HR Wallingford
Working with water

UK fragility curve developments

Jonathan Simm, Jim Murphy (AECOM). Greg Frank (Costello)

ASFPM Phoenix, June 2018

Presenter: Ben Gouldby

Overview of presentation

1. Context setting

2. Hierarchical approach (National to local scale)

3. Further developments

Context setting

HR Wallingford
Working with water

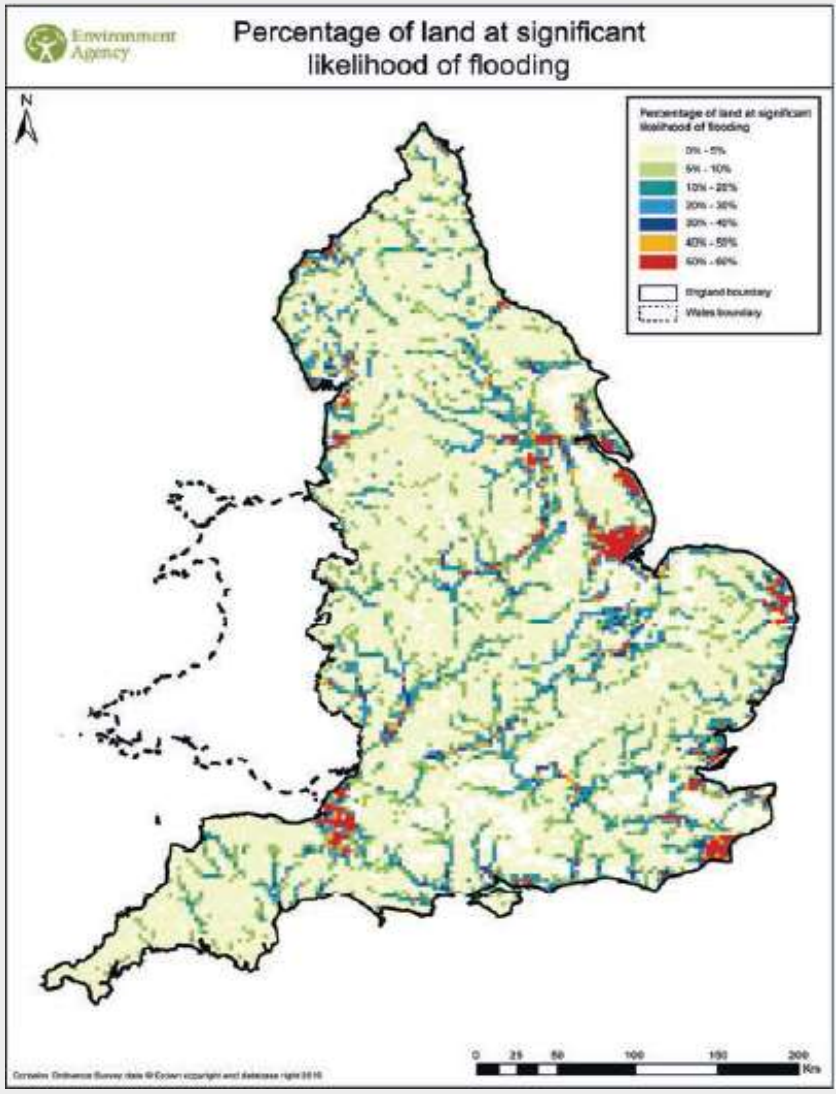
Context

Country or state	Population (million)	Land area ('000 miles^2)	Population per mile^2
USA	323	3806	85
Arizona	7.0	114	61
Texas	27.9	269	103
California	39.2	164	240
Florida	20.6	59	350
North Carolina	10.2	54	190
Virginia	8.1	43	190
England	55.0	50	1,100

Flood defences in England

Approx 9000 km of raised flood defences, i.e. levees and flood walls (National Strategy, 2011)

- Defences reduce chance of flooding for many of the 2.4m households at risk of fluvial & coastal flooding, e.g. in winter floods 2013/14:
  - 11,000 properties flooded
  - 1.4m properties protected



UK - a history of flooding

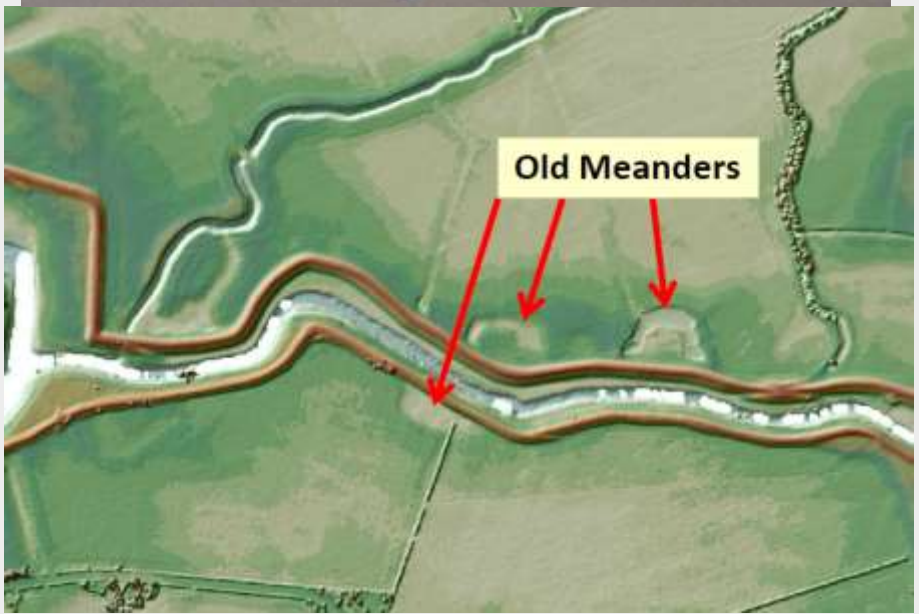
Over last 20 years, major flood events in:

