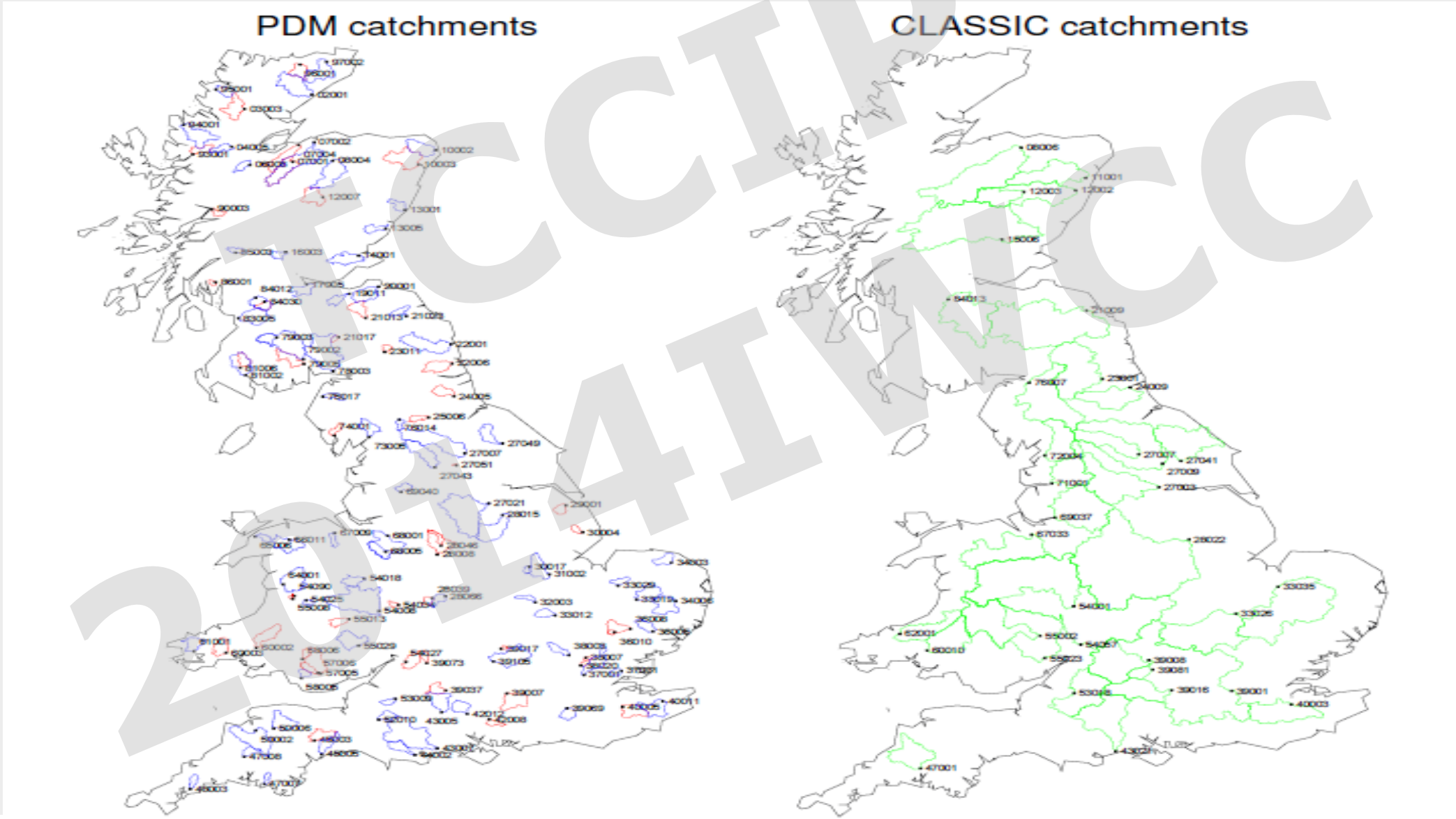
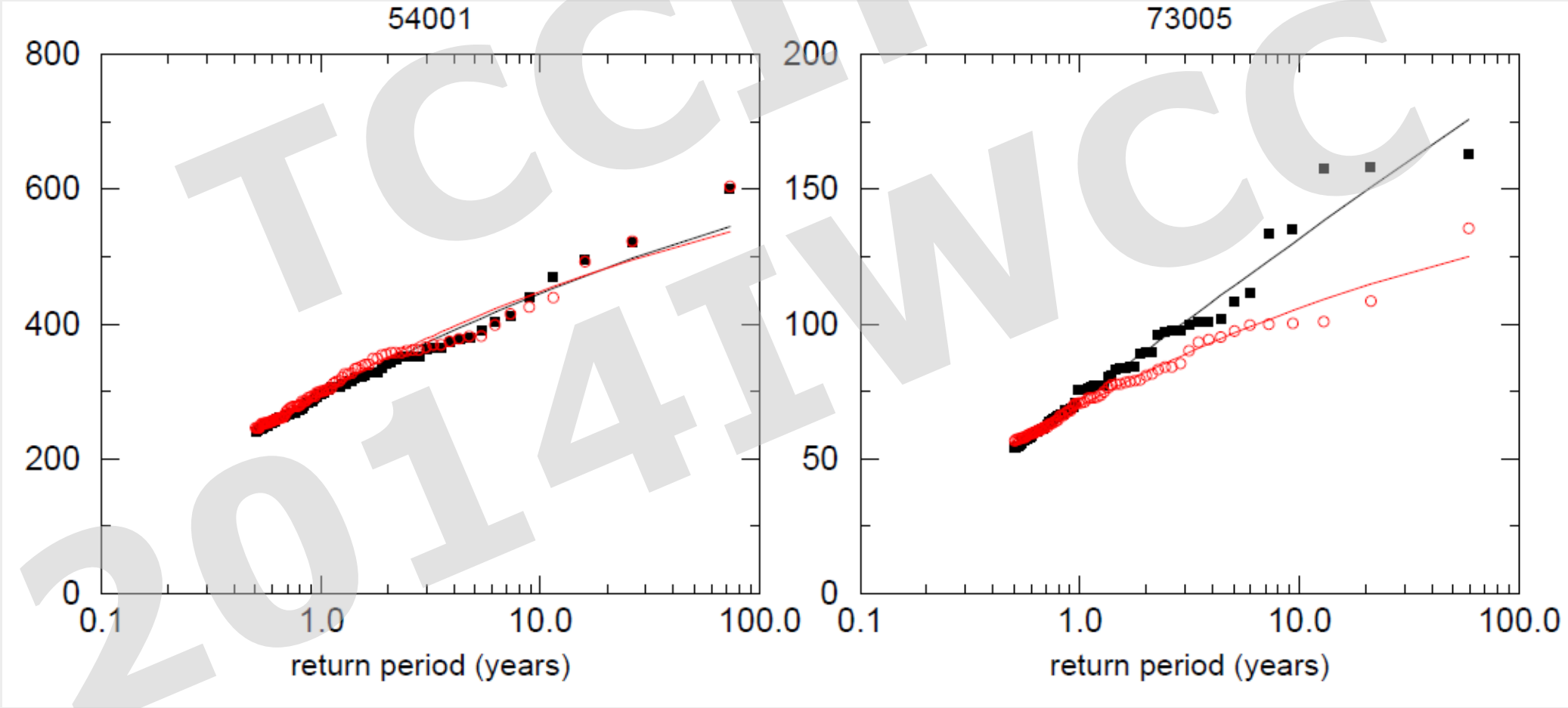
Hydrological models - PDM (Moore) and CLASSIC (Reynard)



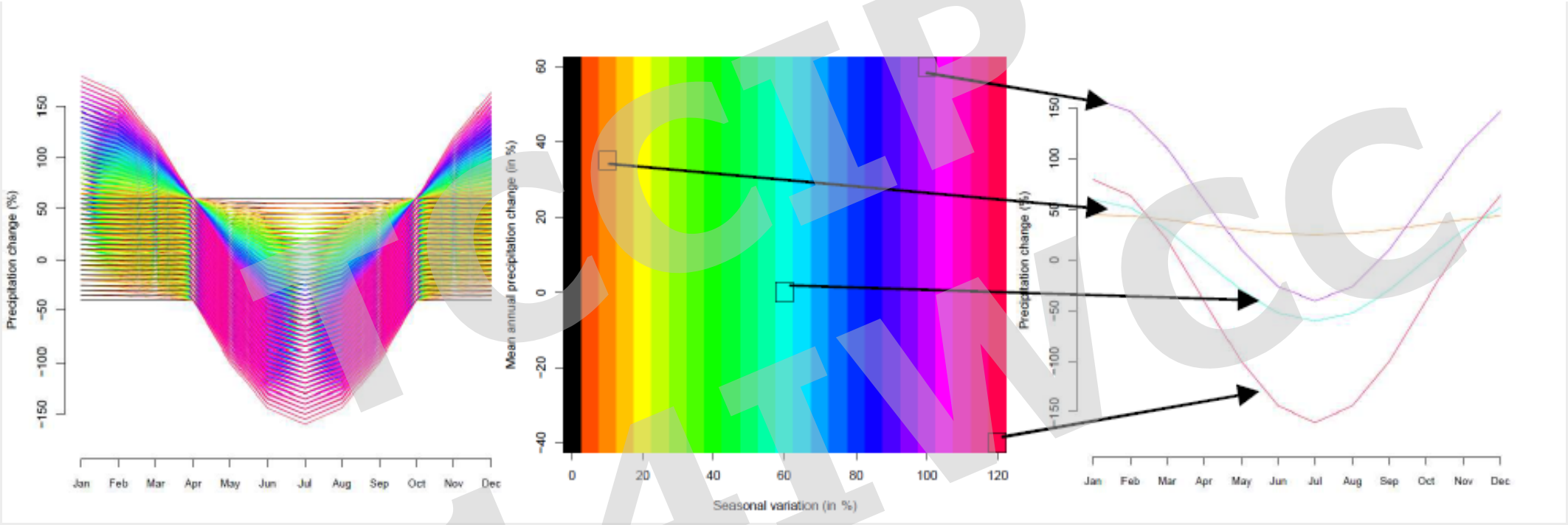
Coverage of river basins modelled (Source CEH, EA FD2020 project)

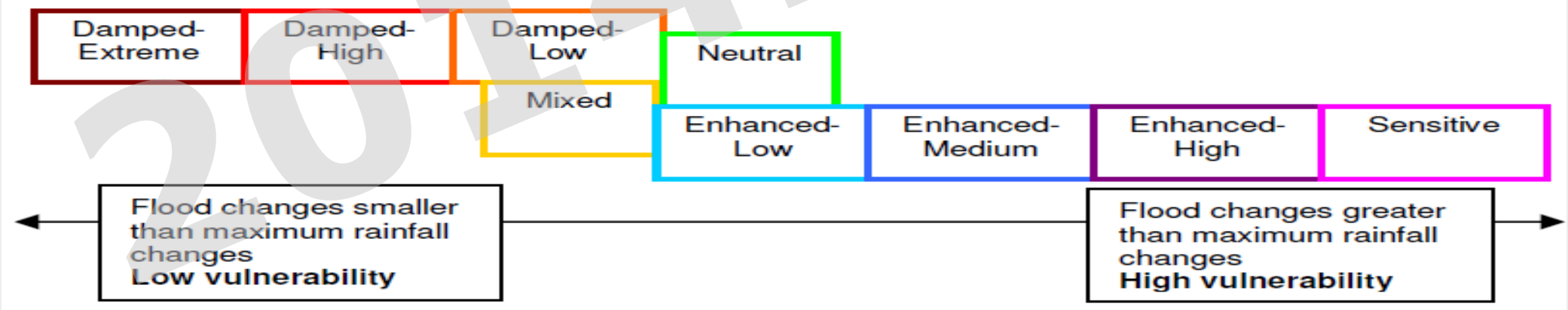


Model skill is variable (Source CEH, EA FD2020 project)

