



Shoreline management in the United Kingdom – a geomorphological & risk management perspective

Coastal resilience: the Environment, Infrastructure & Human Systems

1. Shoreline Management Planning in the UK
... with some geomorphological reflections
2. Resilience, fragility and systems analysis
3. Adaptation

Possible definition of shoreline management ...

*“submitting to chaos and
nevertheless retaining faith in order and meaning”*

(cf. Hermann Hesse, The Glass Bead Game,
comment on studying history)

Resilient? A postcard from England - Dawlish



A bit of recent history ...

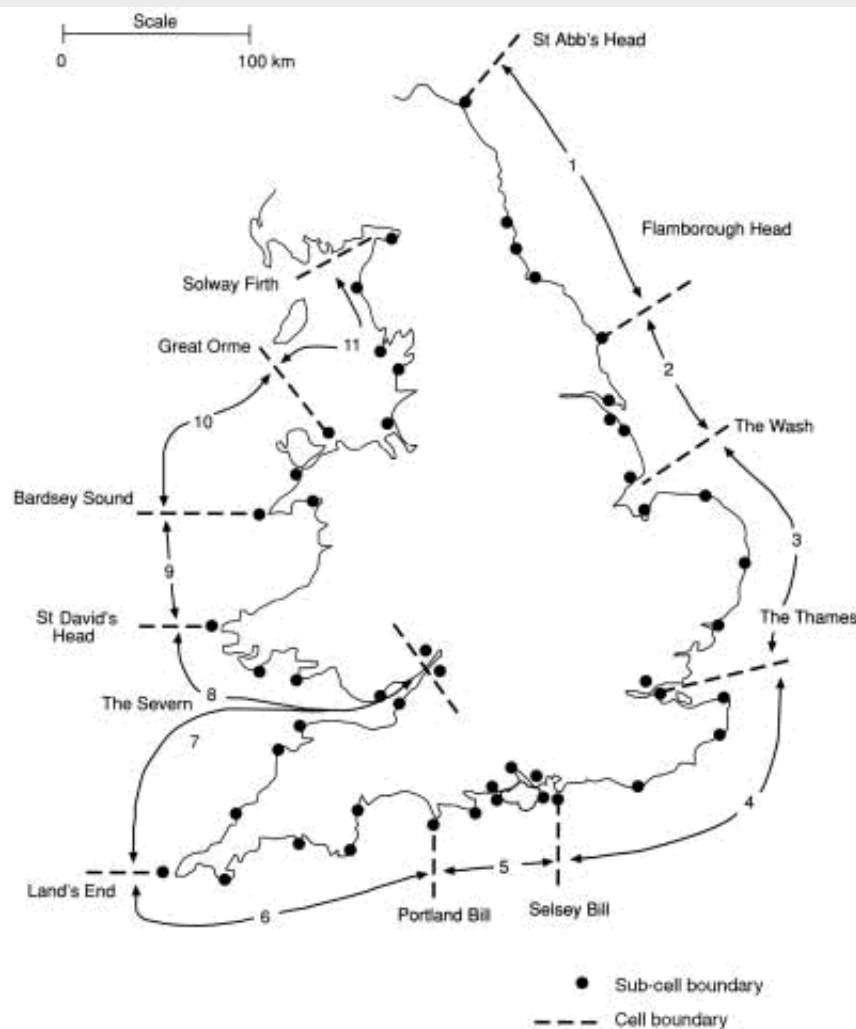
Up to about year 1990, administrative geo-political boundaries were causing irrational and inconsistent management of the UK coast

- Classic example: Chewton Bunny, south coast of England



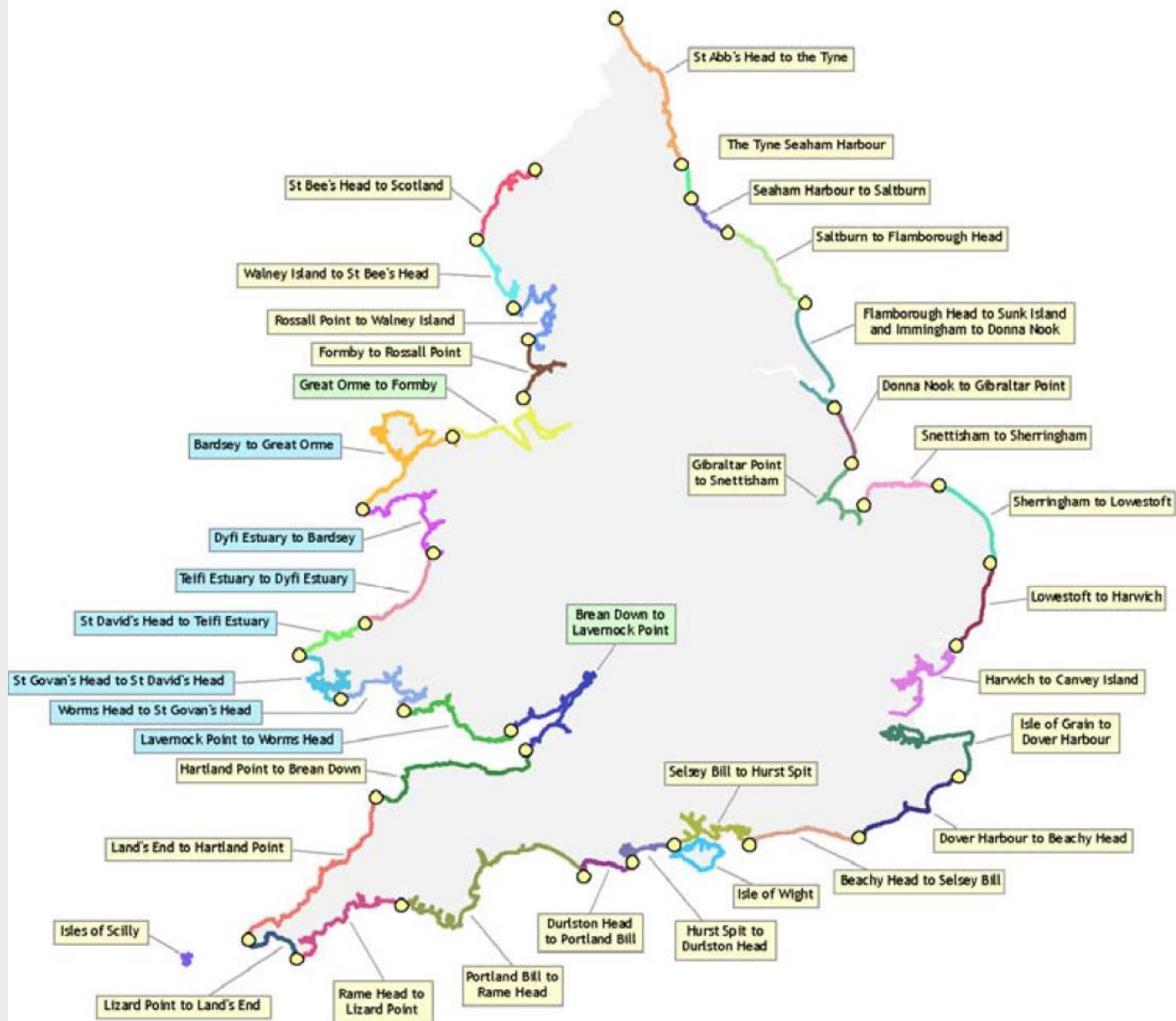
Identification of littoral cells and sub-cells

Motyka & Brampton (1993)



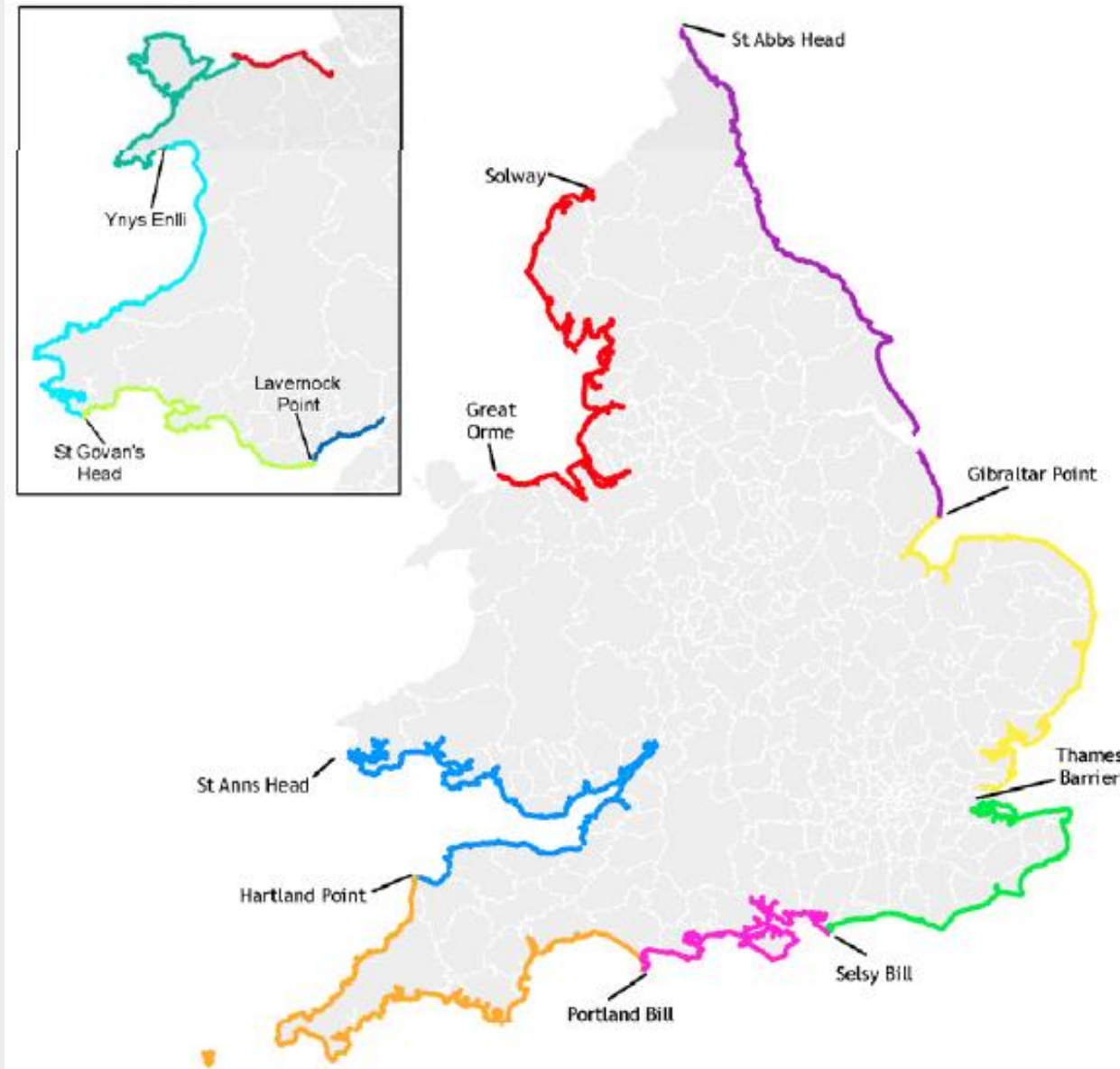
1st Generation Shoreline Management Plans (SMPs)

- Concept introduced by MAFF in 1993, requiring 49 SMPs around the coast of England & Wales, with approximately one SMP per sub-cell
- Guidance was issued and 2 of SMPs in the South East were used as pilots



Coastal Groups formed to support SMP process

- Non-statutory alliances of administrative authorities
- Formed with active encouragement of central government
- Given vision that funding for works would be linked to the new arrangements



The 2nd Generation SMP Pilots should:

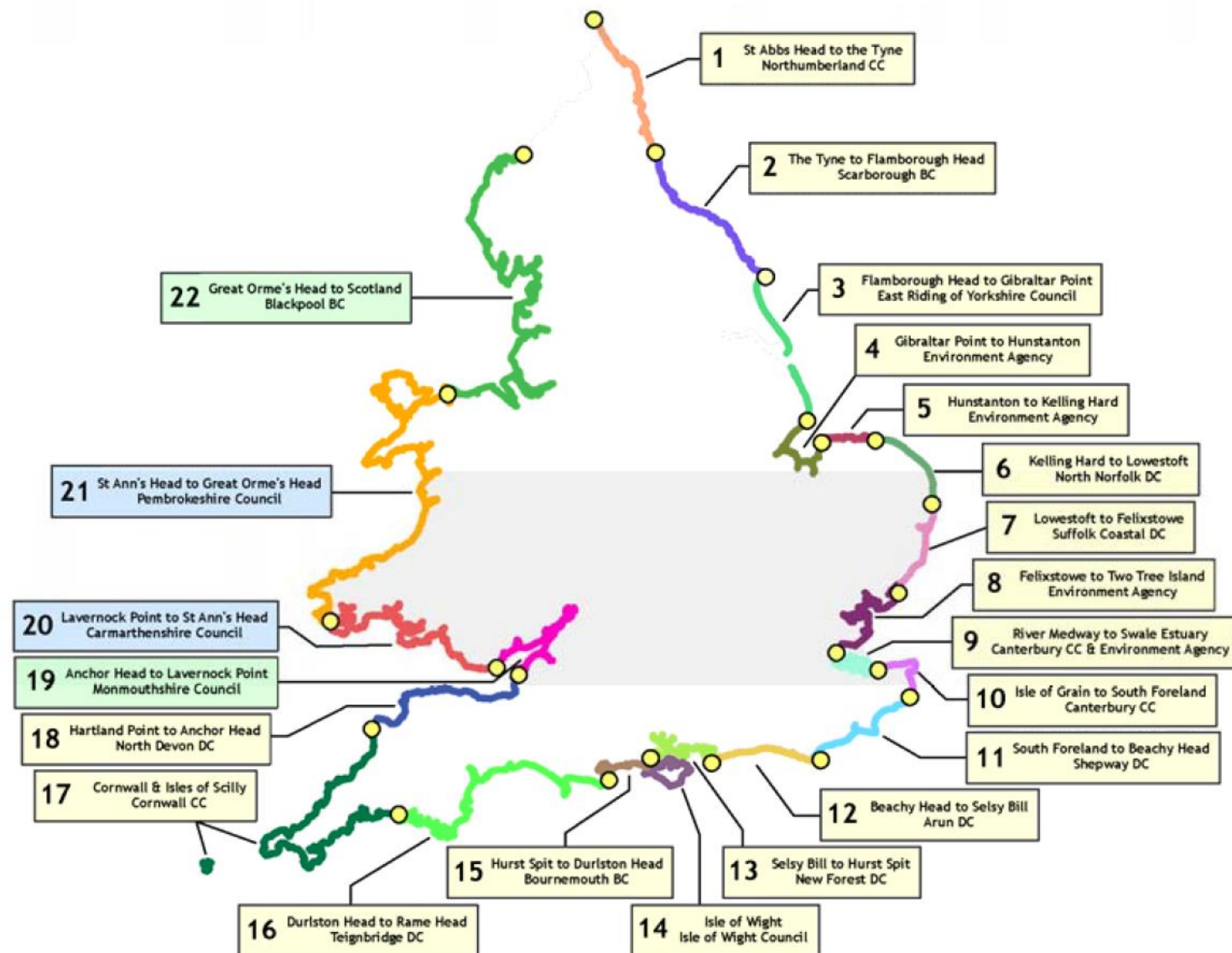
1st generation plans

- inconsistent
- significant imperfections in both content and process
- no benefit from: monitoring data, coastal flooding and erosion modelling, coastal habitat management plans (CHaMPs)