- 1998 – 2000 – 2002 – 2005 – 2007 – 2012 – 2013/14 – 2015/16

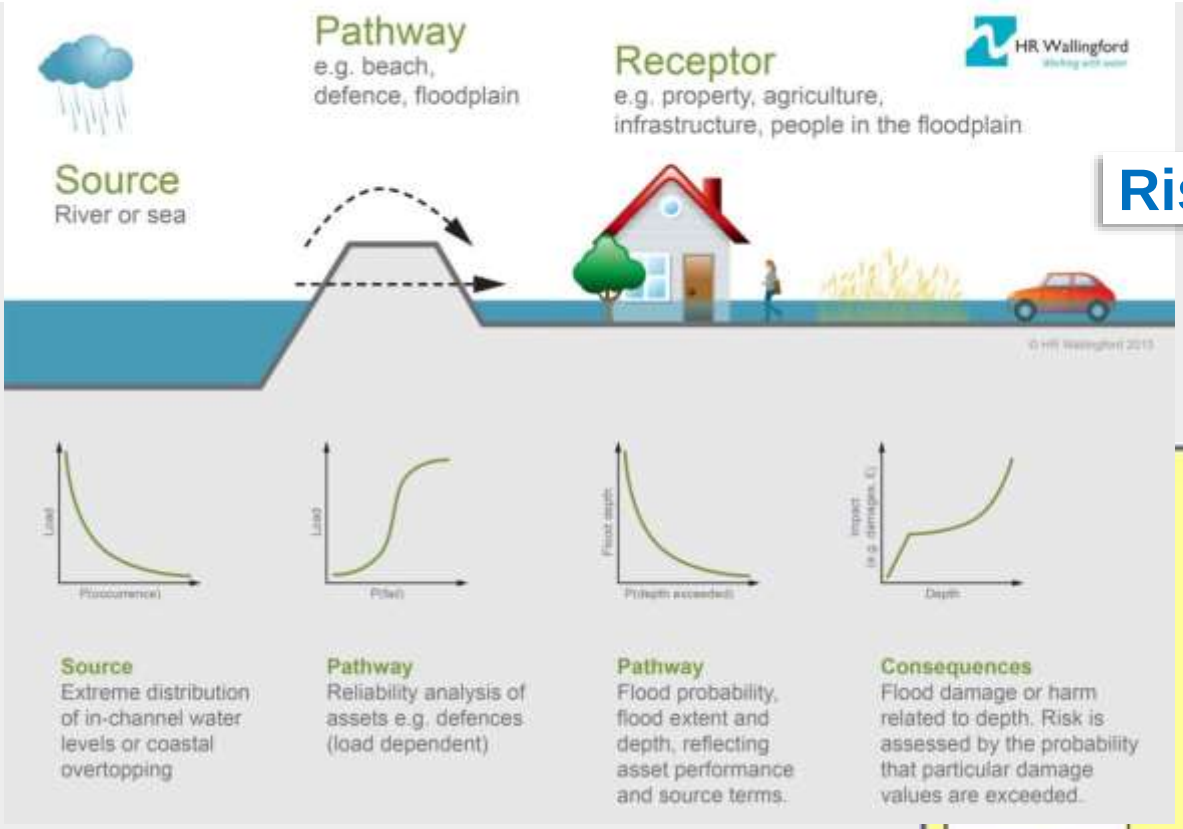
10-15 years of severe floods:
a significant number of failures, primarily in low risk areas