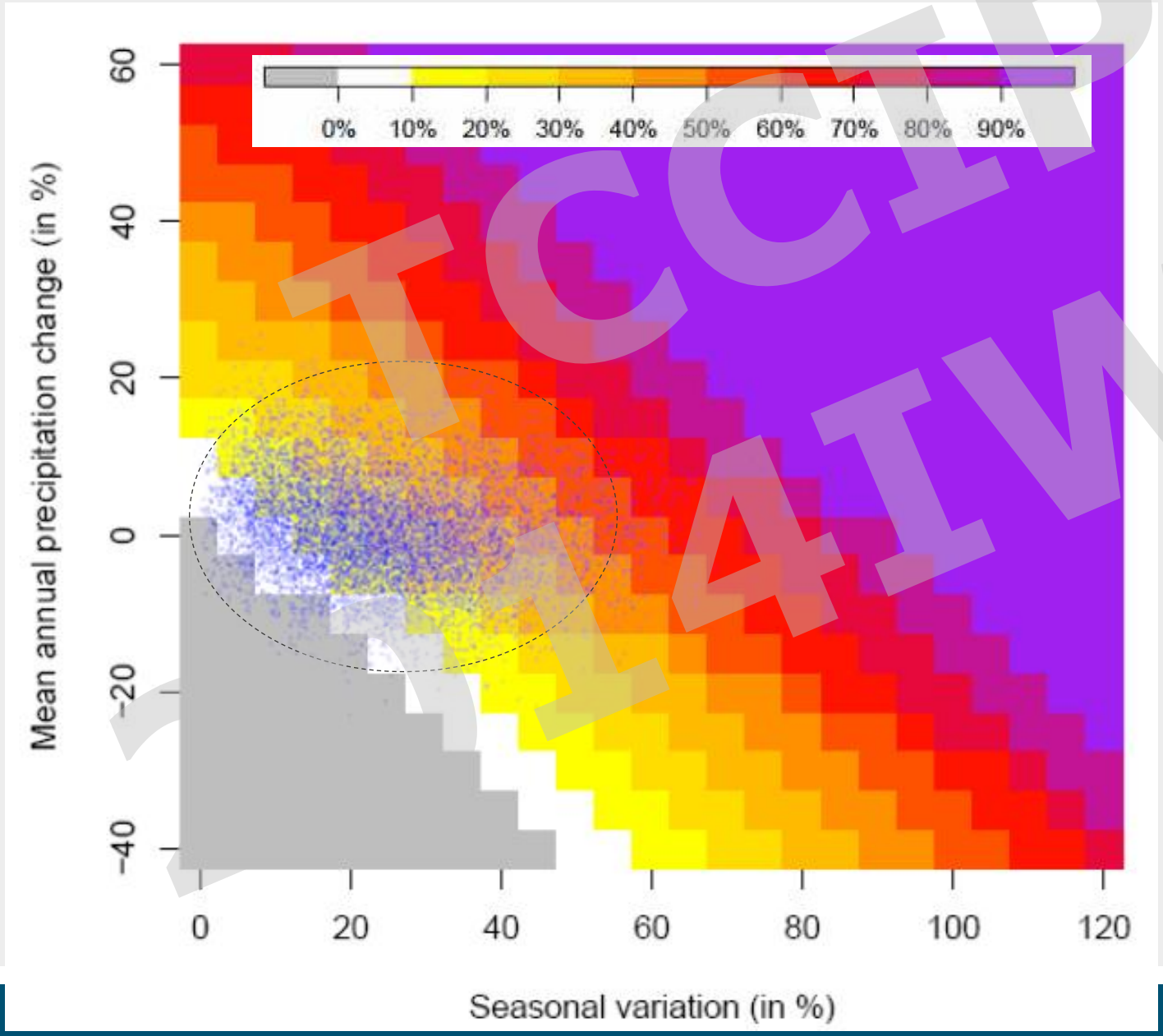


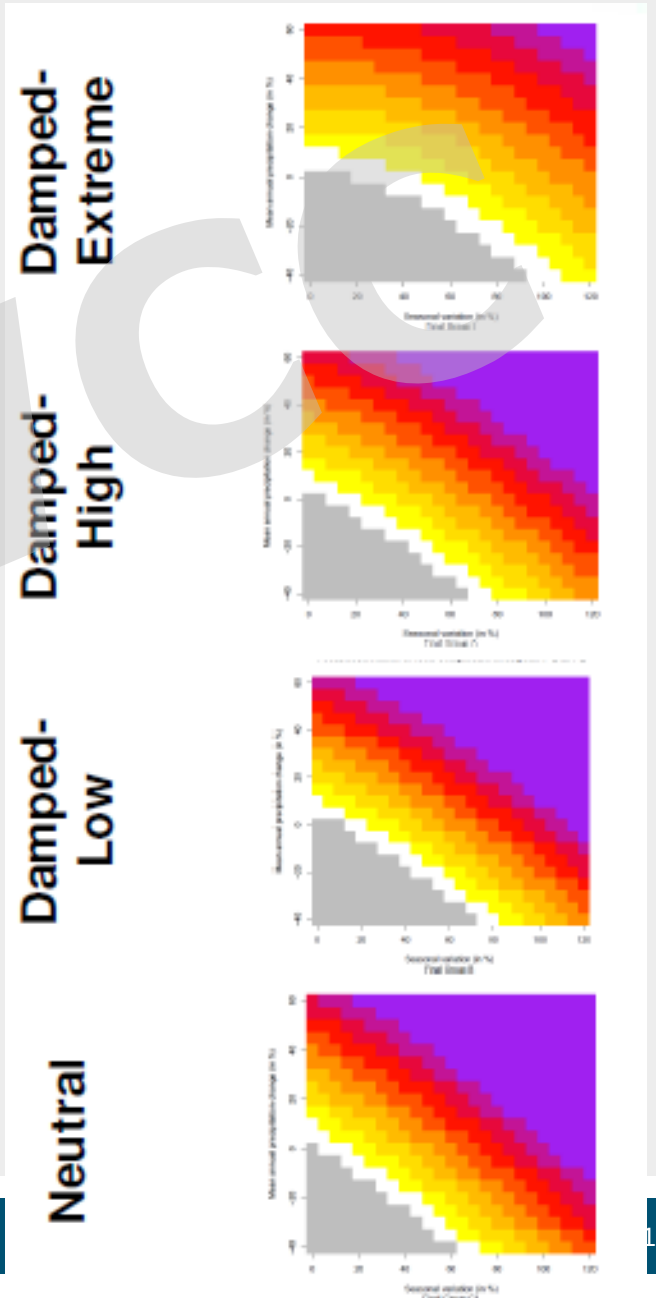
Sensitivity framework for understanding river basin response



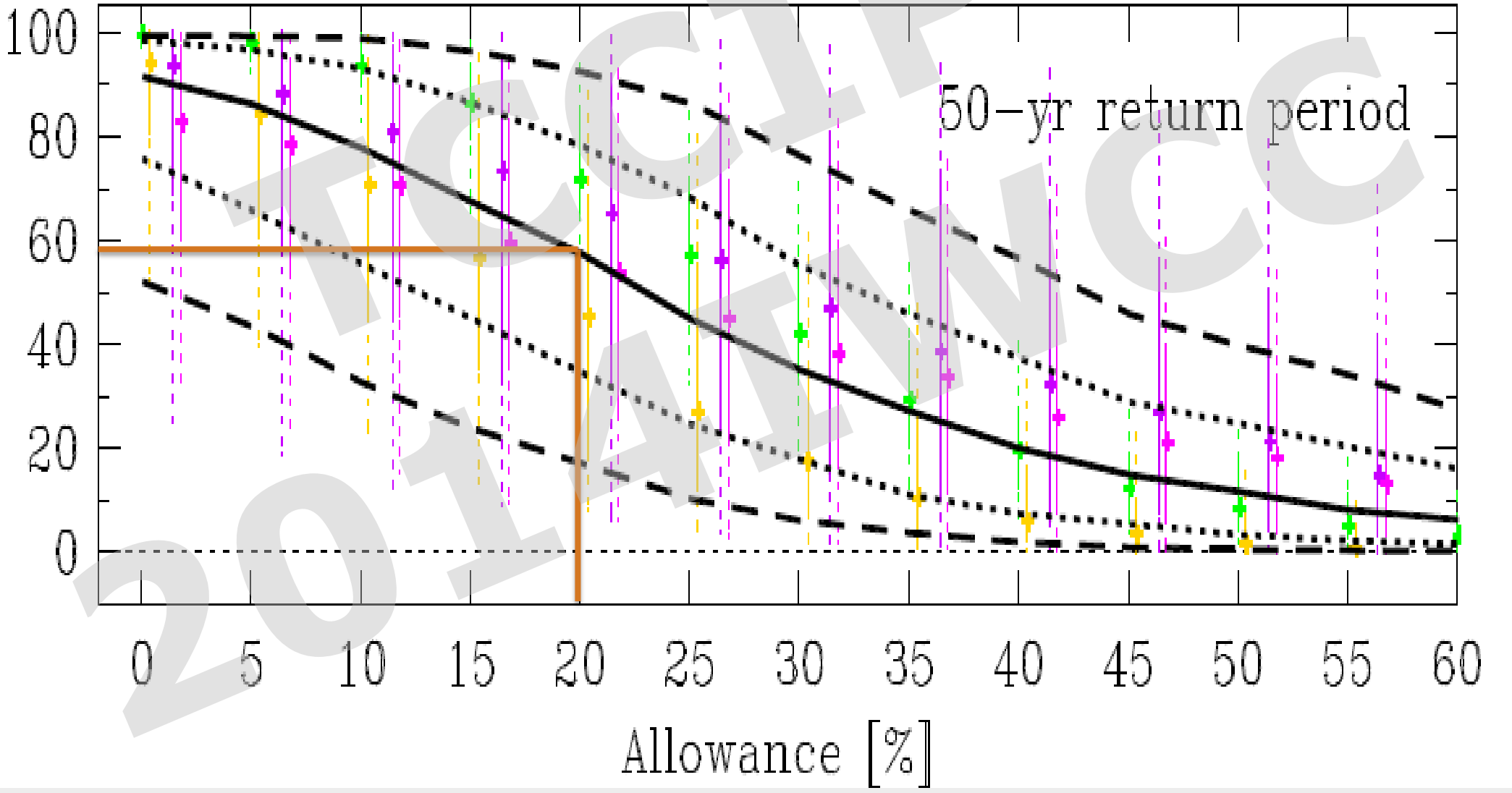


Sensitivity framework for understanding river basin response (CEH, EA FD2020 project)