2nd generation plan objectives

- 100 year Timeframe – 3 Epochs (20, 50 and 100 years)
- Policy Units – from policy appraisal – with clear policy options
- Better baseline understanding by Coastal Groups
- Improved consultation / stakeholder engagement
- Consistency in format
- 3 pilots to give clear examples

- Number reduced from 49 to 22 following review of SMP boundaries
- Completed by December 2010
- 4 Policy Options
 - No Active Intervention
 - Hold the Line
 - Advance the Line
 - Managed Realignment



Outcomes

- Improved baseline understanding
- Each SMP fully integrated with adjoining SMPs
- Format easy to review with improved transparency & auditability and hence increased confidence
- Greater involvement and acceptance by Stakeholders
- Contain an Action Plan (reviewed regularly)

Status

- Non Statutory
- Feed into Long Term Investment Strategy and Medium Term Plans
- Set the scene for future studies, strategies and research
- Should feature in Local Development Framework (statutory)

iCOASST next generation vision

1. **Integrated understanding of estuary, coast and offshore systems** previously considered in isolation;
2. **Formalised knowledge of system linkages** at scales (decades to centuries; 10s to 100s km) relevant to understanding and predicting climate change impacts;
3. Coastal area models used to understand **multi-scale transport pathways** for both non-cohesive and cohesive sediments;
4. **New generation of coupled landform behaviour models** within **robust computational and uncertainty frameworks**.

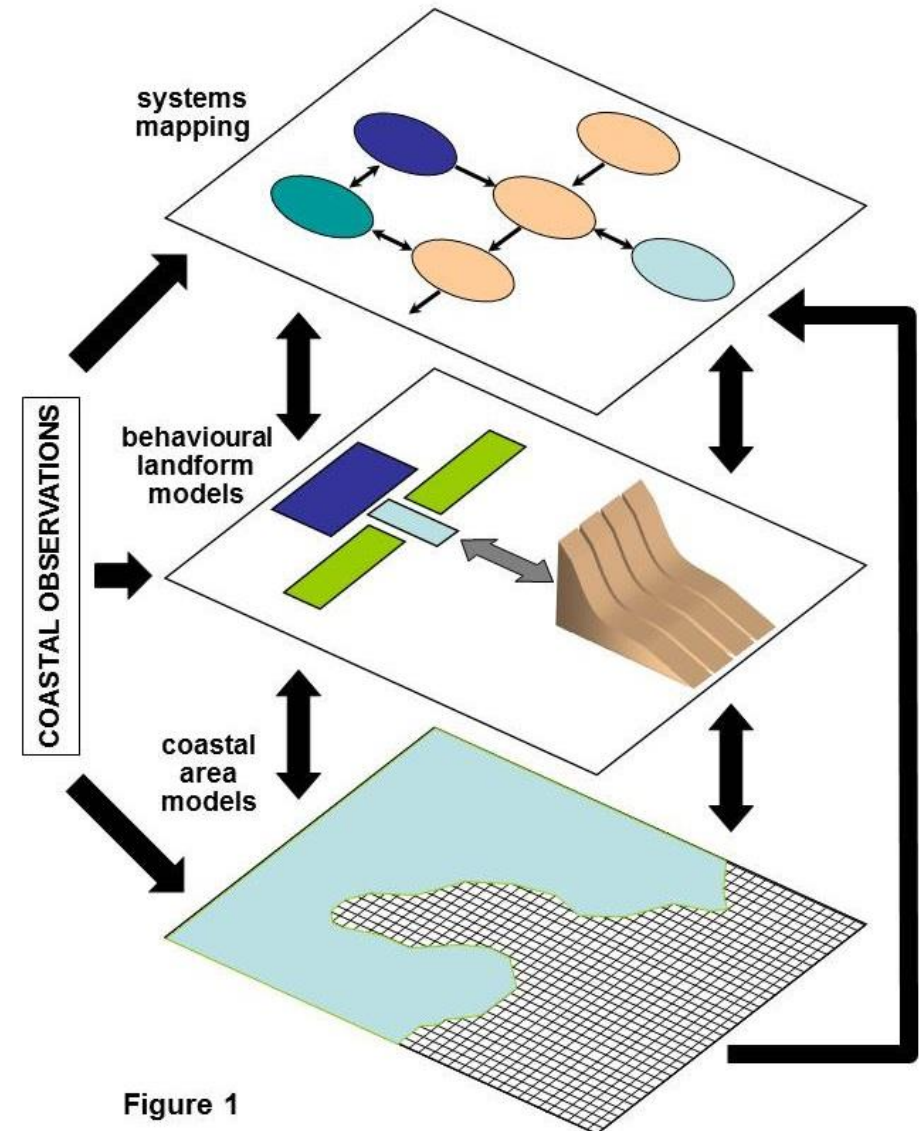
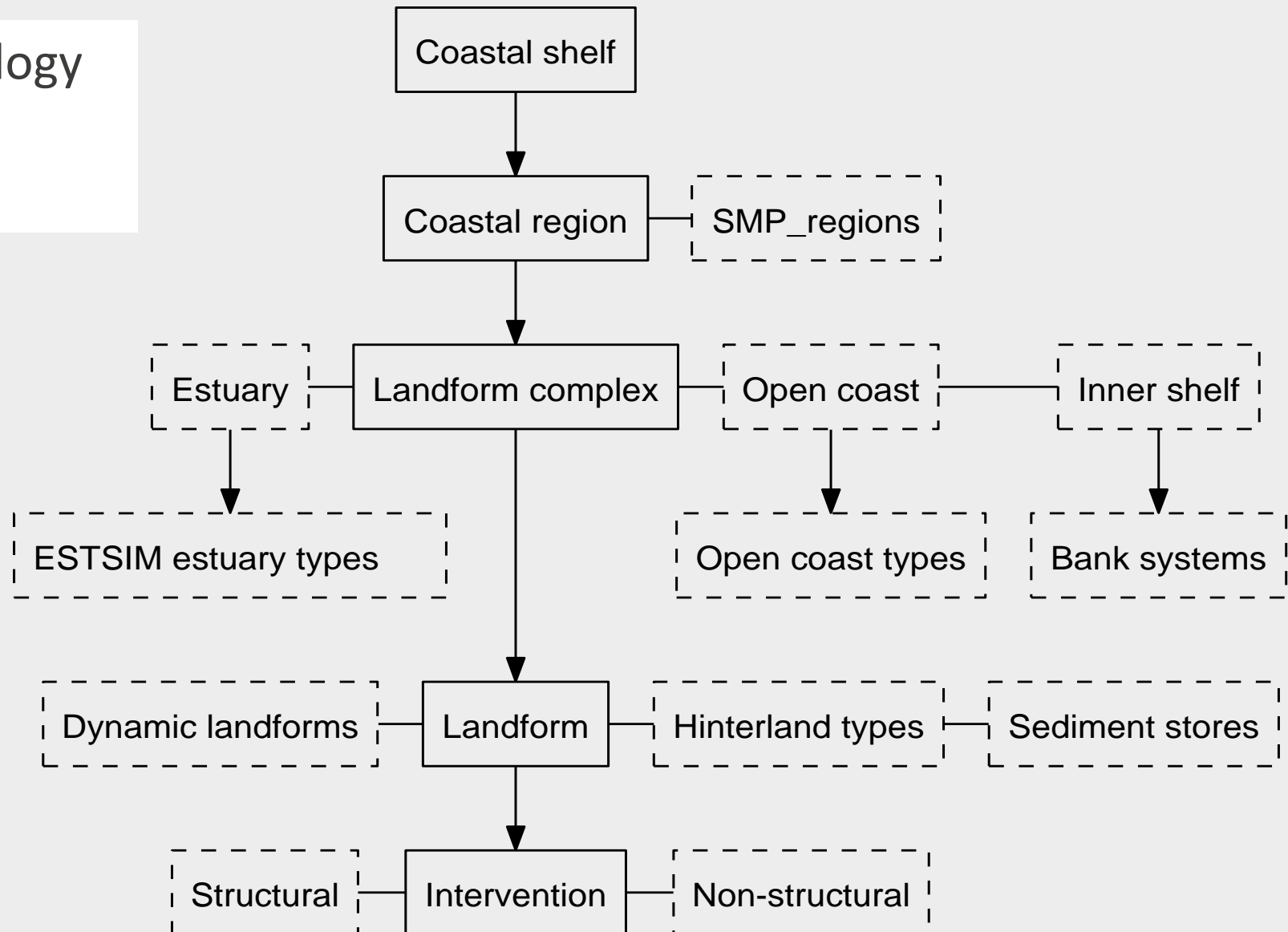