Croston
2016

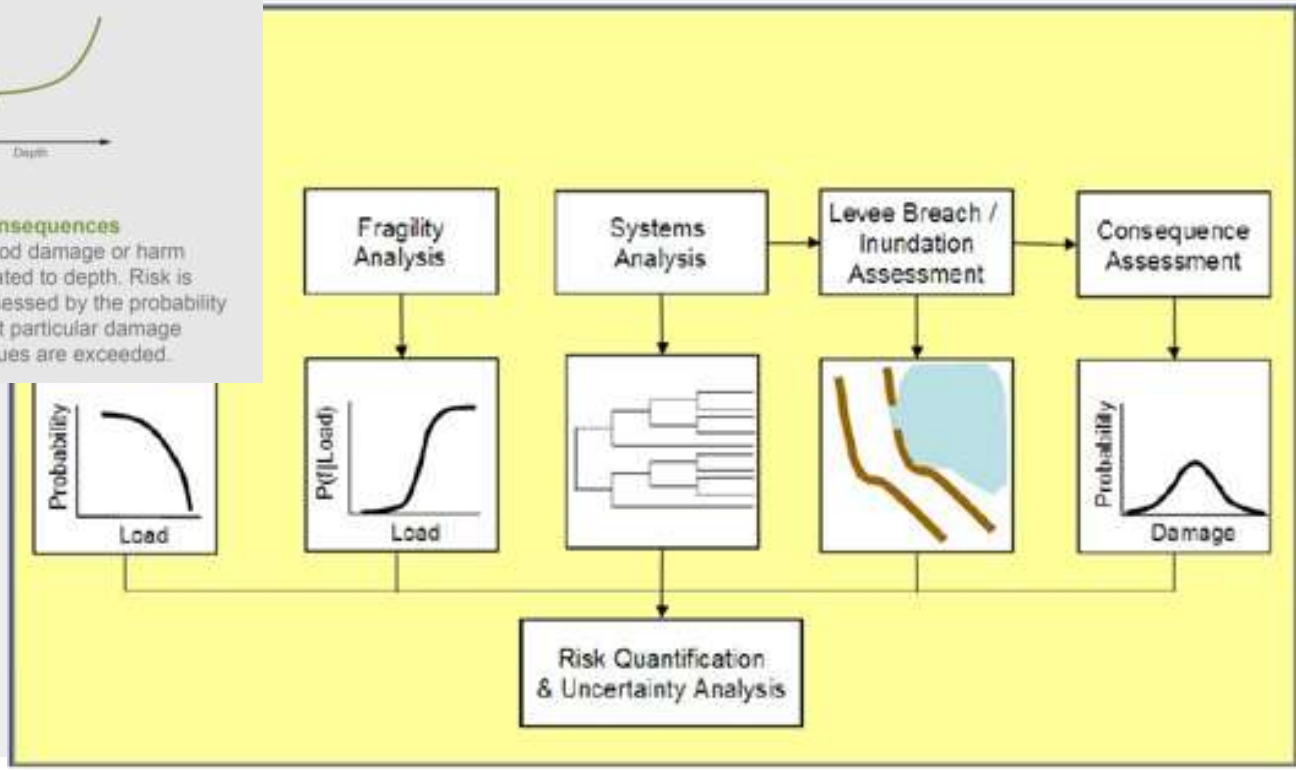
River
Torne
2007



Full flood risk system modelling

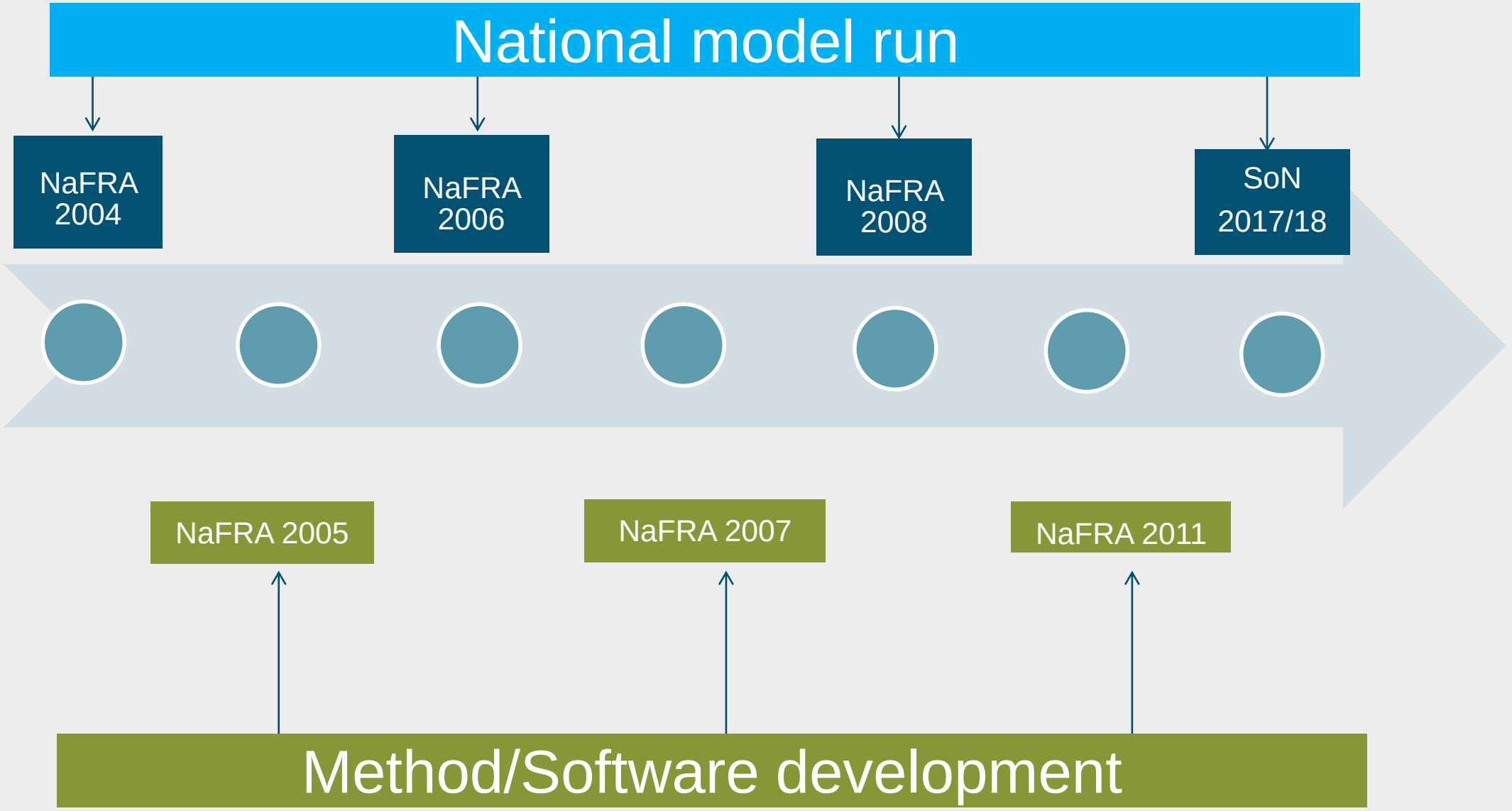


Risk= f(probability and consequence)