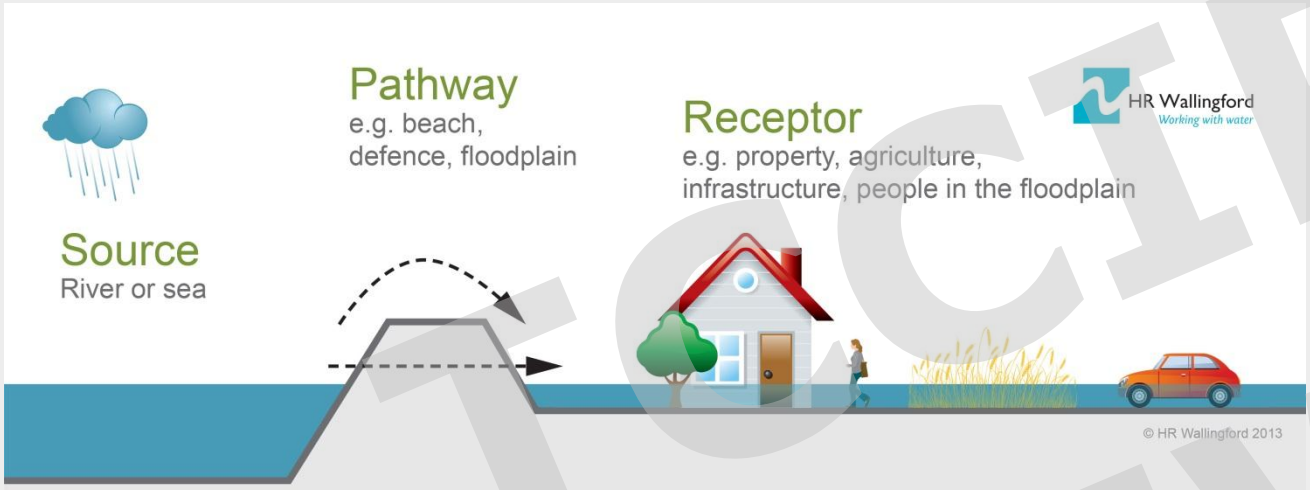




Regional response and likelihood of exceeding precautionary allowances



National Flood Risk Assessment (NaFRA) tools (behind the response function)



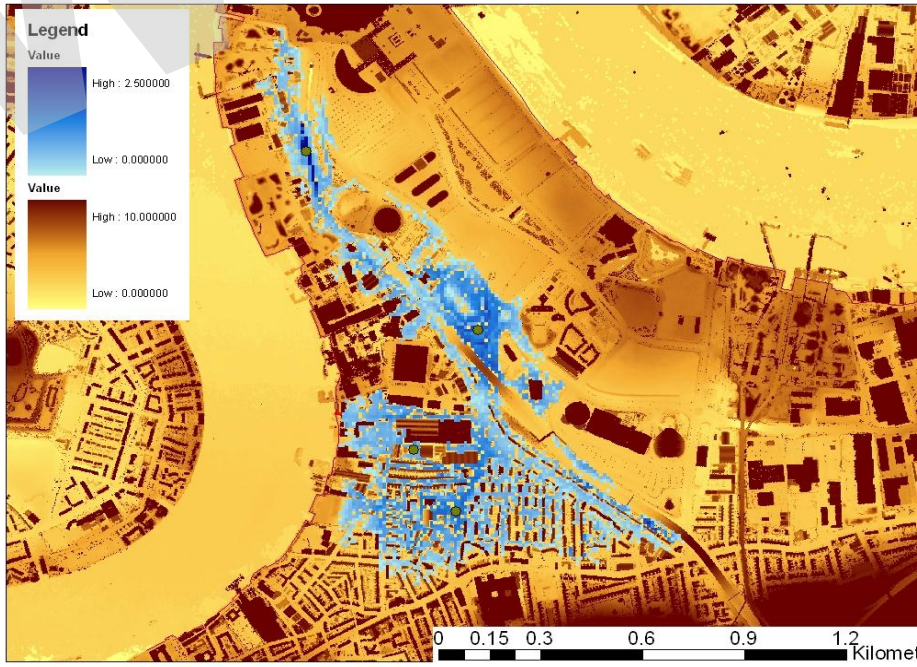
Source
Extreme distribution of in-channel water levels or coastal overtopping

Pathway
Reliability analysis of assets e.g. defences (load dependent)

Pathway
Flood probability, flood extent and depth, reflecting asset performance and source terms.

Consequences
Flood damage or harm related to depth. Risk is assessed by the probability that particular damage values are exceeded.

All inundation scenarios
A new super fast inundation model (**HR RSFM**) enables 10000s of inundation scenarios to be realised
Runtime: <0.1 sec