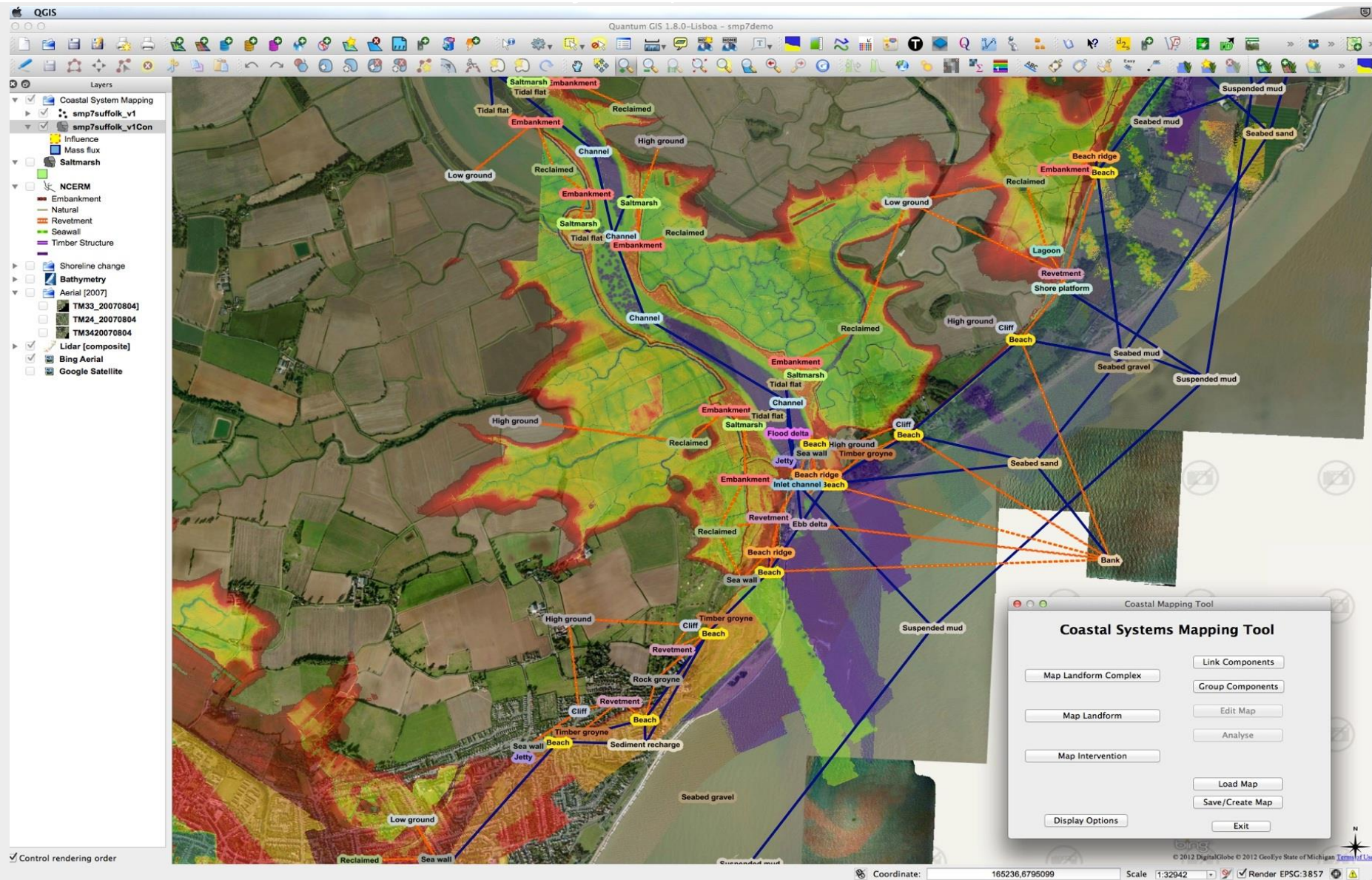
Figure 1

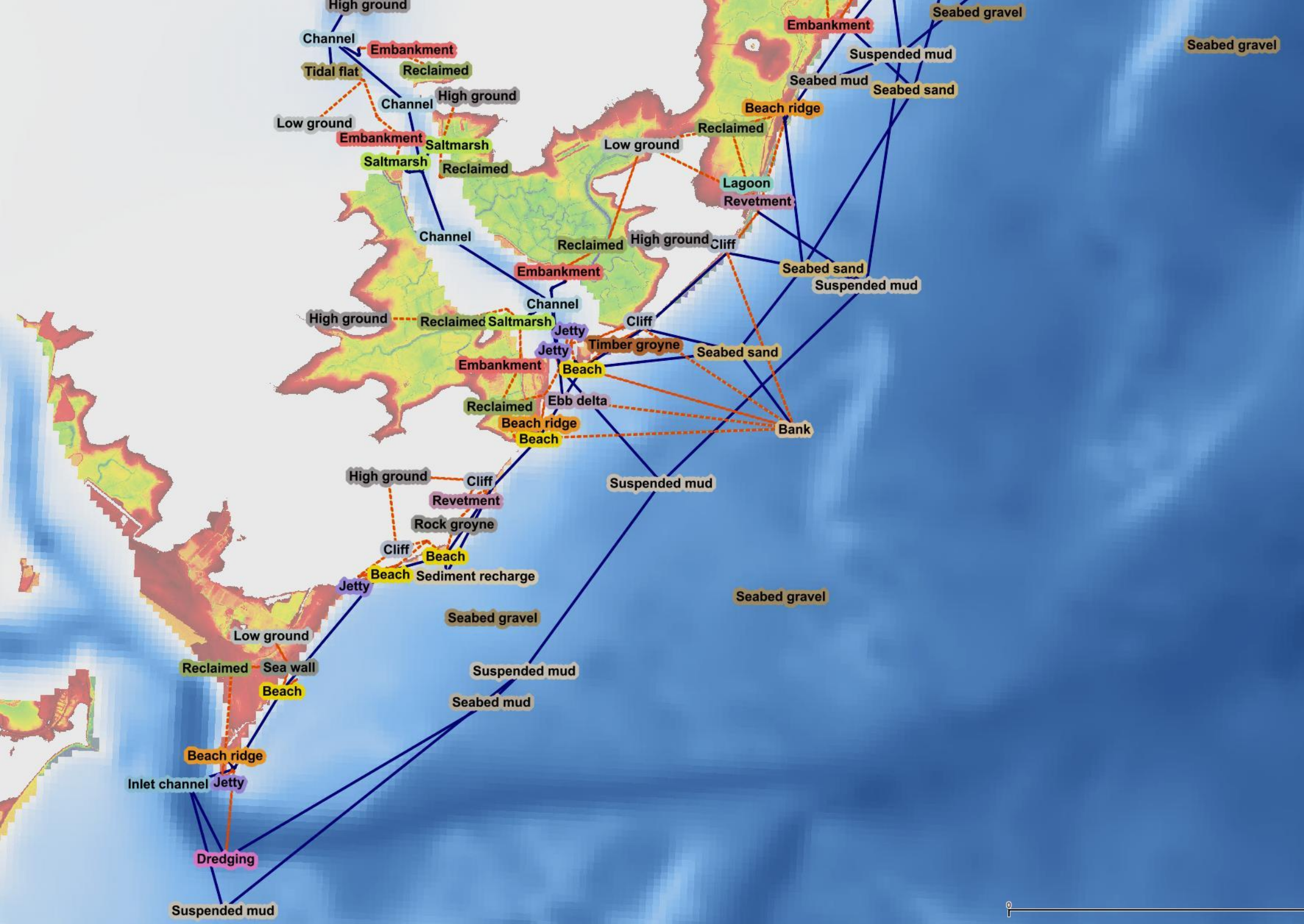
Estuary-coast-inner shelf system ontology

iCOASST ontology
v1.3
(UCL, WP 1.2)



iCOASST system mapping tool (QGIS)

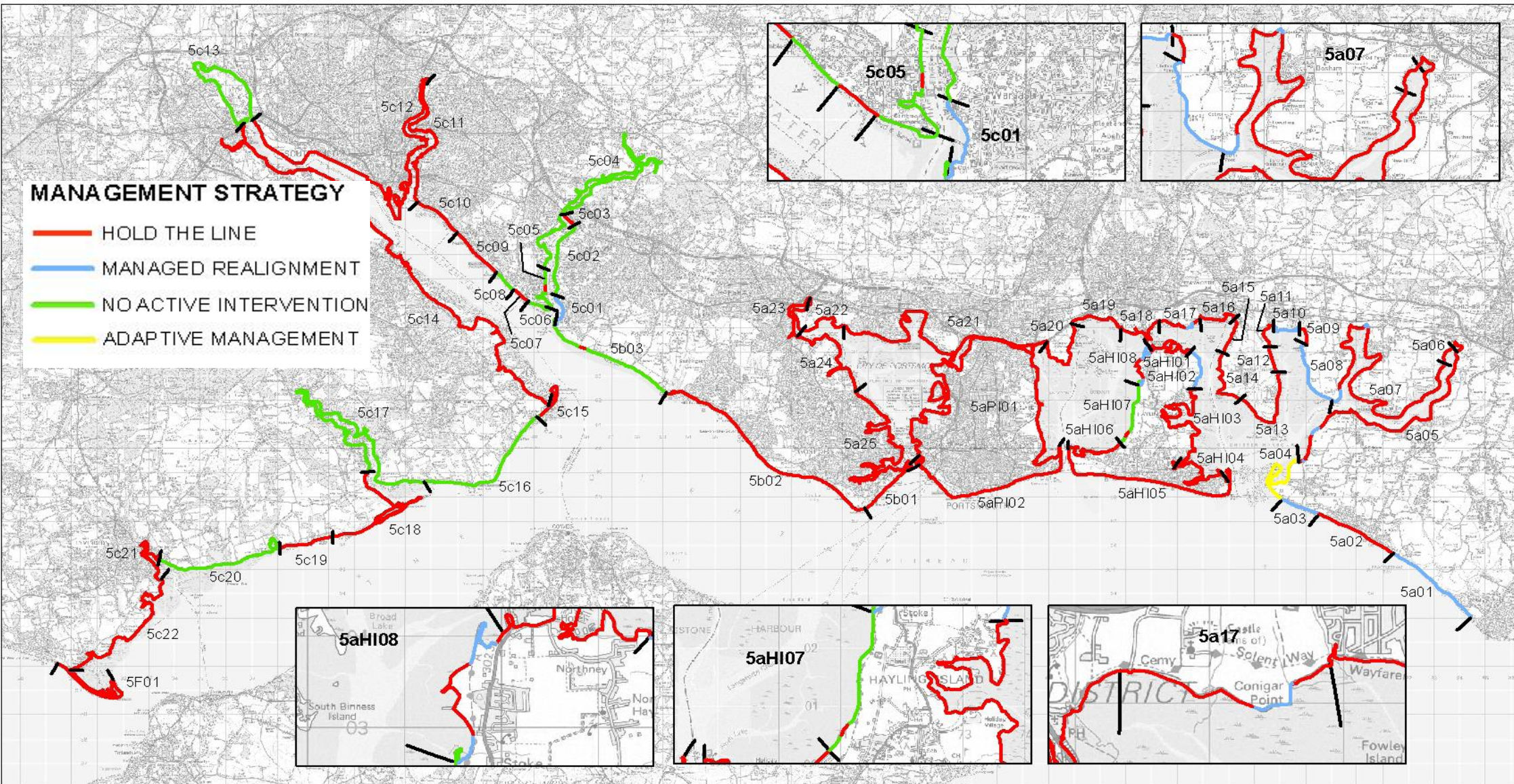




SMP illustration: Solent, England



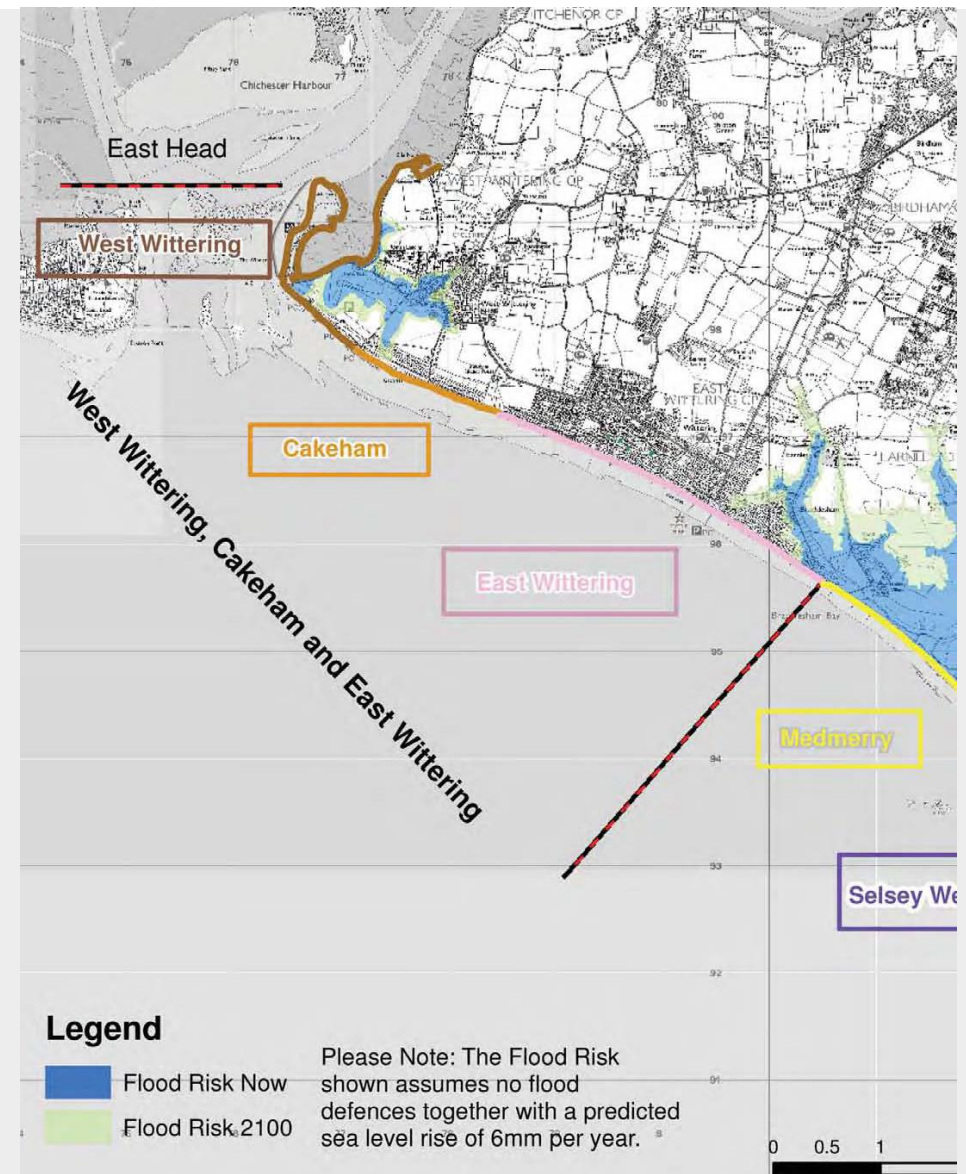
North Solent SMP: 0 – 20 years



Rationale behind proposed policy options

Example: East Head area, Hampshire

Adaptive management practices will become increasingly important for the future of this unit, not only to conserve its environmental, amenity and socio-economic values but also to manage the effects of coastal process on the wider harbour which is **designated as environmentally important** for a number of national and international features and is also an Area of Outstanding Natural Beauty.



Rationale behind proposed policy options

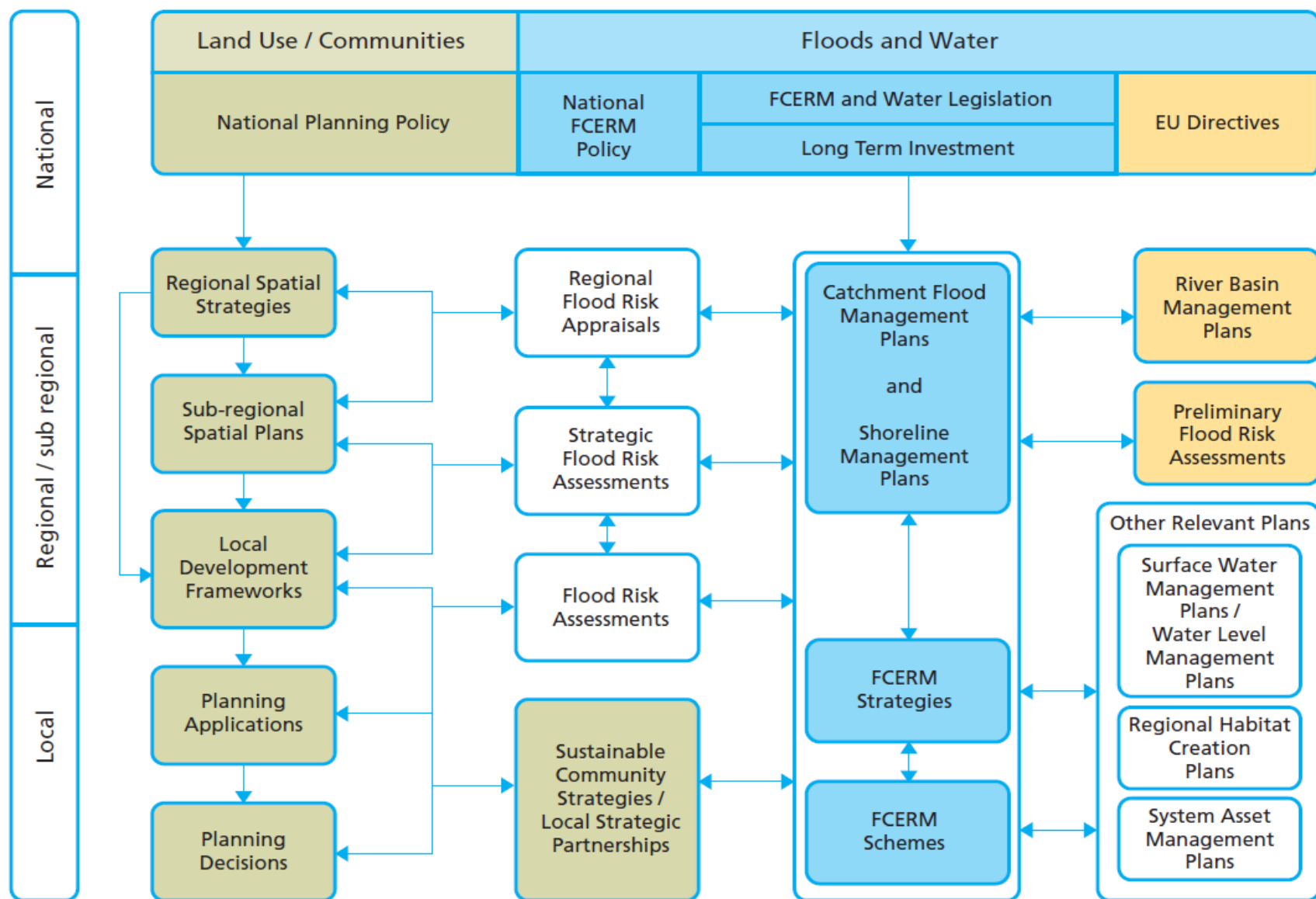
Example (contd.): East Head area, Hampshire

Ongoing coastal monitoring, defence maintenance and recycling activities will be required to maintain the integrity of the system at East Head spit. To manage the flood risk to West Wittering Village new flood defences will also need to be constructed ...