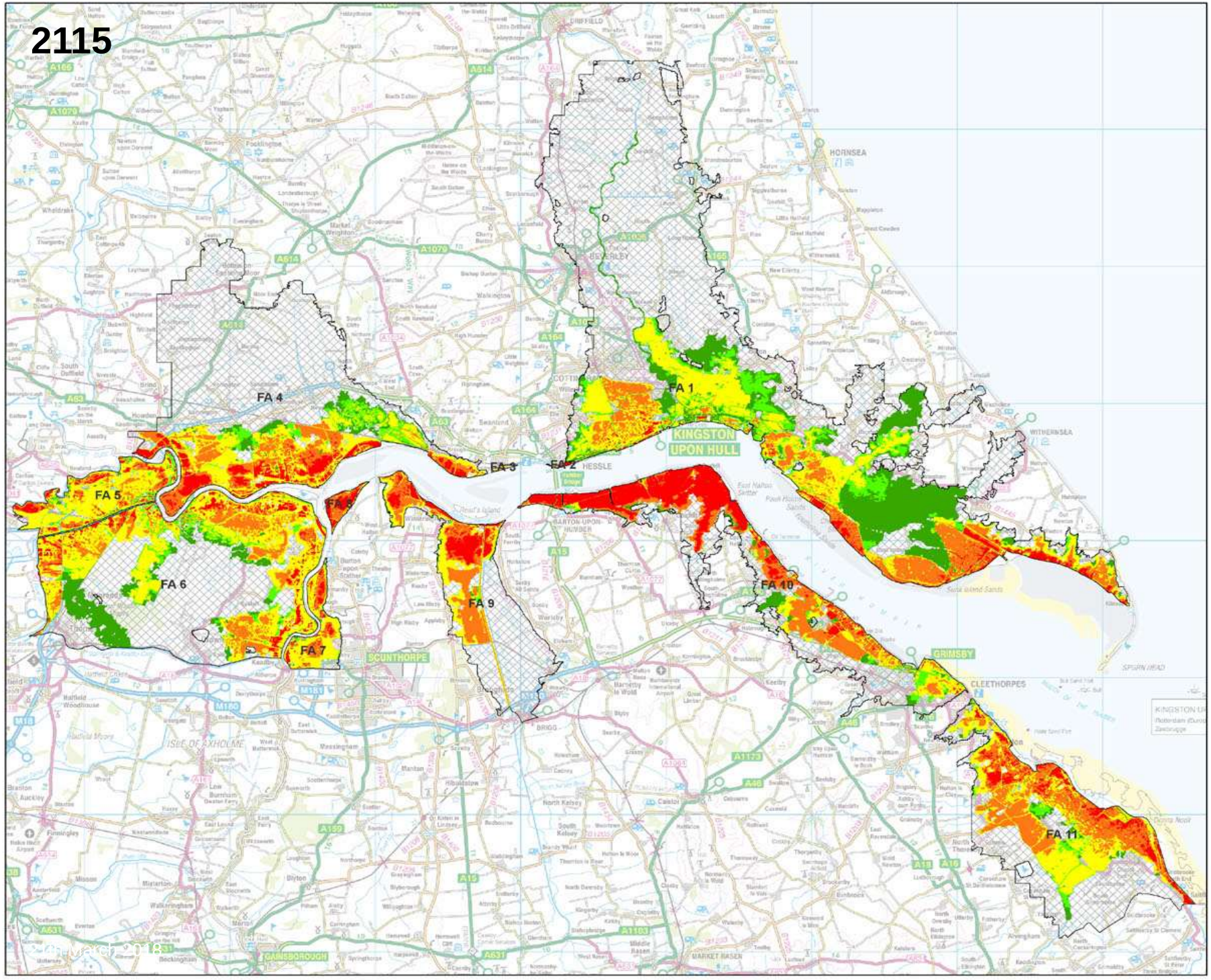


National Research Council (2013)
"Levees and the National Flood Insurance Program Improving Policies and Practices"