ArcGIS national generalised modelling

- Spatial and river modelling methods

River Network Analysis

Extreme Rainfall Data

Hydrology of Soil Types

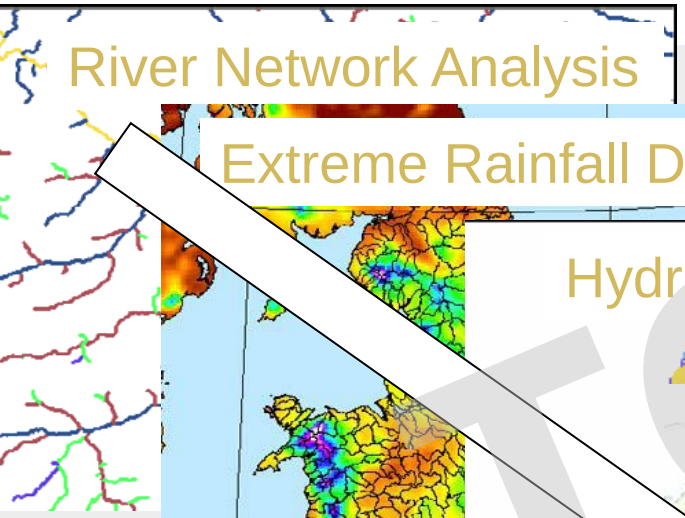
Topography

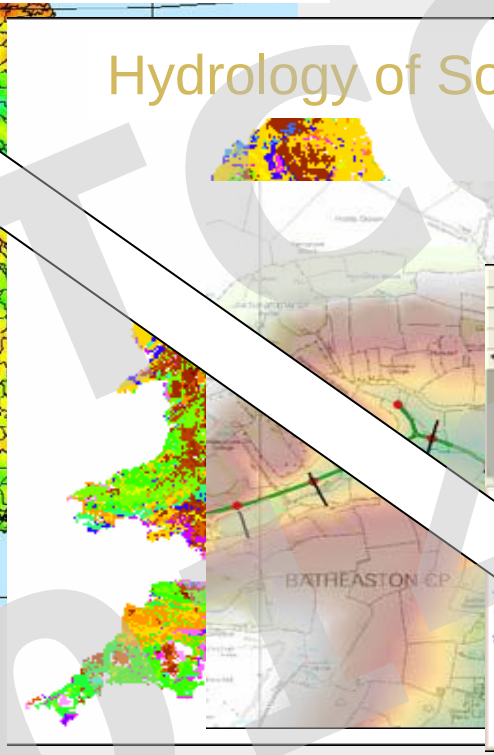
Cross-sections analysis

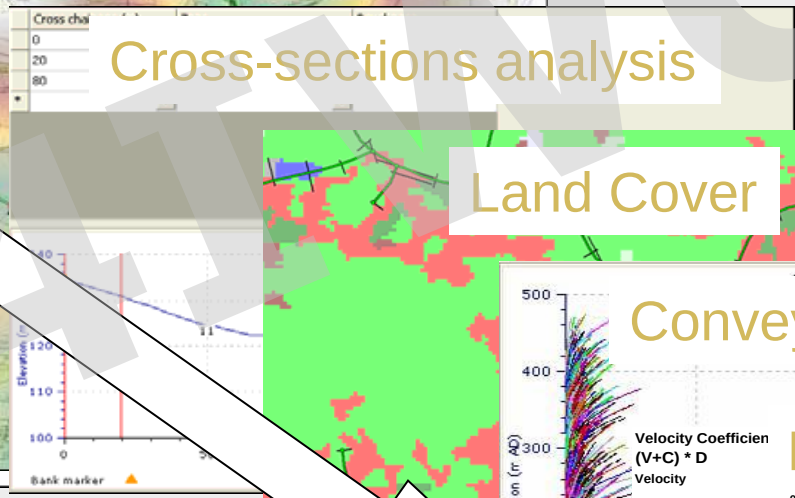
Land Cover

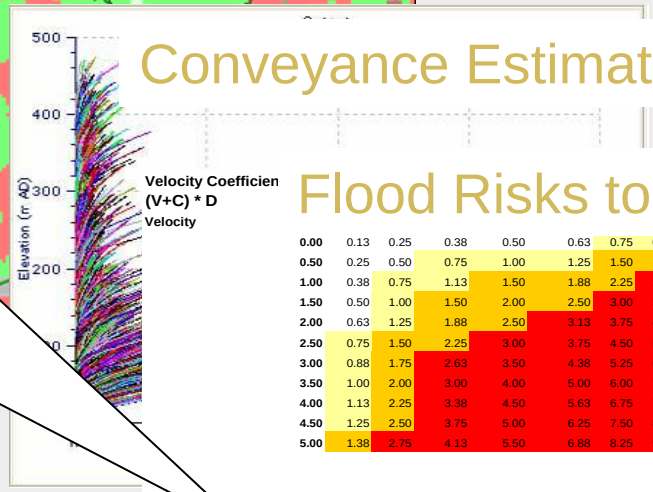
Conveyance Estimation

Flood Risks to People



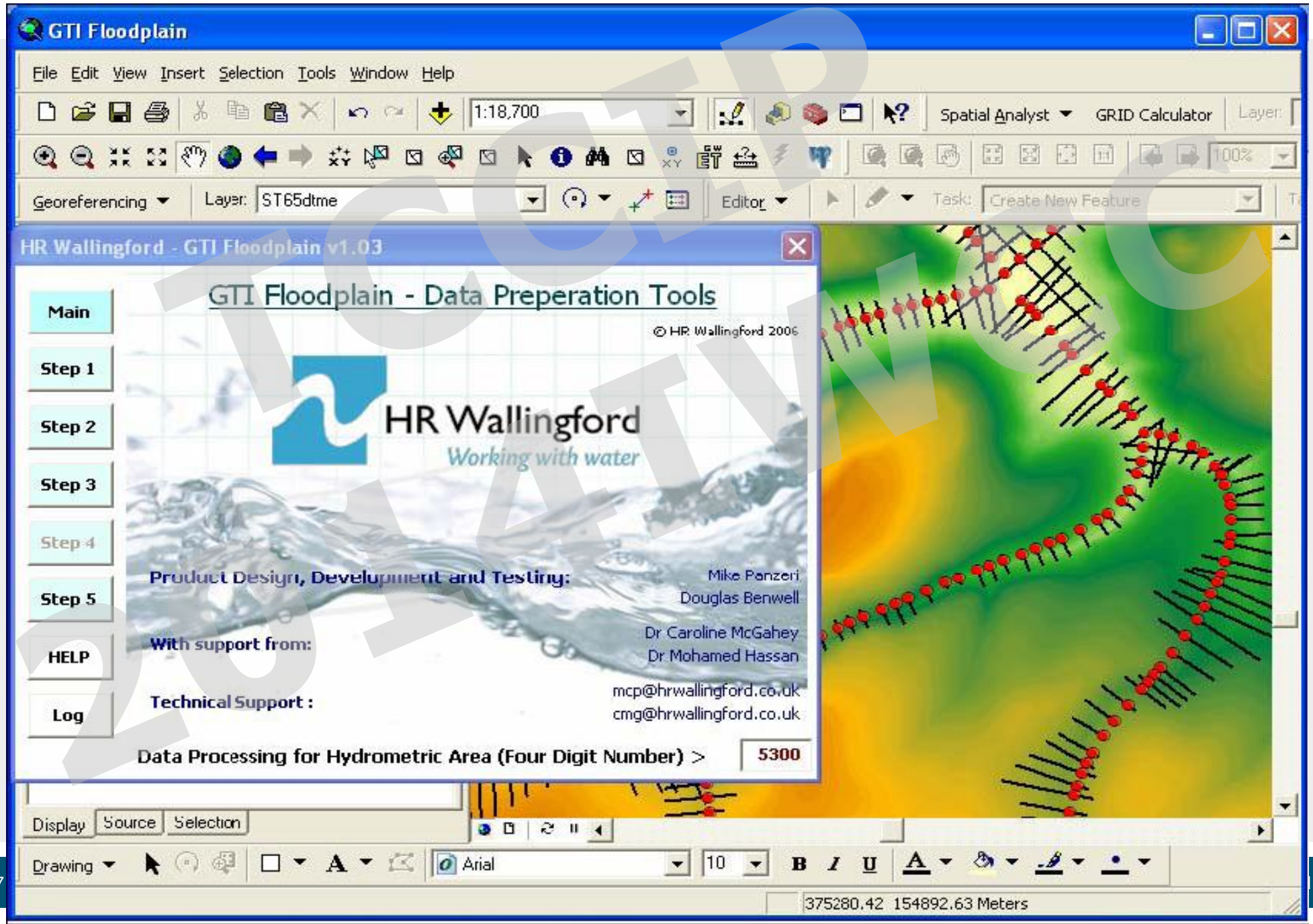




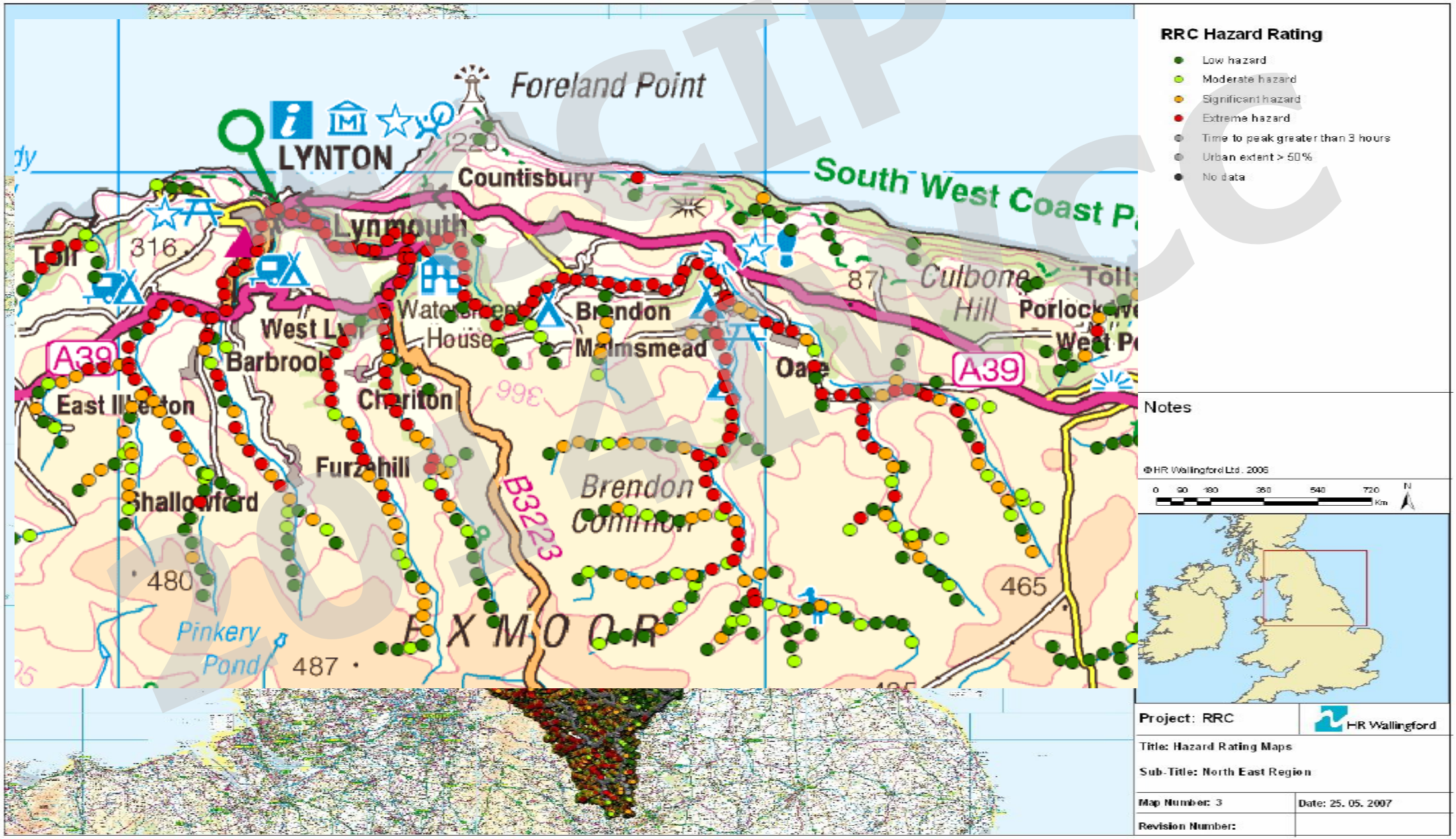


- Based upon nationally