Although discounted as not economically viable, there is a potential opportunity for localised habitat creation at West Wittering, currently behind privately maintained defences. Secondary defences would be required to manage flood risk but losses of designated coastal grazing marsh would need to be recreated at a more sustainable site elsewhere. This localised option could only be realised with landowner consent. It is likely that a change in defence management in the longer-term may be required. Rights of private owners to maintain their defences remain.

It is unlikely that central government funding would be secured for adaptive management but likely for flood bunds at West Wittering ... No public funding would be available for continued maintenance of defences by private owners.

Relationship between various UK plans, strategies & schemes



National network of regional coastal monitoring programmes

Programmes generally include:

- Establishment and maintenance of a control network
- Beach profiles/topographic data
- Bathymetric data
- Wave and tidal measurements
- Aerial survey and LIDAR
- Ecological mapping



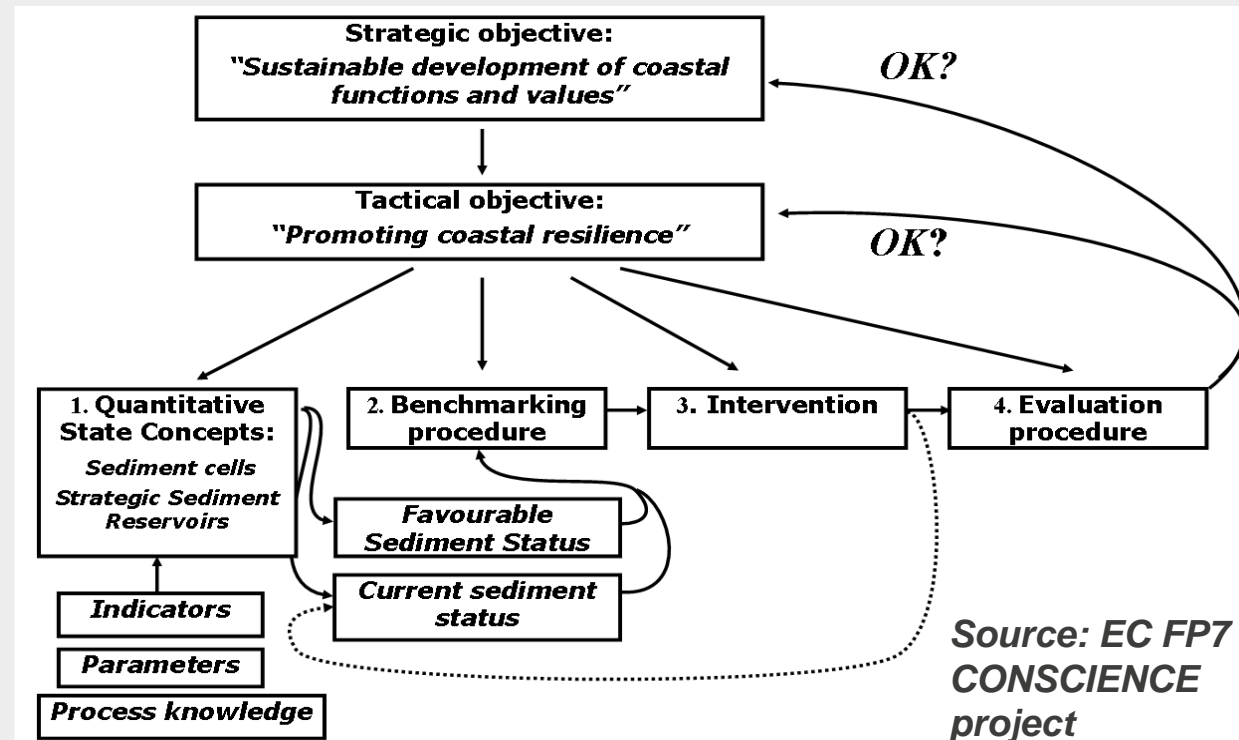
Coastal State Indicators (CSIs) for functional performance of coastal systems

Coastal State Indicators

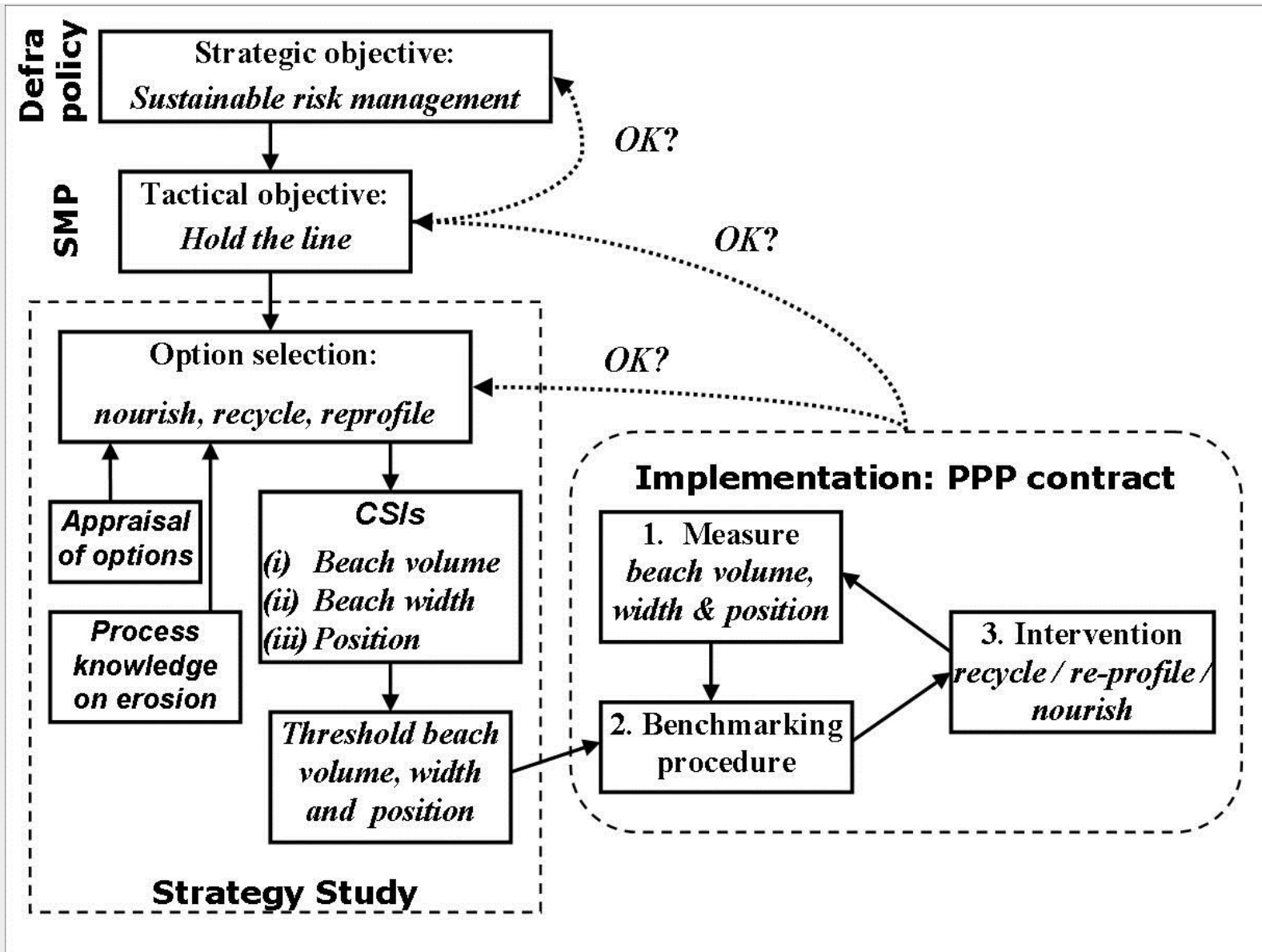
- “a reduced set of parameters that can simply, adequately and quantitatively describe the dynamic-state and evolutionary trends of a coastal system.”
(Jiménez and van Koningsveld, 2002)

Functions of Coastal State Indicators:

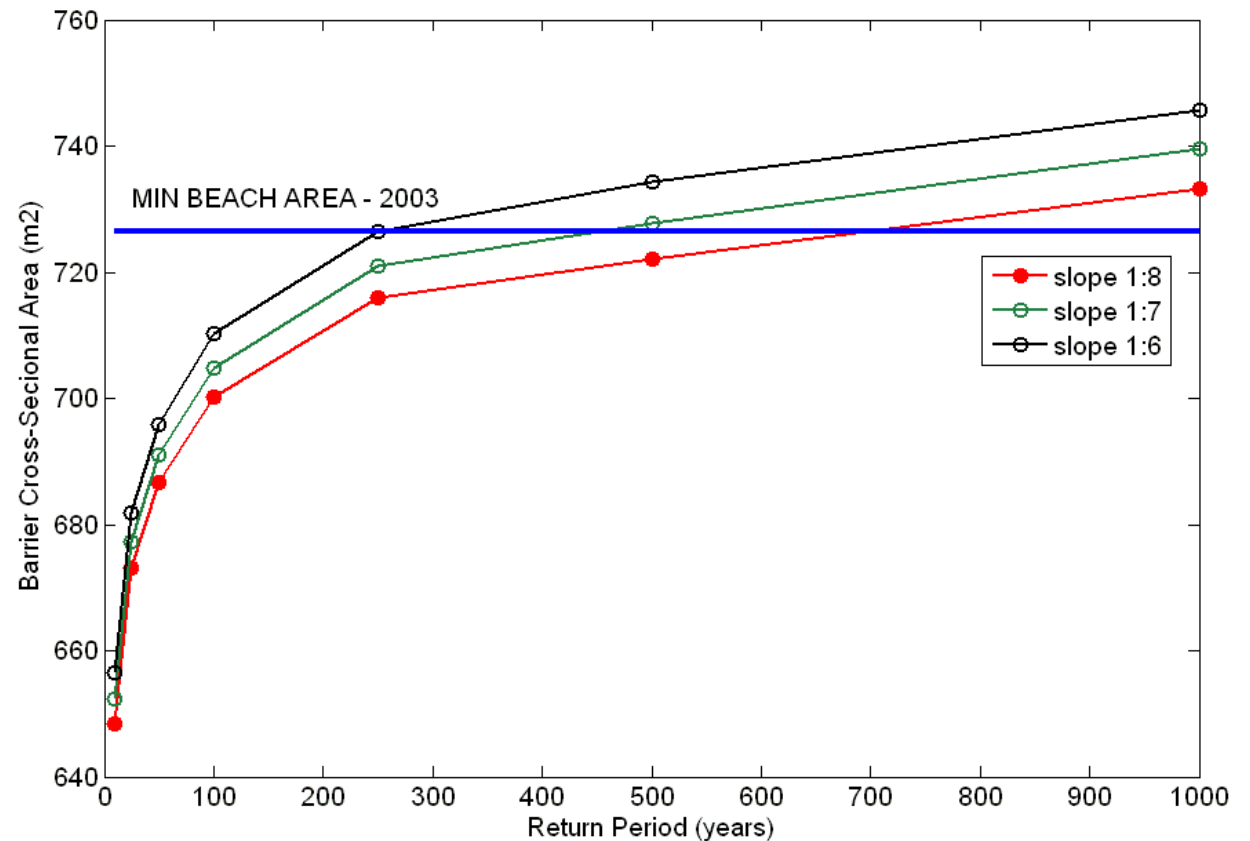
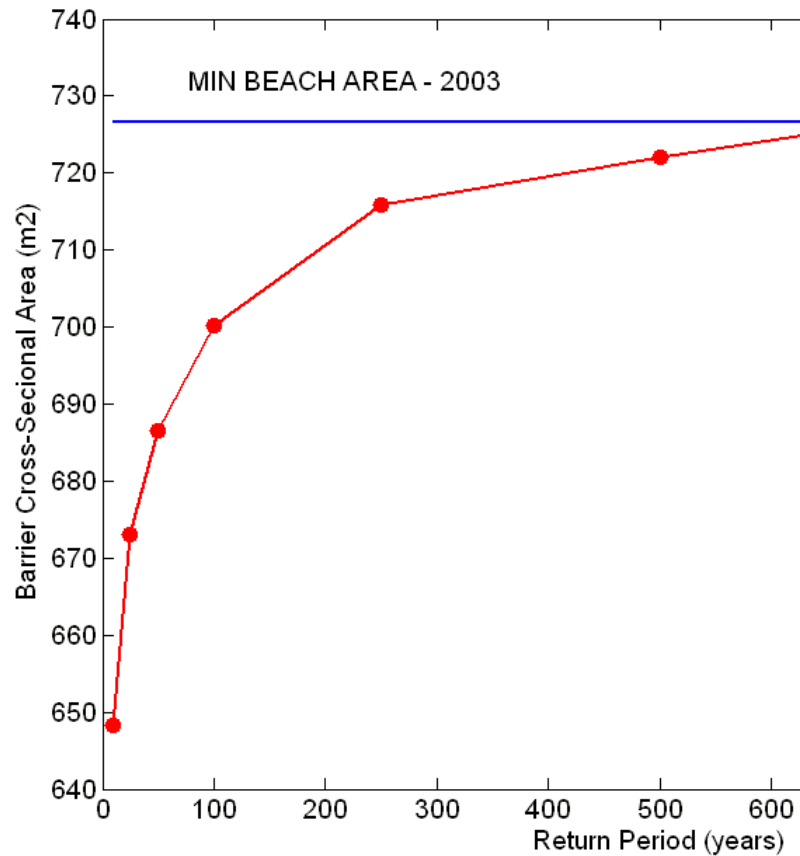
- Assess condition of environment
- Compare across situations
- Monitor trends
- Diagnose problems
- Anticipate need for intervention