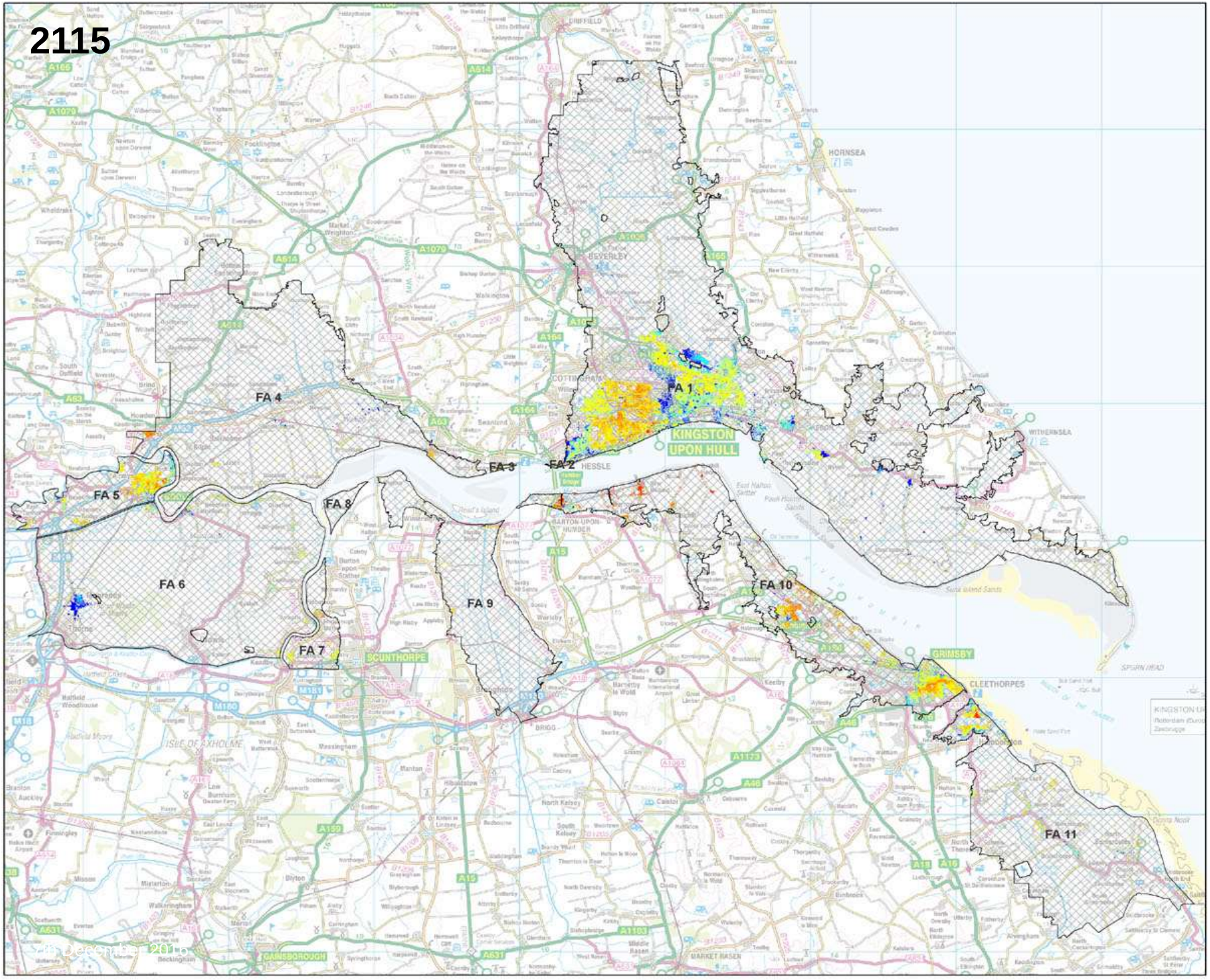
National Flood Risk Analysis (NaFRA)