- available data

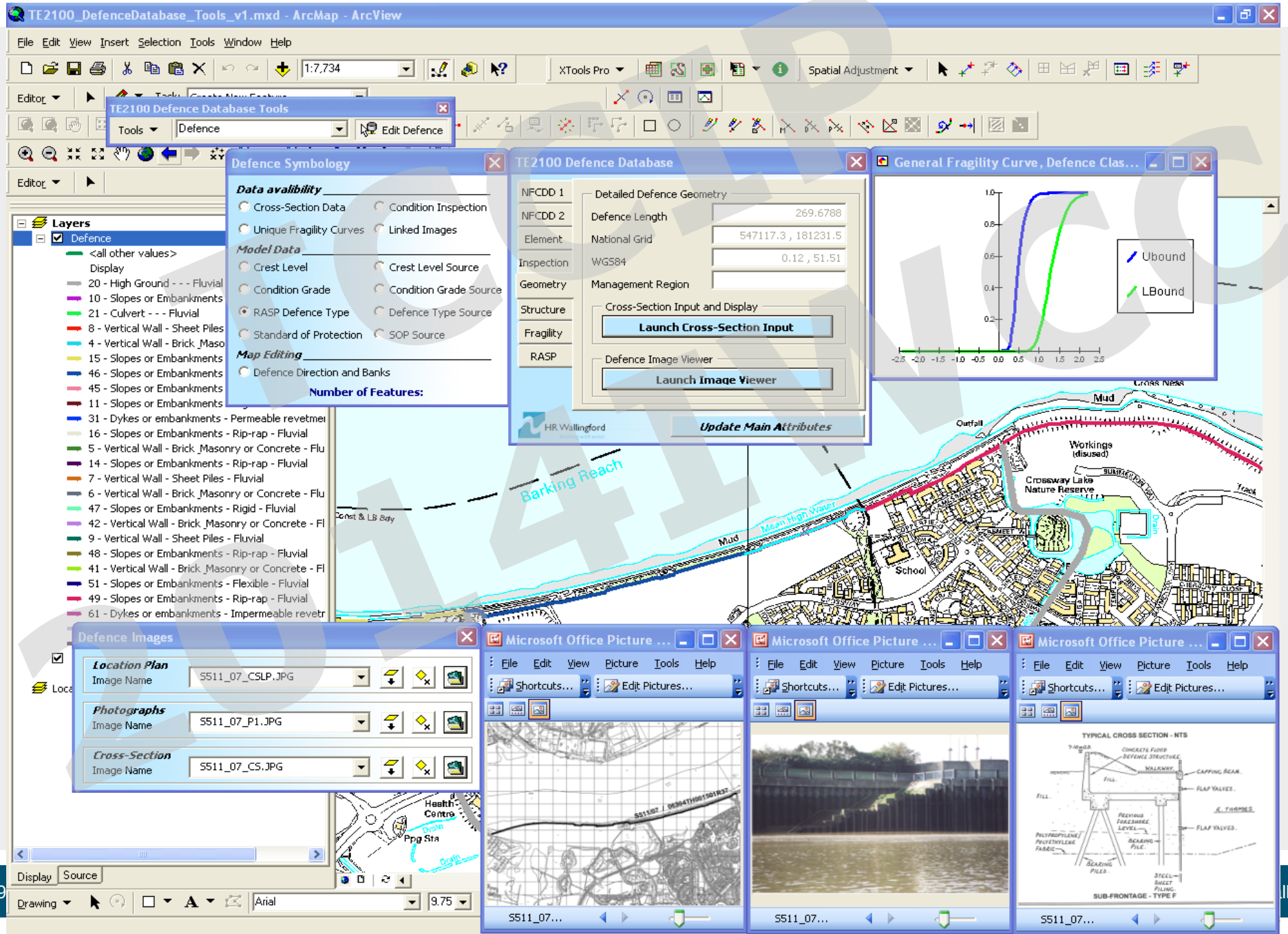
ArcGIS national generalised modelling



ArcGIS national generalised modelling



Databases Integrated with GIS



The system model

Flood volume given a breach

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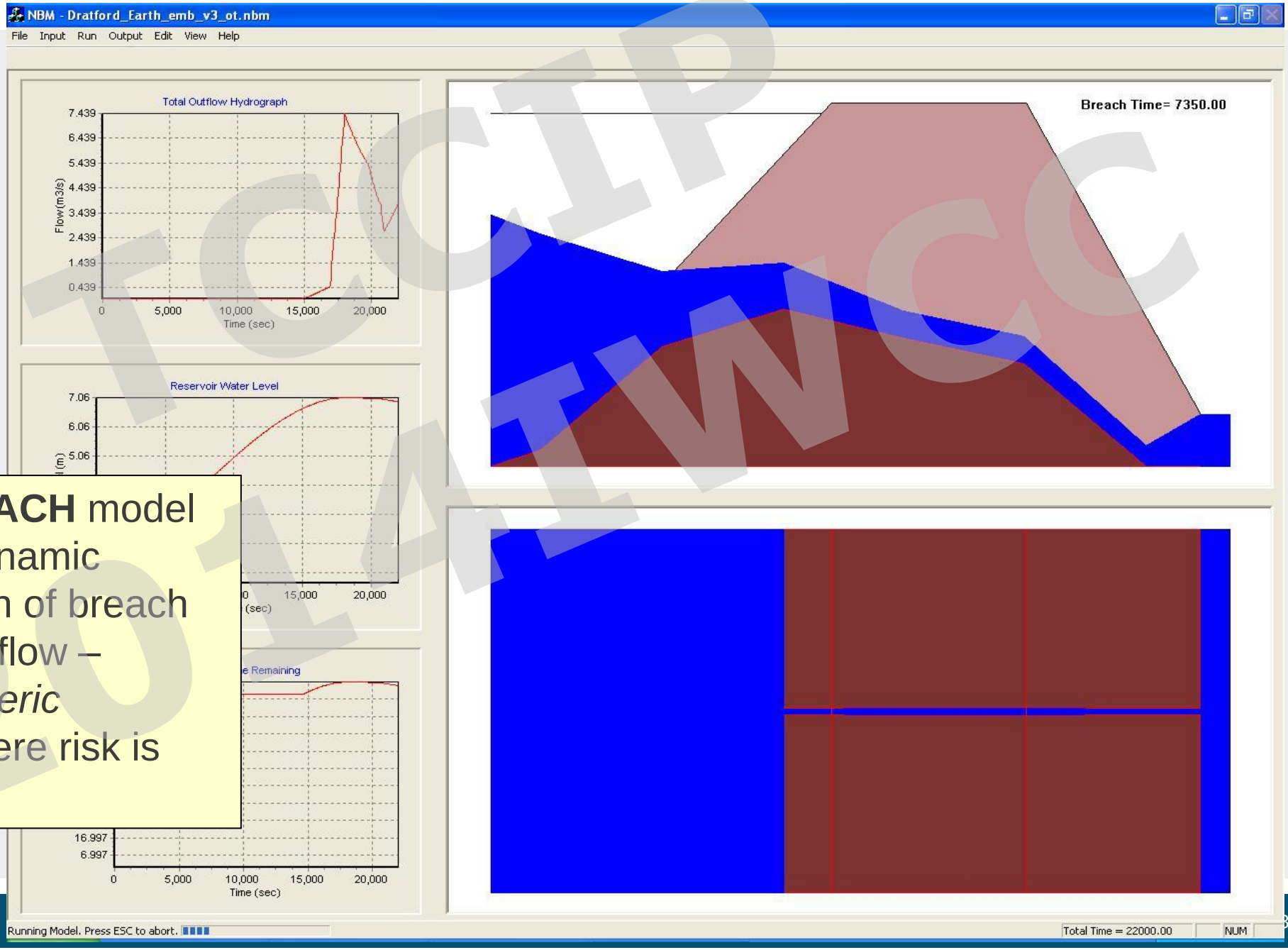
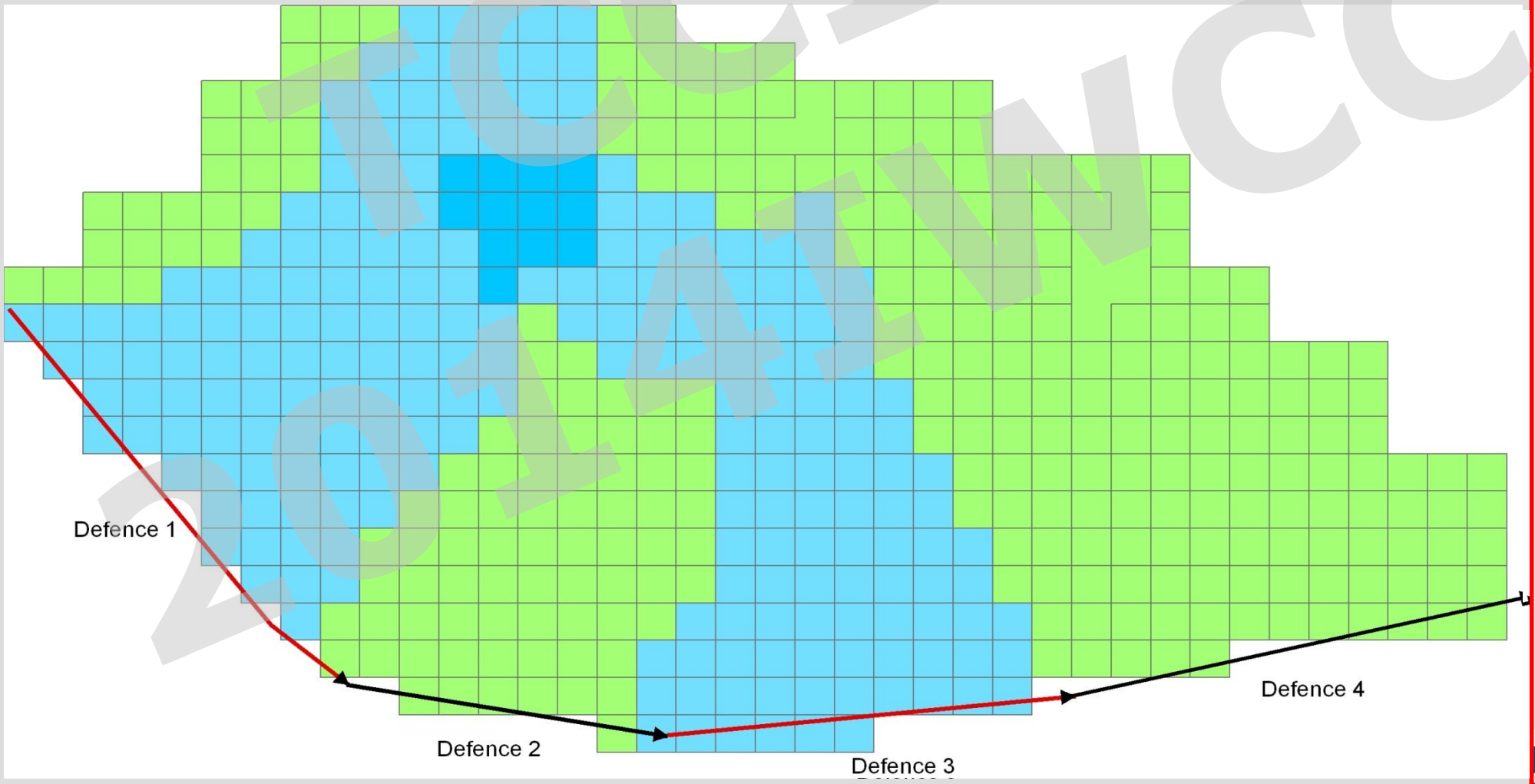


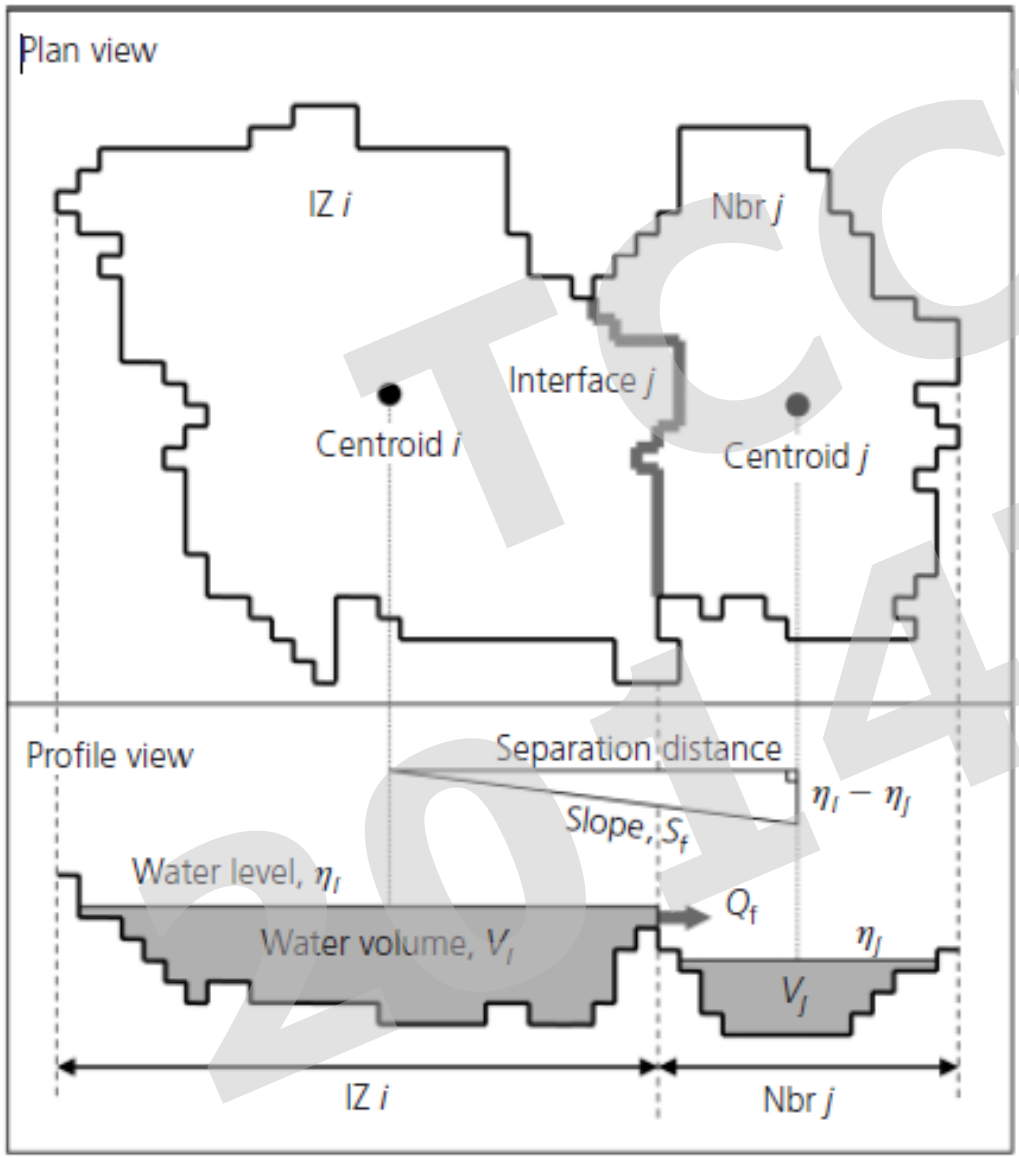
The **HR BREACH** model provides a dynamic representation of breach growth and inflow – replacing *generic* estimates where risk is highest.