Coastal State Indicators UK example - Pevensy

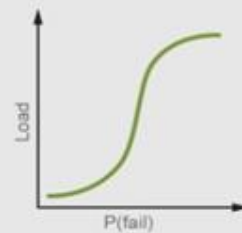


Example of UK CSI at Pevensy: shingle beach area





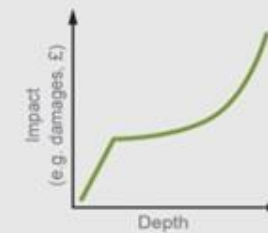
Source
Extreme distribution of in-channel water levels or coastal overtopping



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



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

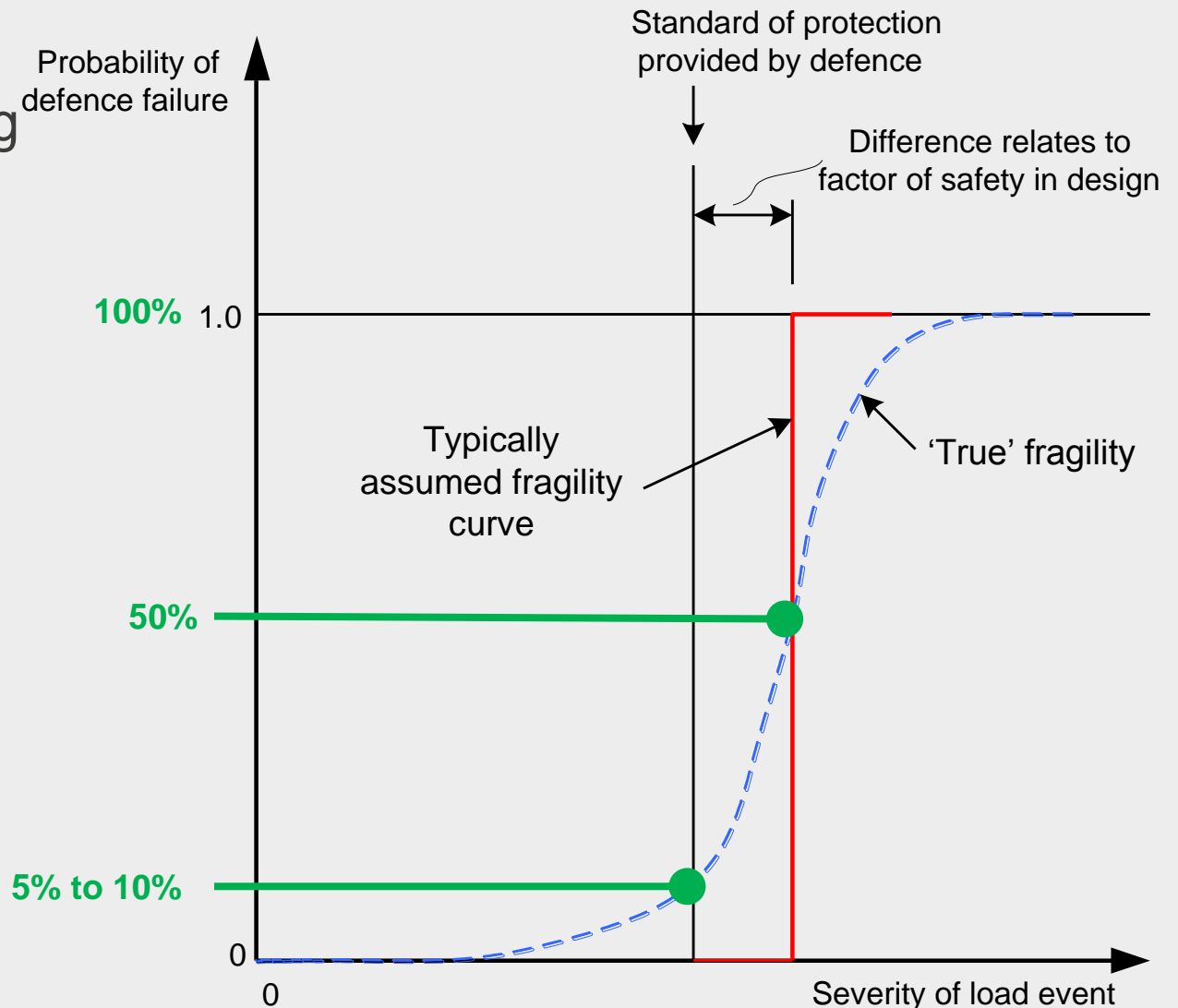


Consequences
Flood damage or harm related to depth. Risk is assessed by the probability that particular damage values are exceeded.

Fragility curves – a resilience measure

Fragility curves

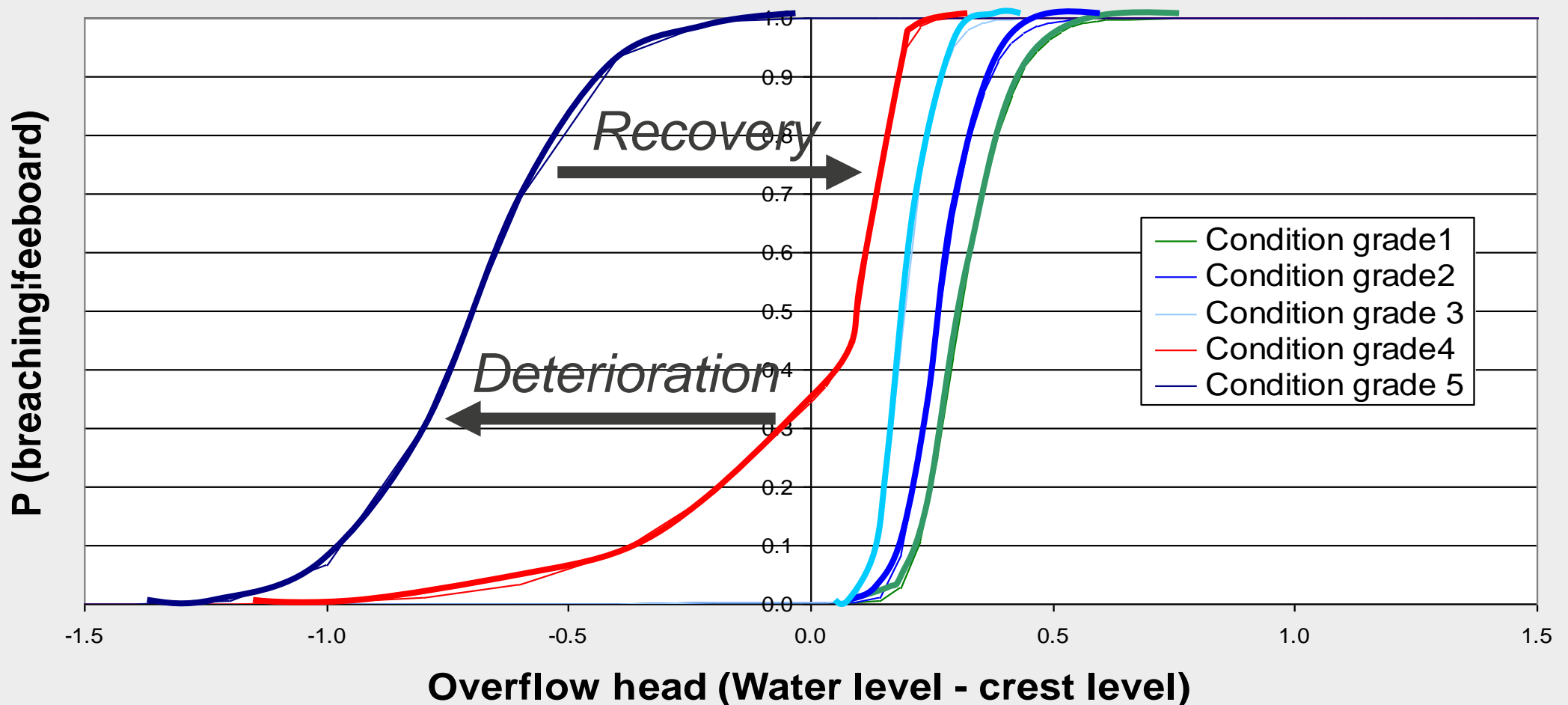
- Express resilience as a varying probability of failure with load
- Allow inclusion of defence performance in flood systems analysis
- Can be generalised for broad scale or bespoke for local system or individual asset
- Allows the inclusion of expert judgement
- Deterioration in coastal defences can be captured as changes in the fragility curves



Fragility curves and resilience

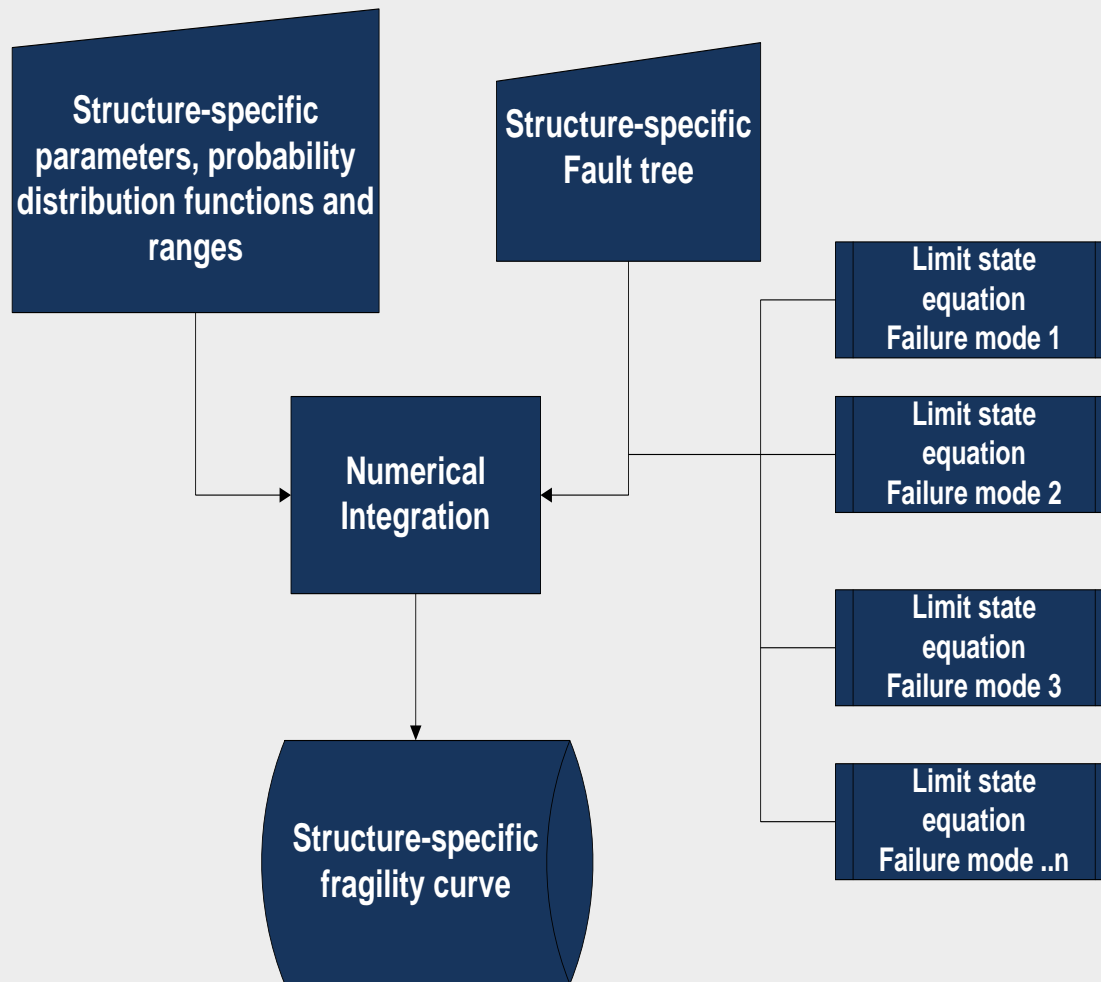
Single fragility curves expresses *resistance* probabilistically