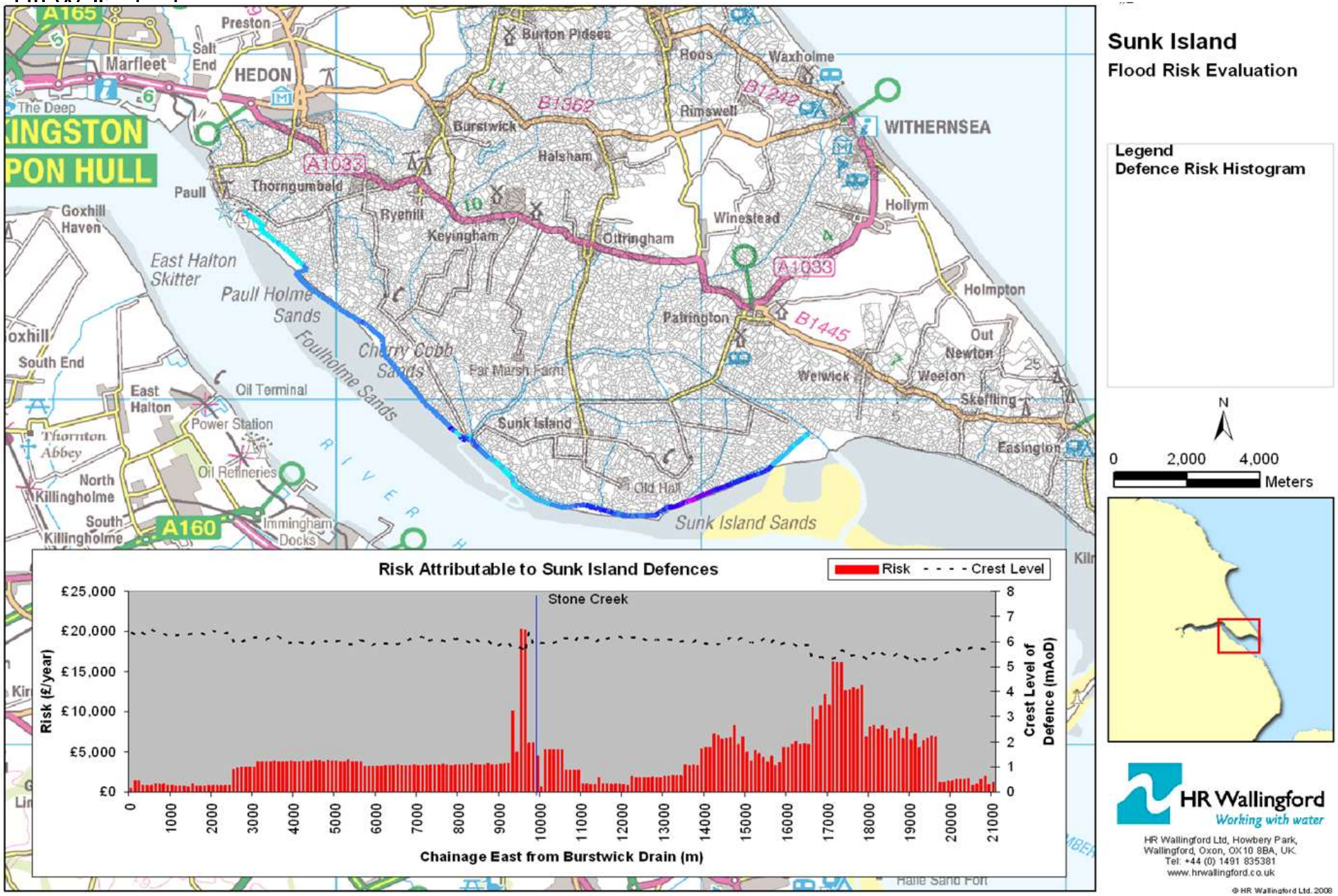


Outputs - probability of flooding

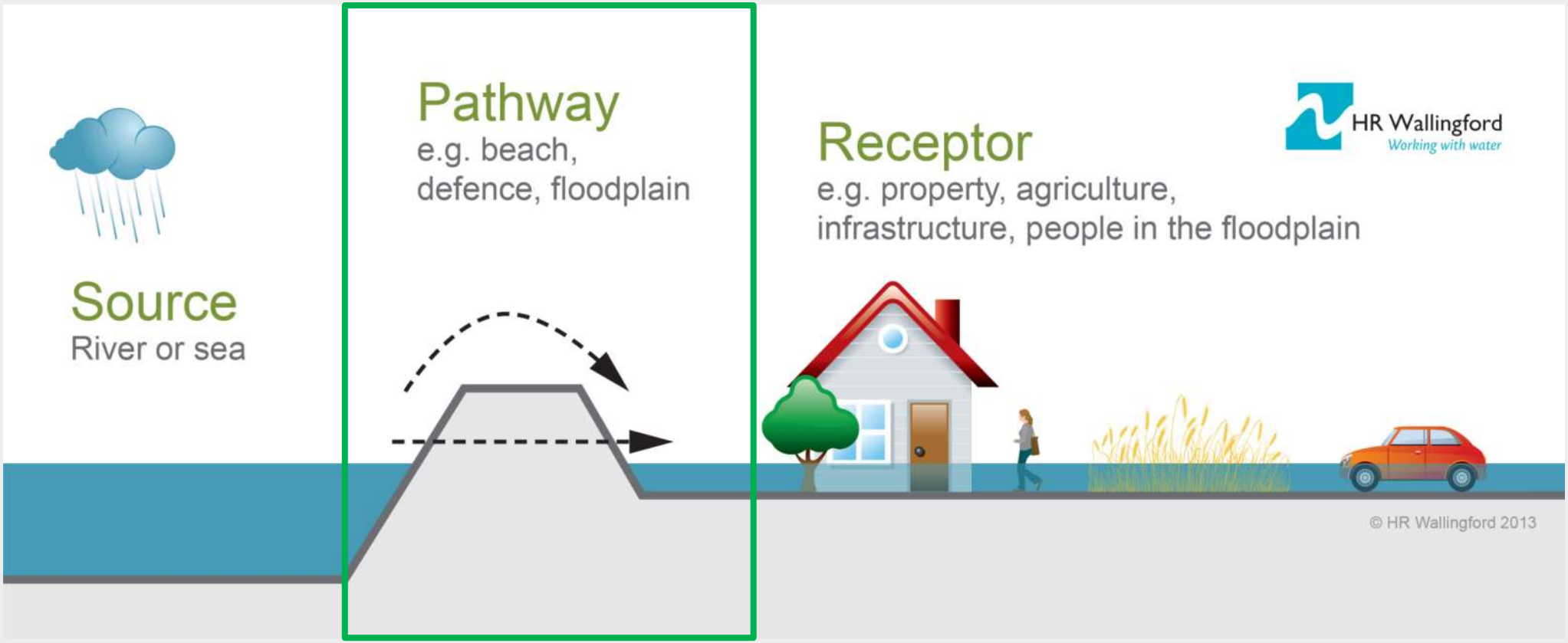


Outputs - risk





Representation of levee performance important for flood risk systems analysis



Fragility curve fundamentals