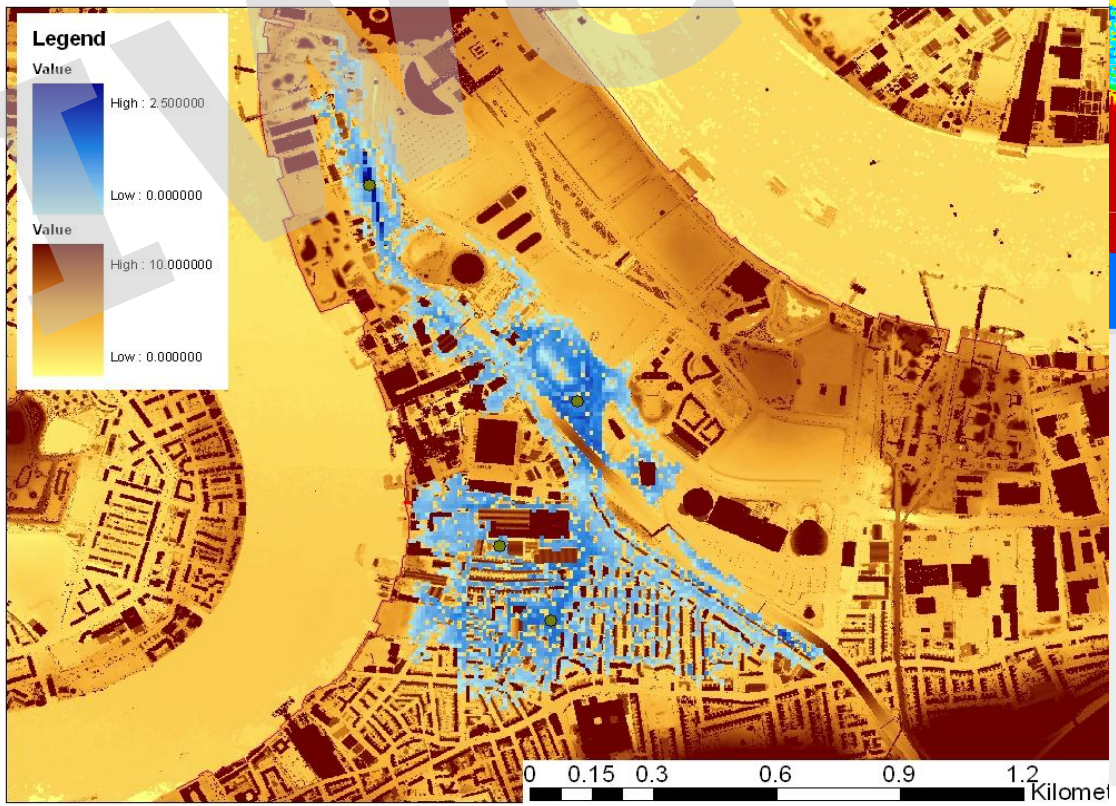
The system model:

- Recognises that levees behave as "defence systems"
- A flood depth versus probability distribution is established by considering multiple combinations of storm loading and possible levee failure

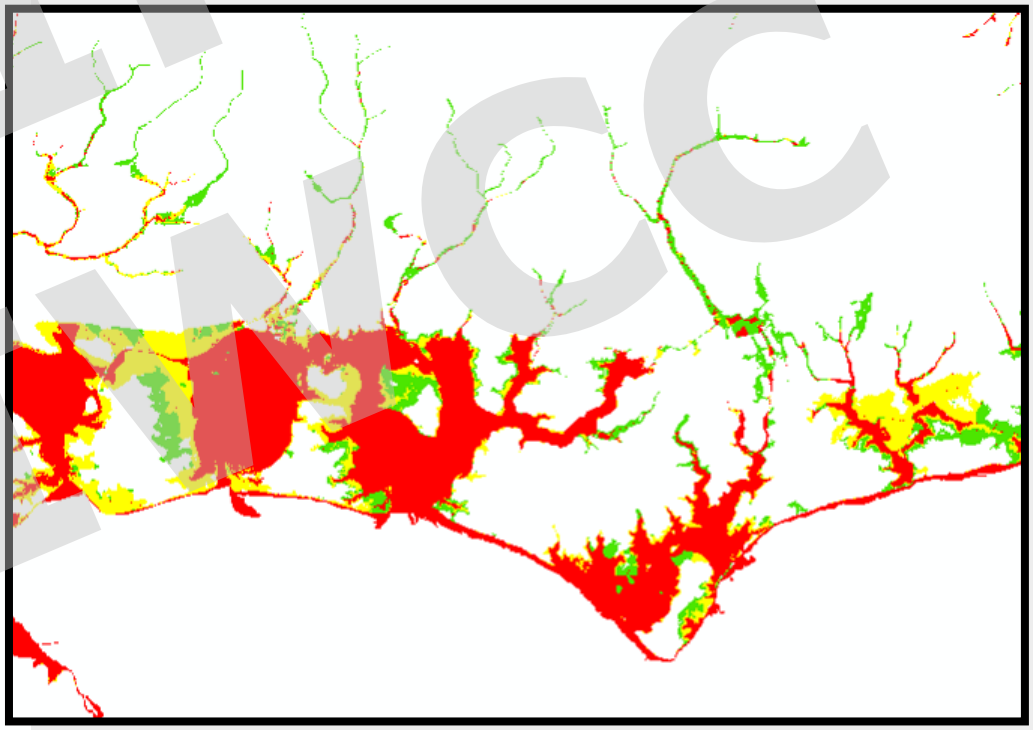


Development of super fast inundation models





National Flood Risk Assessment (NaFRA)



Flood Risk

The risks of flooding are projected to increase significantly across the UK

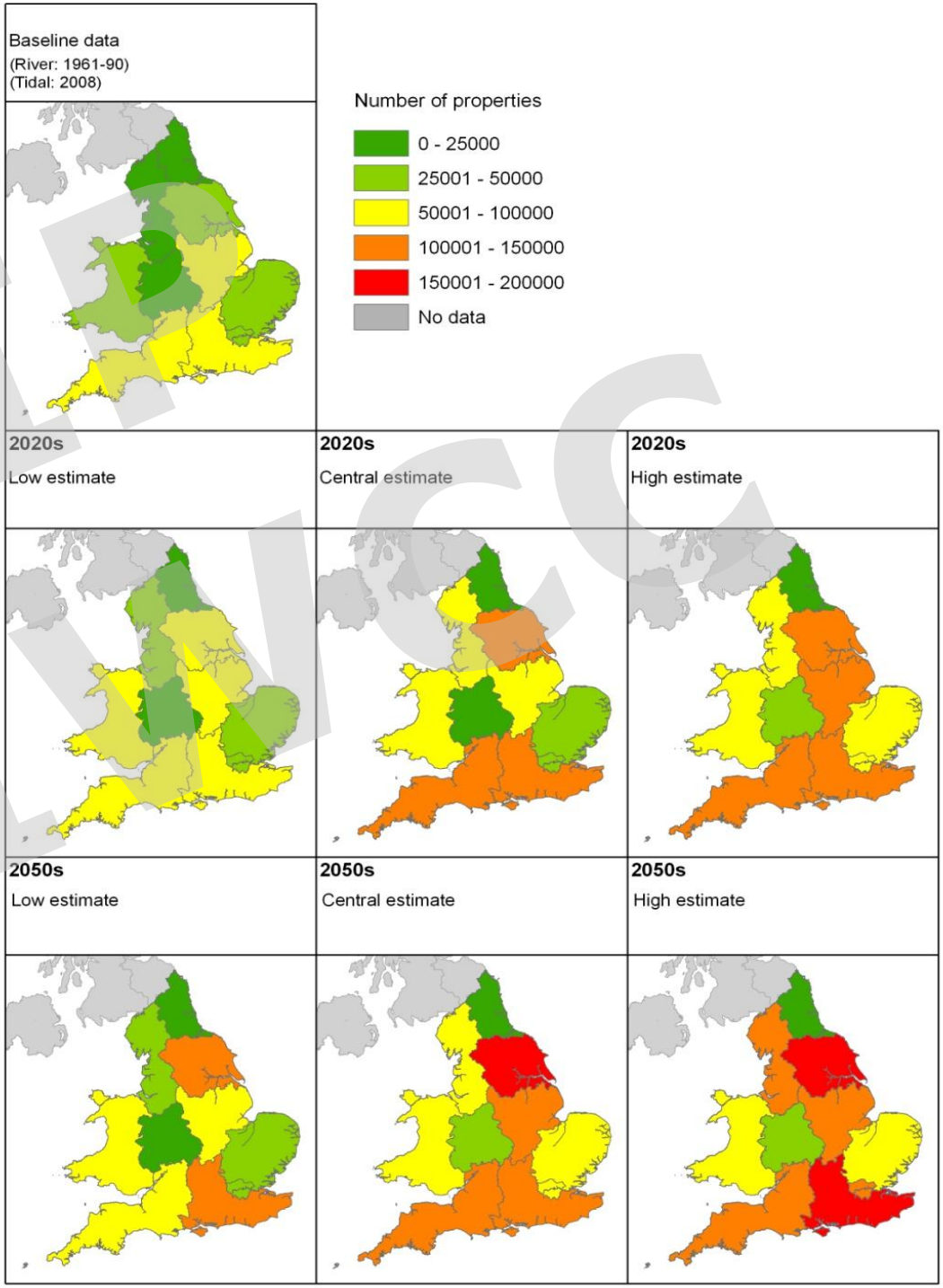
England and Wales

Currently 370,000 residential properties

→ 900,000 by the 2050s under the Medium emissions scenario, central estimate (range of approximately 530,000 to 1 million).

→1.1 million (with a range of 690,000 to 1.3 million) based on the principal population projection

High Confidence



Conclusions

UKCP09 has provided a range of different outputs for different users

- Simple headline messages to multi-model ensembles of monthly changes (n=10,000). All products have strengths and weaknesses and their use is dependent on applications.
- Downscaled products include weather generators and transient model runs from HadRM3 (n=11)
- The CEH 'Future Flows' project also created a transient 1km data sets for P, T and PET.
- Suggestions for TCCIP
- Talk to stakeholders, understand their needs and the decisions that might be affected by information on future climate change
- Push ahead with developing sector based risk tools for floods/droughts
- Consider broader scale national methods using simplified techniques as well as detailed case studies using the 'best' tools

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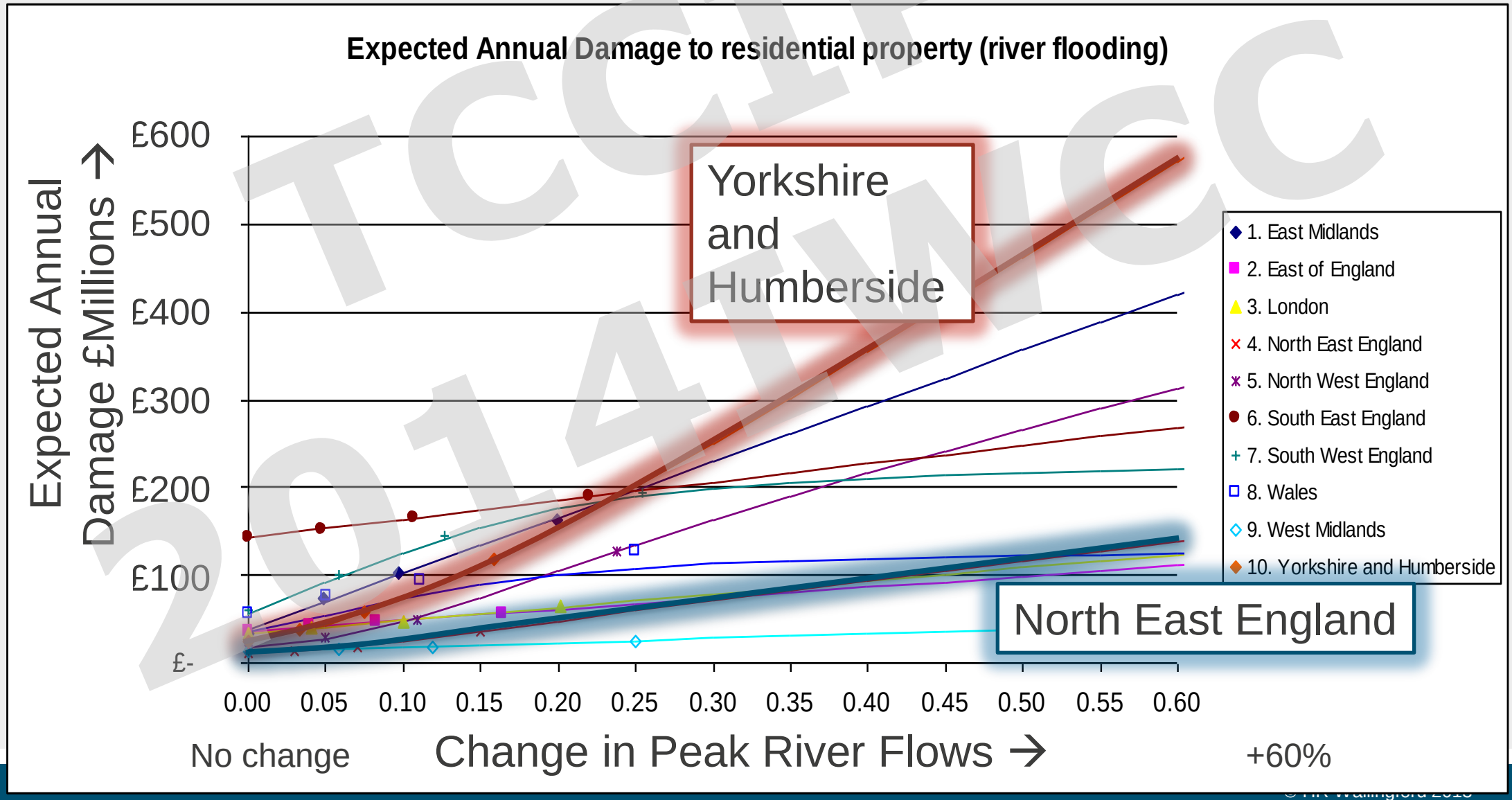
Open forum