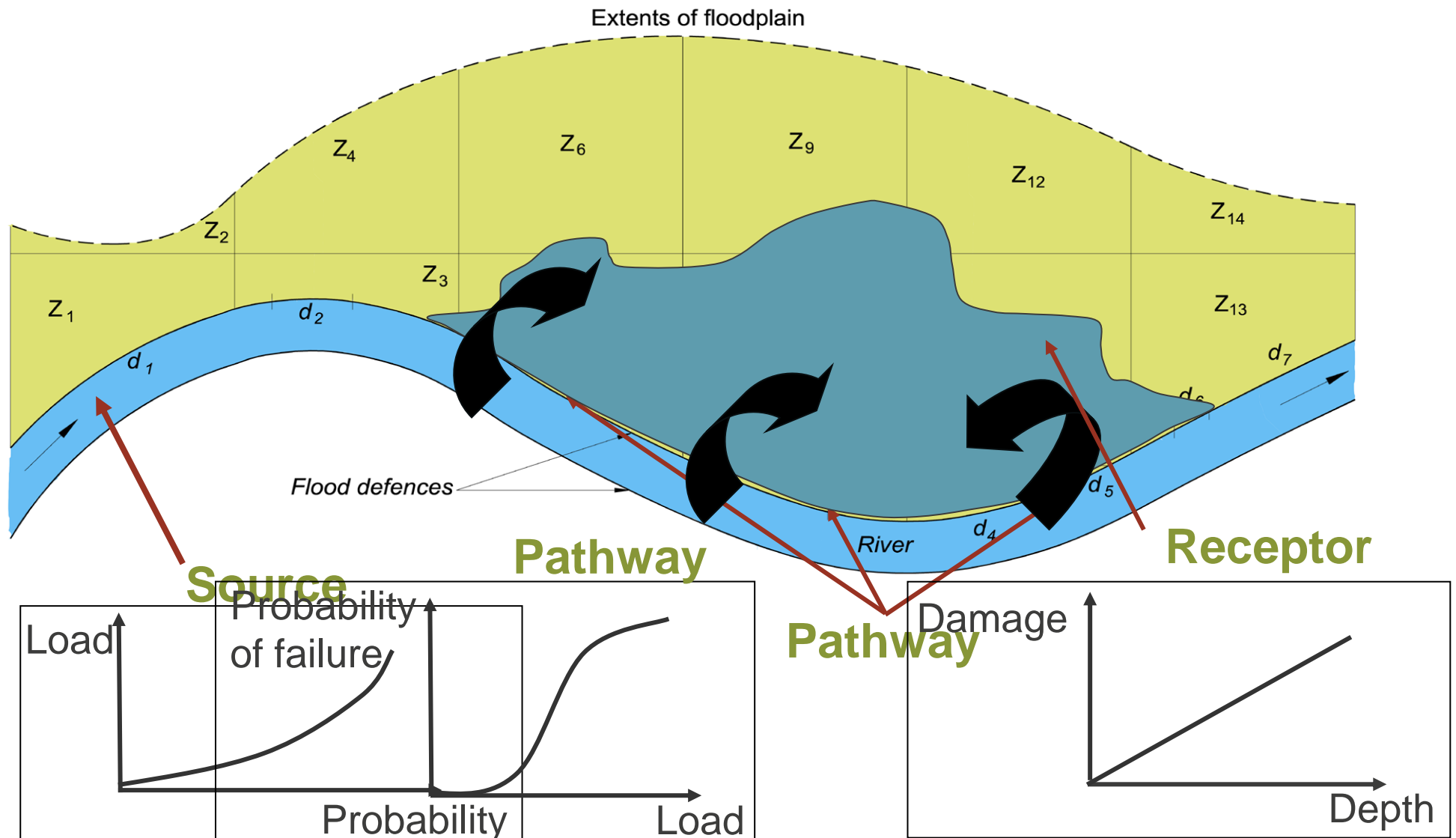
Moving between curves expresses deterioration or repair/recovery



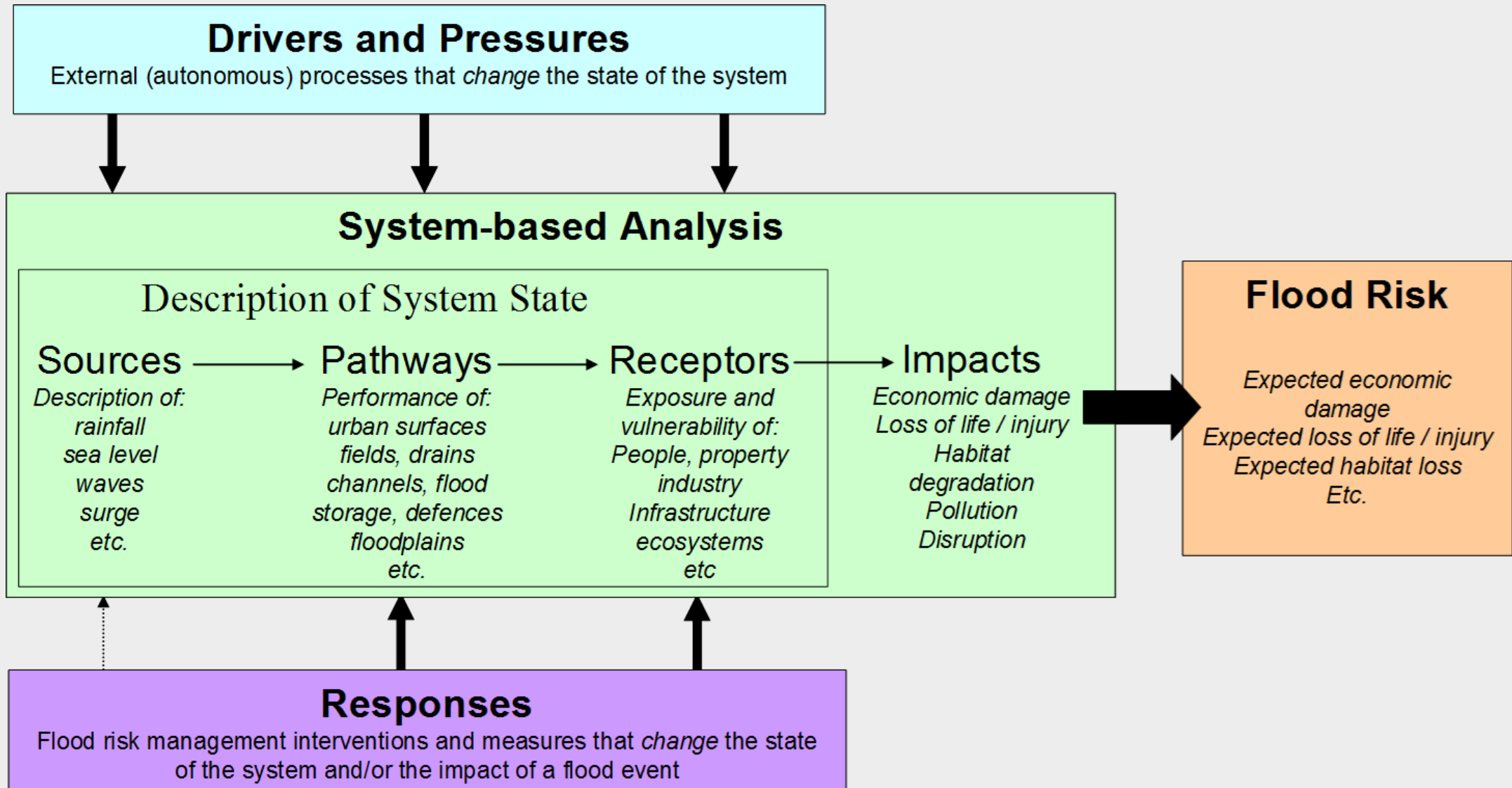
Fragility curves - bespoke

- Identify failure modes
- Identify Limit State Equations (LSE's)
 $Z \text{ (reliability)} = R \text{ (strength)} - S \text{ (loading)}$
- Schedule parameters and uncertainties
- Prepare fault tree
- Perform many reliability analyses, for a single hydraulic loading across a range of parameter uncertainties (i.e. Monte-Carlo sampling). For each loading analysed, the probability of failure is the proportion of times that $Z < 1$.
- Repeat for other hydraulic loadings and plot the resulting fragility curve





Pressures and responses on flooding system



Humber Estuary, England



Estuary mouth driven by mean level rise (surge tide) & waves

**Estuary mouth –
driven by mean sea
level rise (surge &
tide) & waves**

Humber - probability of flooding

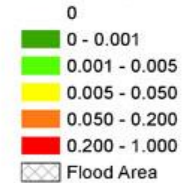
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Humber Estuary

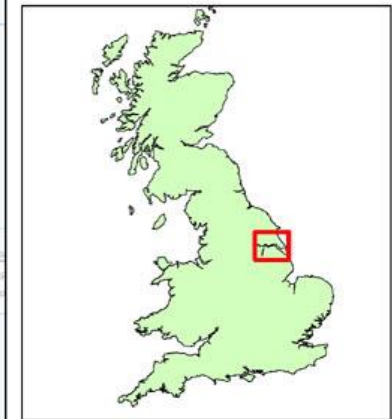
Strategy modelling - Maintain 2115

November 2010

Probability of flooding



0 2.5 5 10
Km



HR Wallingford Ltd, Howbery Park,
Wallingford, Oxon, OX10 8BA, UK.
Tel: +44 (0) 1491 835381
www.hrwallingford.co.uk

Humber - risk

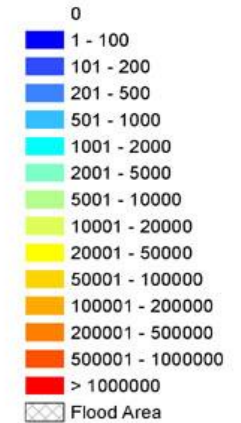
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Humber Estuary

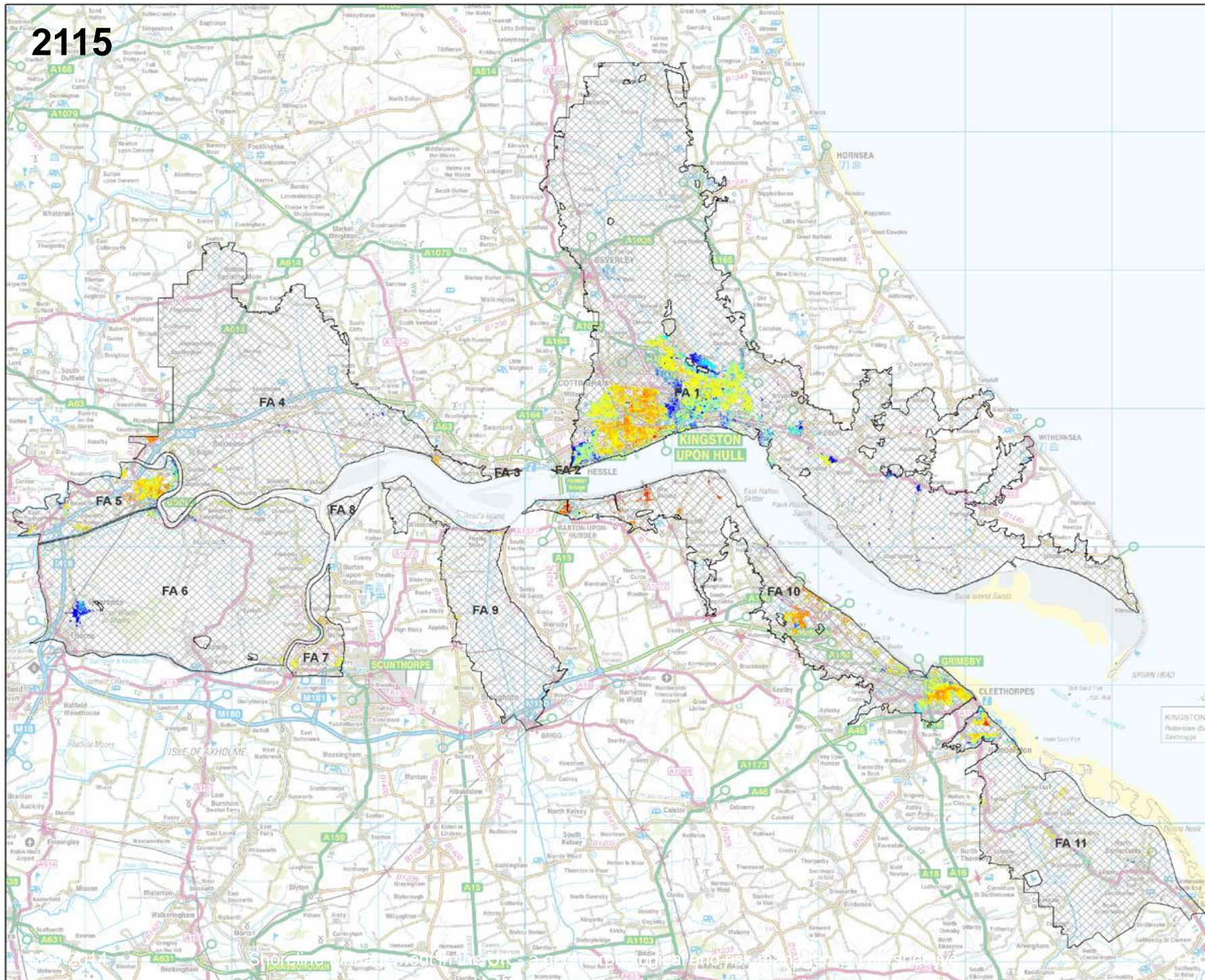
Strategy modelling - Maintain 2115

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Total Risk (£)



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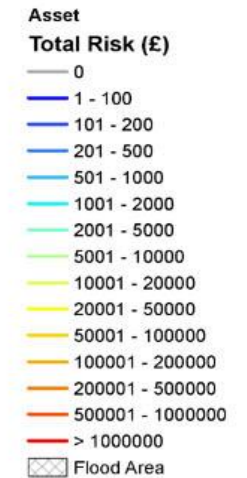
Humber - risk attribution to levees

2115

Humber Estuary

Strategy modelling - Maintain 2115

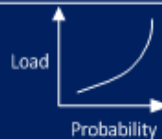
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UK approach vs FEMA LAMP

SYSTEMS FLOOD RISK ANALYSIS (FRE MODEL)

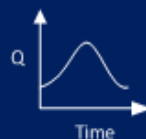
Hydraulic loading:
Full distribution of loads