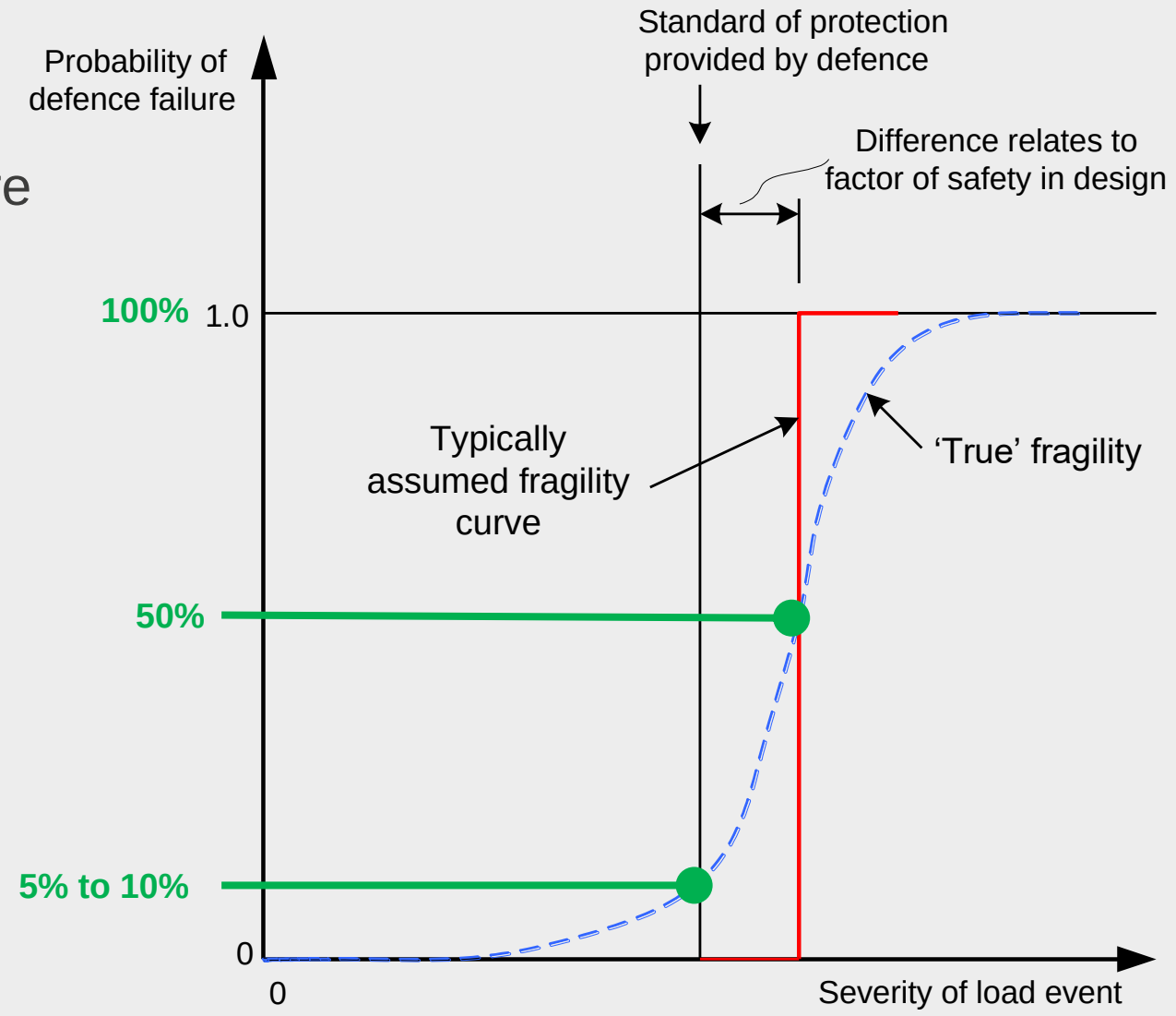
The Fragility method

A fragility curve is a curve which expresses the probability of failure of a defence as a function of the loading

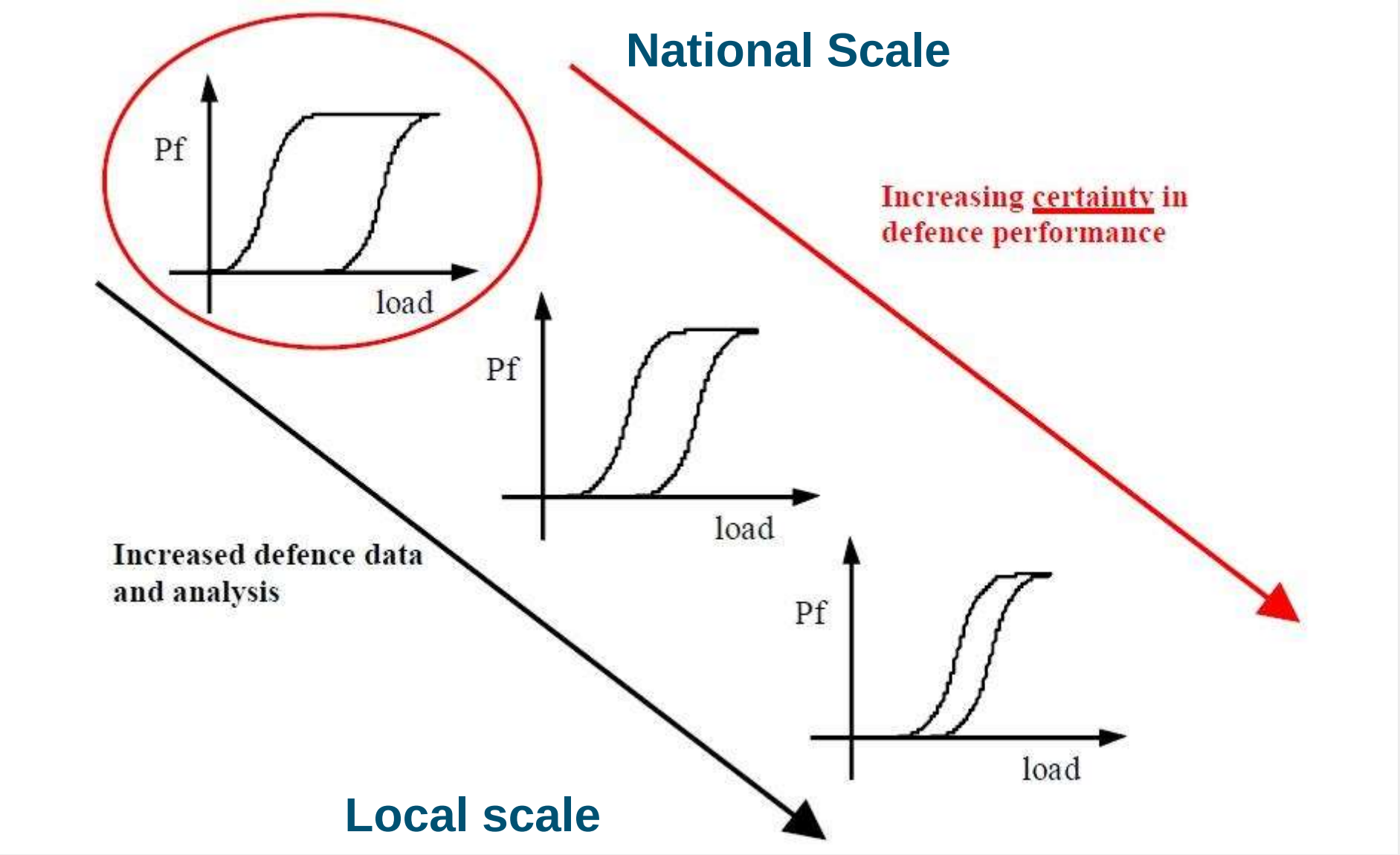
Z (*reliability*) = *R* (*strength*) – *S* (*loading*)