DAY 3 – Adaptation decision-making

Application of response functions: An example for flooding from rivers

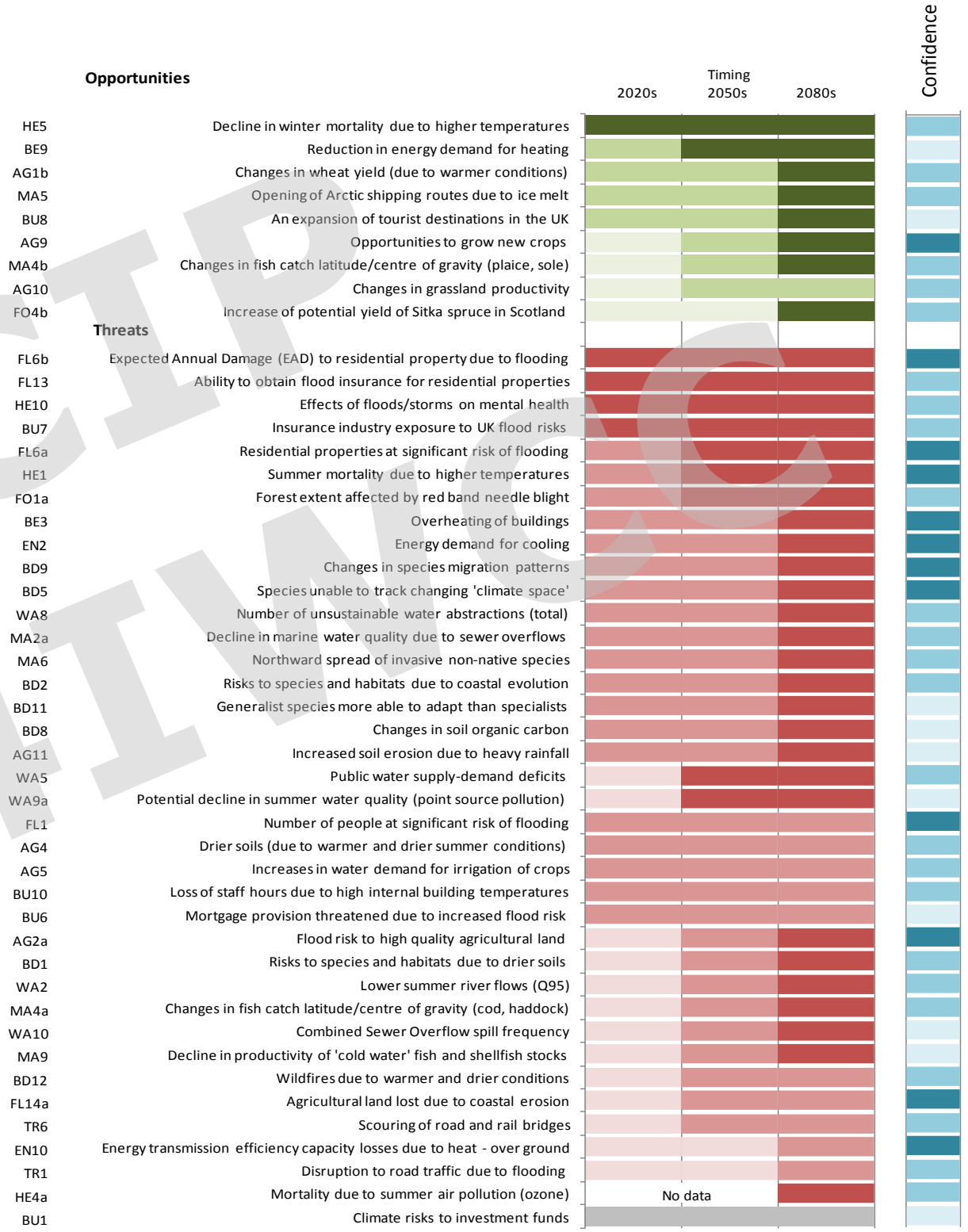


Which potential risks require early action?

Overall, the findings of the CCRA indicate that the greatest need for early adaptation action (i.e. within the next 5 years) is in the following areas:

- Flood and coastal erosion risk management;
- Specific aspects of natural ecosystems, including managing productivity and biodiversity;
- Managing water resources, particularly in areas with increasing water scarcity;
- Overheating of buildings and infrastructure in the urban environment;
- Health risks associated with heat waves and other risks that may affect the NHS; and
- Opportunities for the economy, particularly to develop climate adaptation products and services.

These findings should only be considered as preliminary, as the rationale for Government action is subject to another ongoing study, the Economics of Climate Resilience (ECR).



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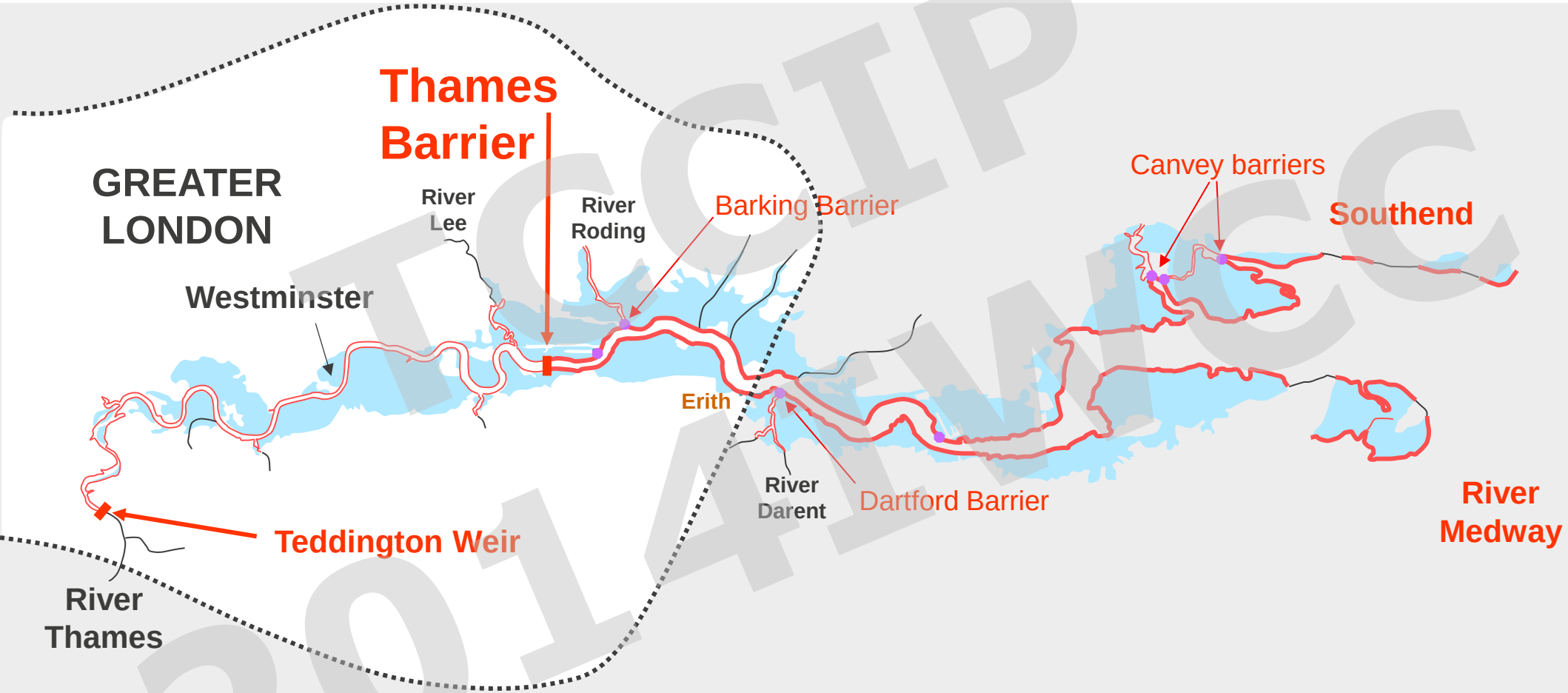
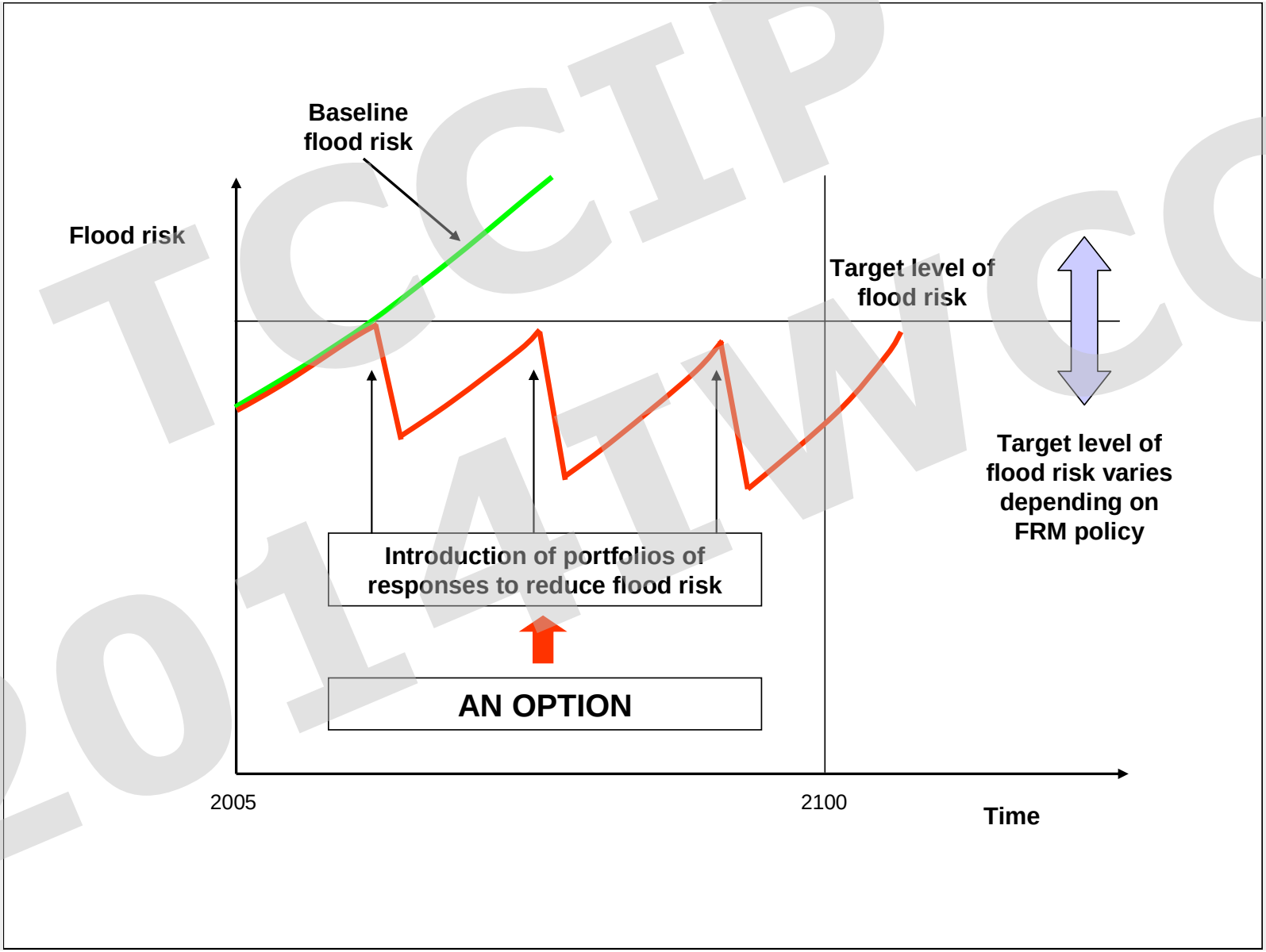
The Thames Estuary