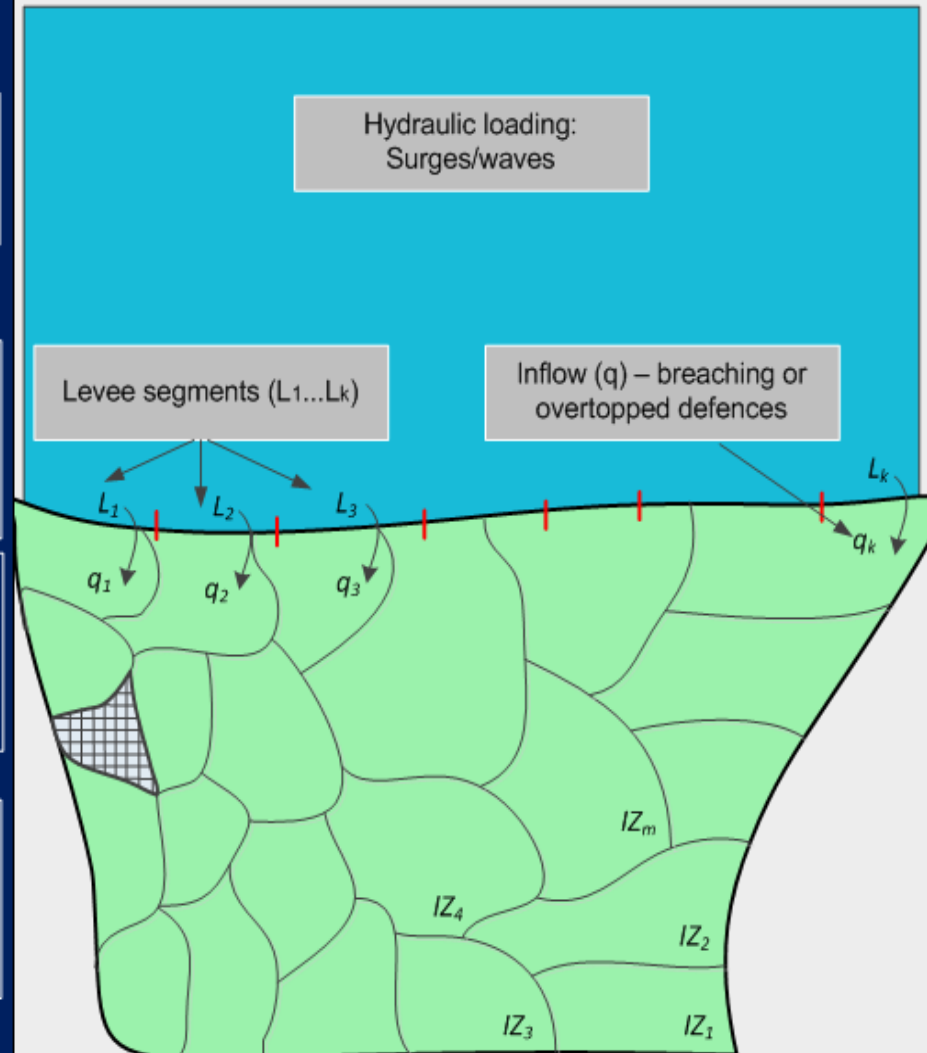
Levee Performance:
Full fragility curve for each defence segment



Breach representation:
Inflow hydrographs for all levee reaches for full distribution of hydraulic loads

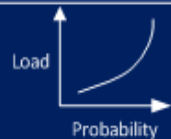


Inundation simulation:
Simulations of multiple breach scenarios and full distribution of hydraulic loads



LAMP

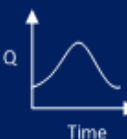
Hydraulic loading:
1% loading level



Levee Performance (only SIP):
Probability of failure at 1% level



Breach representation (only SIP):
Inflow hydrographs 1% hydraulic load (+ sensitivity)

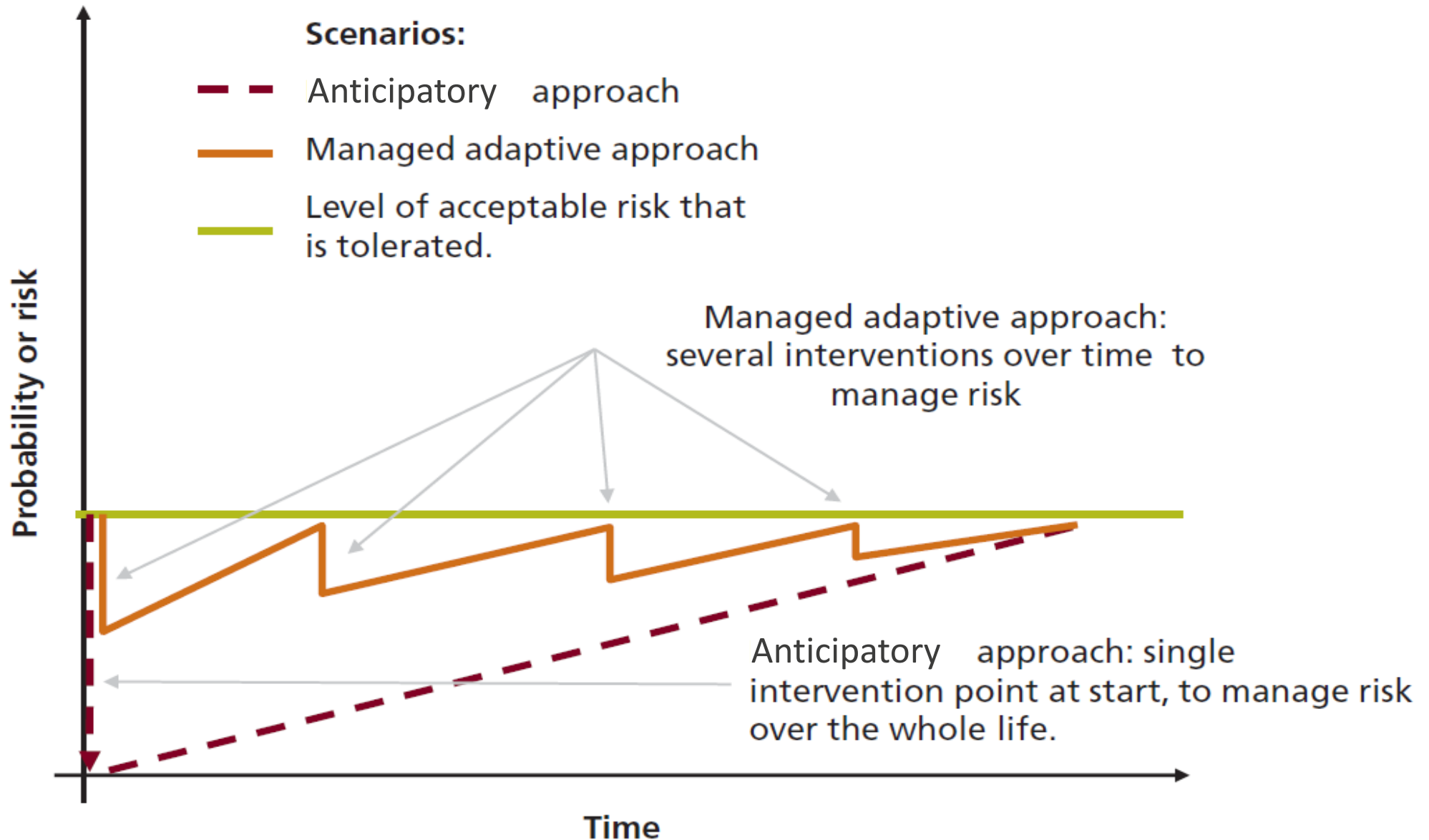


Inundation simulation:
1% load

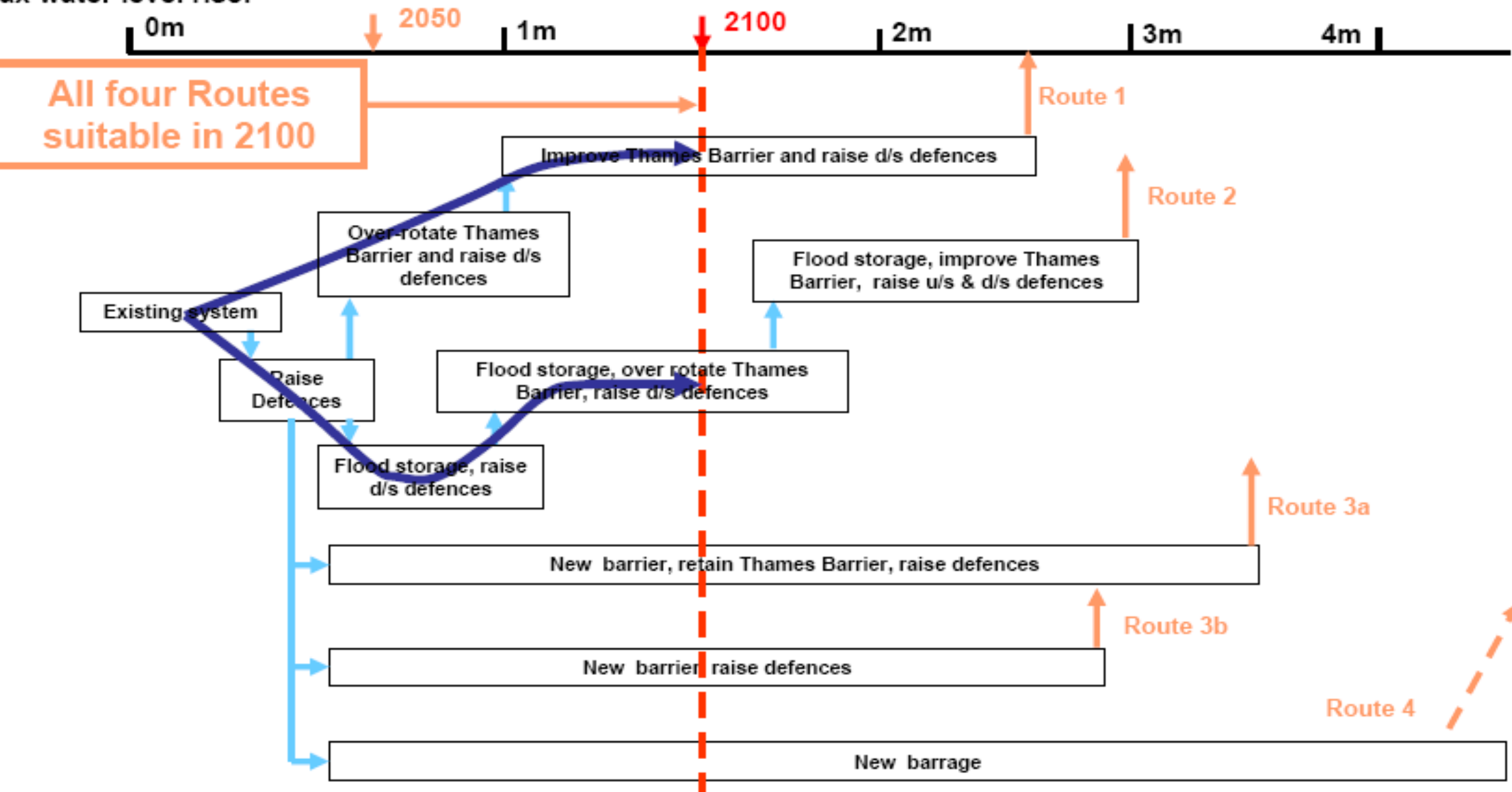
Resilient? a final English postcard – the Thames Barrier



Anticipatory vs managed adaptive approaches



Max water level rise:



Alternative Routes for achieving the plan

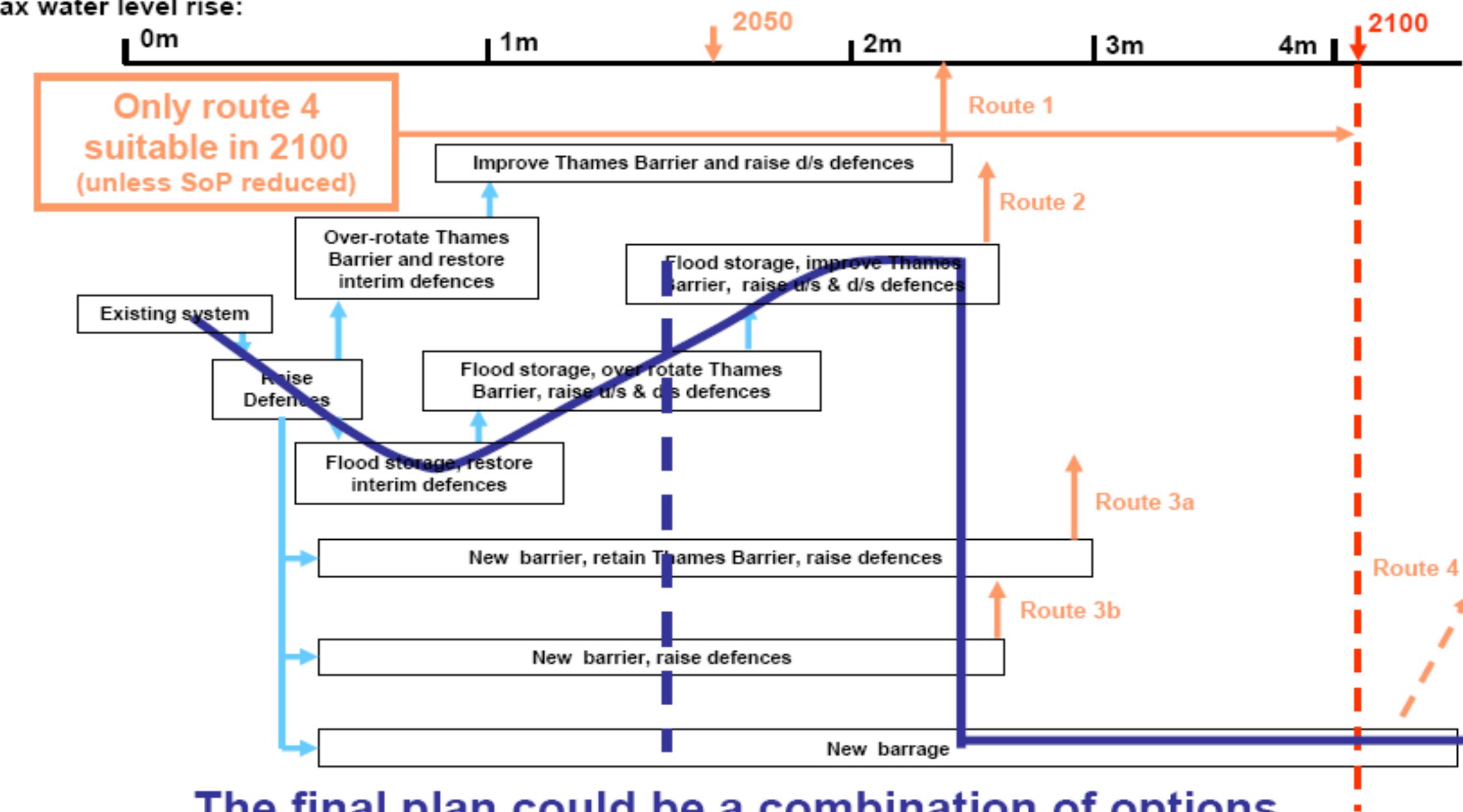
Note:

Each box represents one or more portfolios of responses

The arrows indicate paths for adapting options for different sea level ranges

Medium High Climate
Change Scenario

max water level rise:



The final plan could be a combination of options

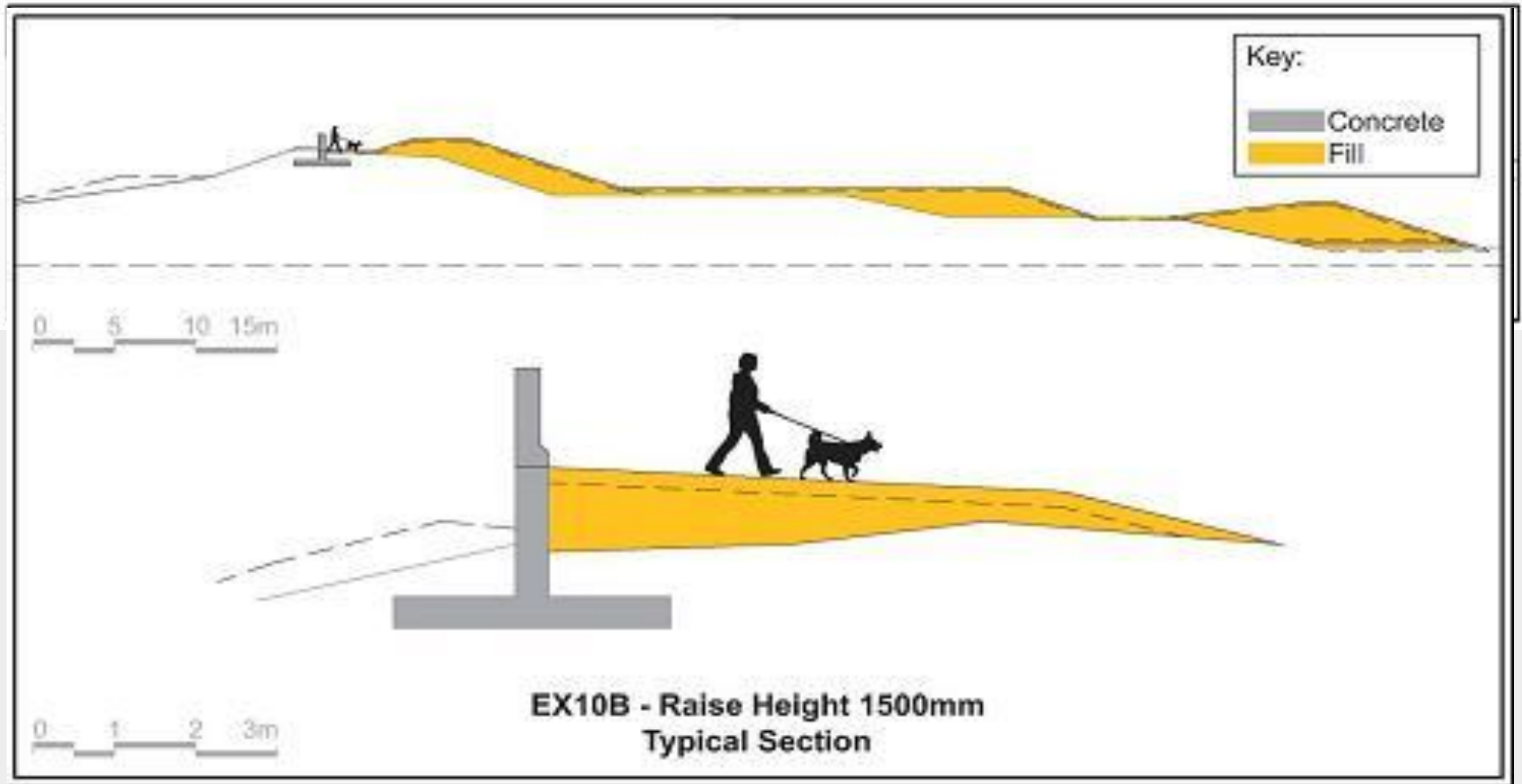
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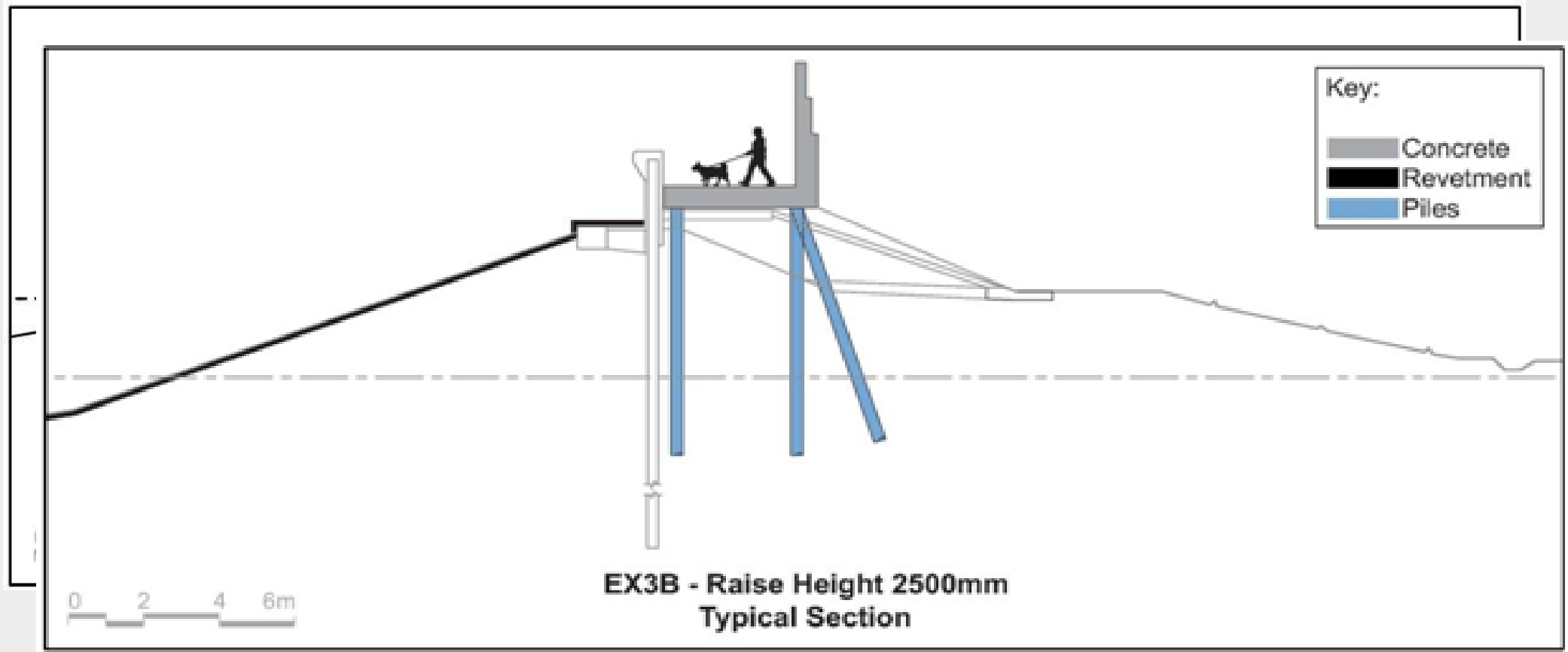
The arrows indicate paths for adapting options for different sea level ranges

**High++ Climate
Change Scenario**

Adapting Thames levee to SLR



Adapting Thames levee to SLR

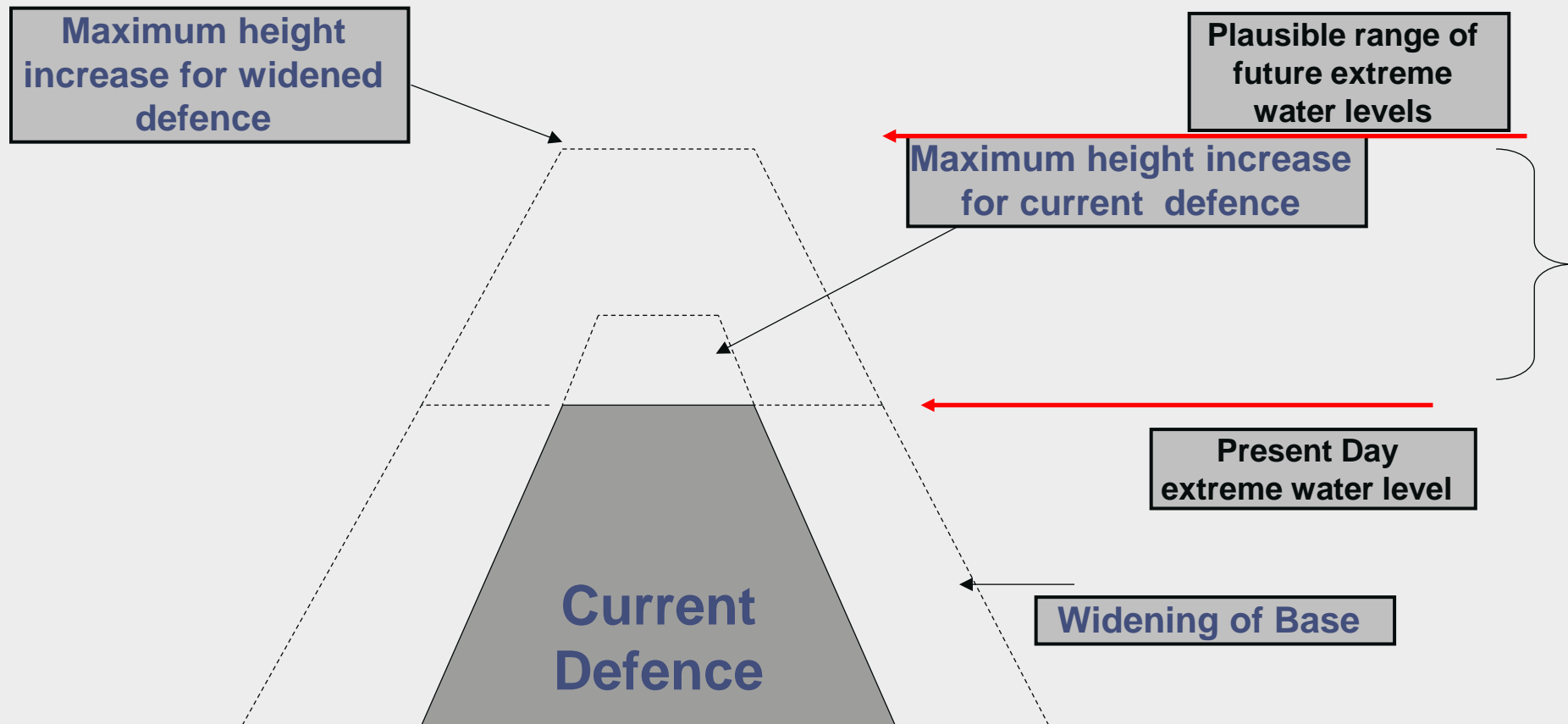


Accounting for the Effects of Climate Change

June 2009

Supplementary Green Book Guidance

“A Real Option is a choice that becomes available through an investment opportunity or action”





HR Wallingford
Working with water



Questions?

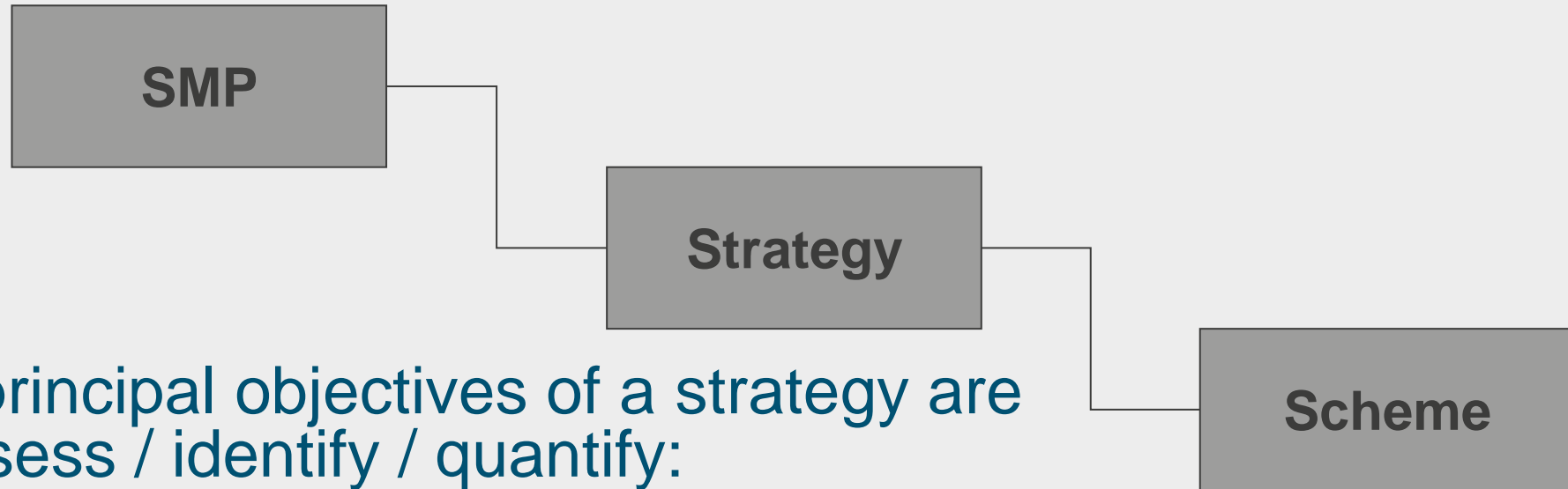
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May 2014
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The principal objectives of a strategy are to assess / identify / quantify:

- Sustainability of the SMP management policies (producing alternatives where necessary)
- Locations where managed intervention may be required
- Current condition & future performance of existing coastal defences
- Erosion/flood risk attached to each management option
- Implications of environmental legislation through preparation of Strategic Environmental Assessment
- Fully costed programme of priority works for first 5 years

Outputs - risk attribution to levees in detail