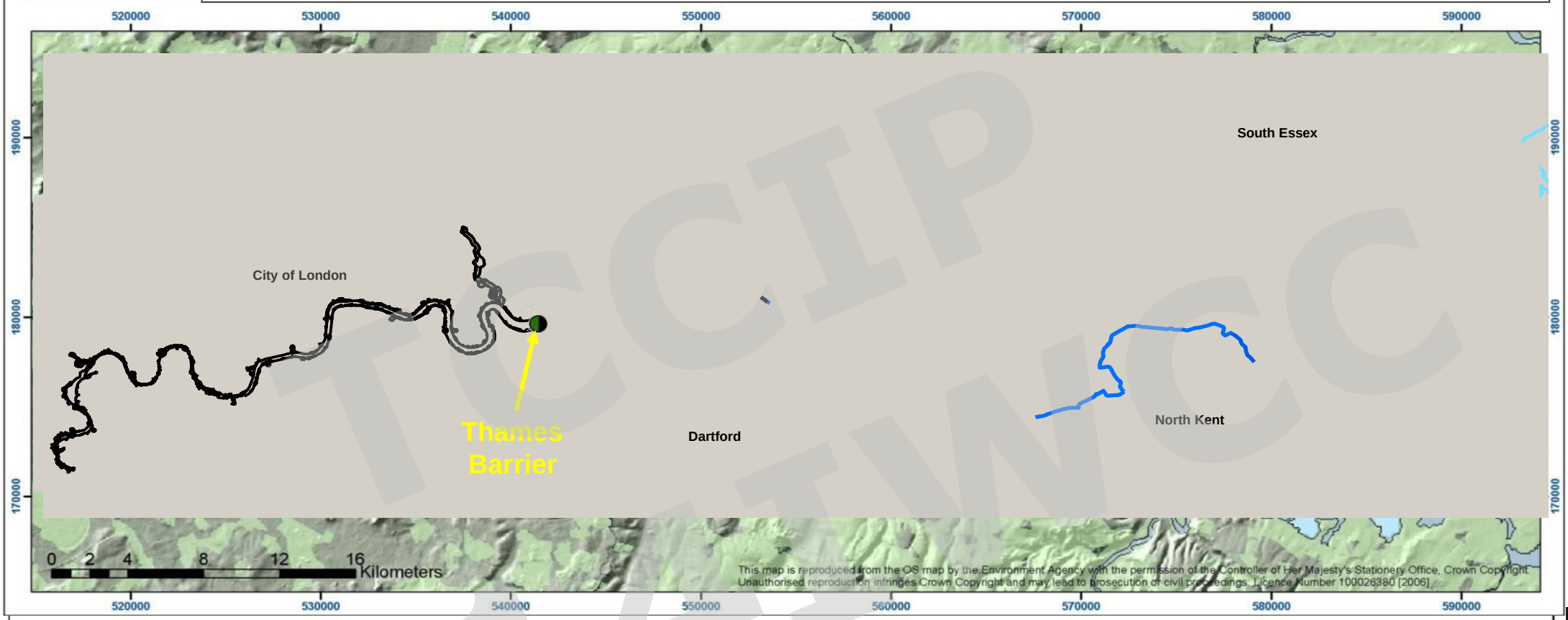


Length of estuary: About 100km
Length of defences: About 350km
Number of properties in floodplains: About 540,000

Flood risk management option



HLO2 - Floodplain storage and raised defences (3 Climate Change Futures)



Time Line - Tidal Flood Management

(Dates apply to High +)

2015

2100

Extreme Flood Extents

Urban Area

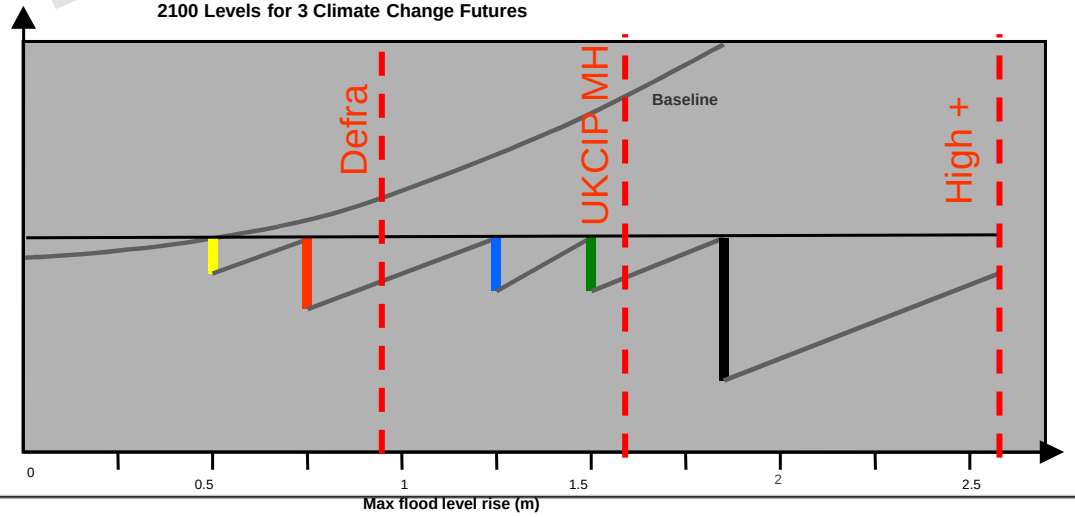
2030
- Managed Realignment
- New Defence
- Raise downriver defences by 0.3m
- Flood Storage
- Flood Storage area if available

2050
- New Defence
- Raise downriver defences, Restore Interim defences
- Flood Storage

2060
- 2060, Over rotate Thames Barrier
- Raise downriver defences by additional 1.5m (

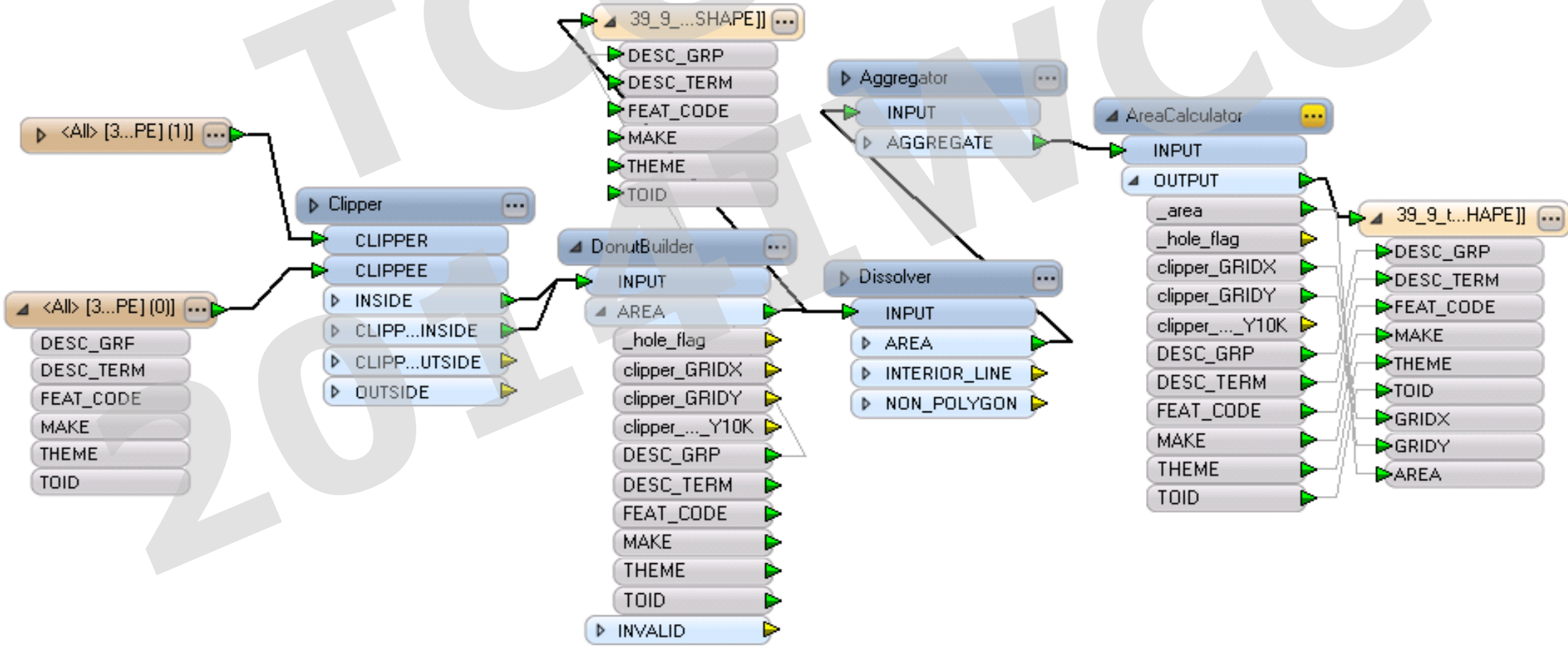
2075
- 2075, Raise upriver defences (total raise of 1m), Raise defences (but covered in 2060)
- 2075, Improve Barrier

2100 Levels for 3 Climate Change Futures



FME – Detailed spatial modelling at a national scale

Workbench and Server used to automate complex spatial processing tasks



From scenarios to probabilistic projections