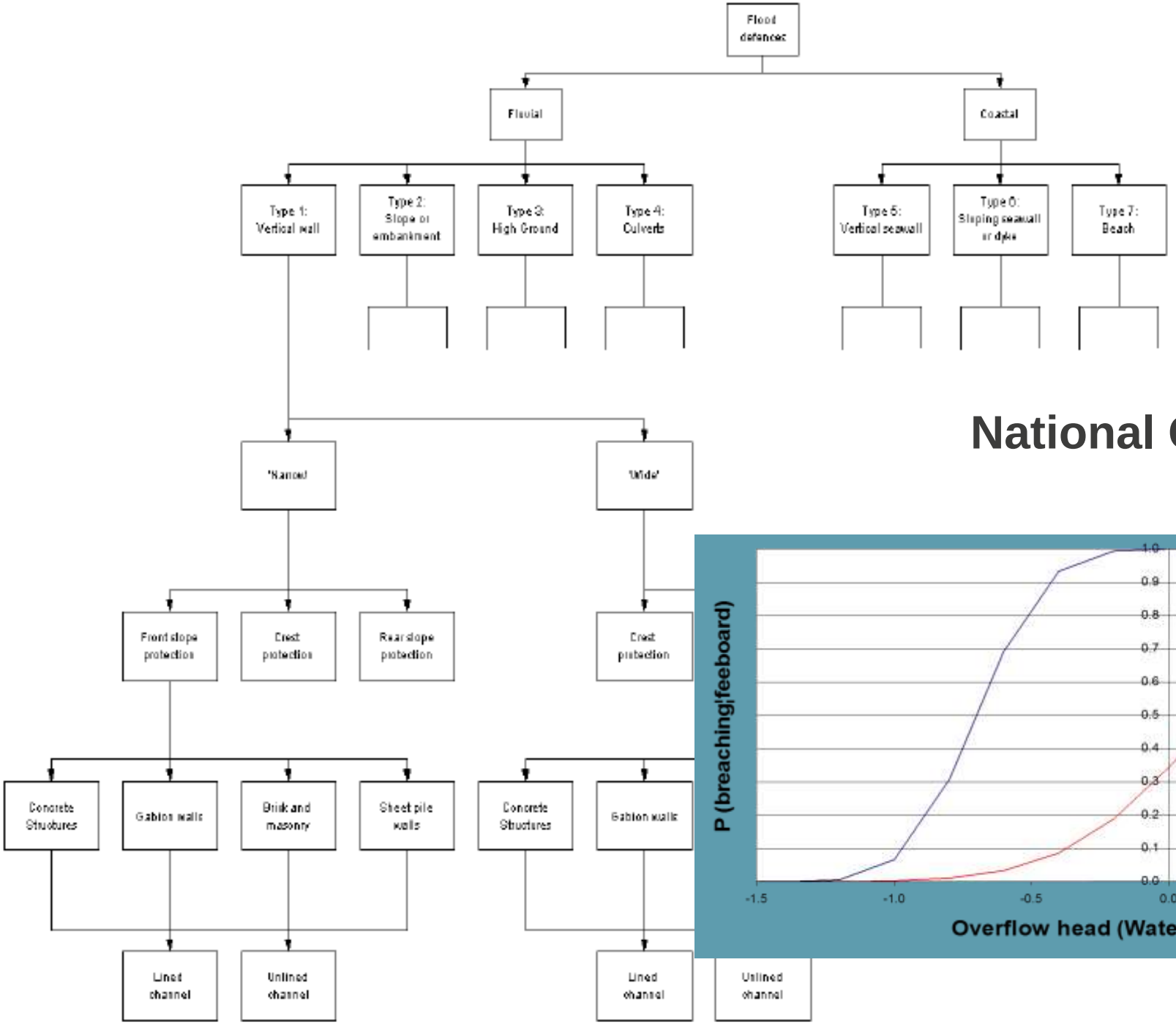
KEY POINT:

- Probability of failure:
  - for |load > design load| < 100%
  - for |load < design load| > 0%



Improving fragility curve science

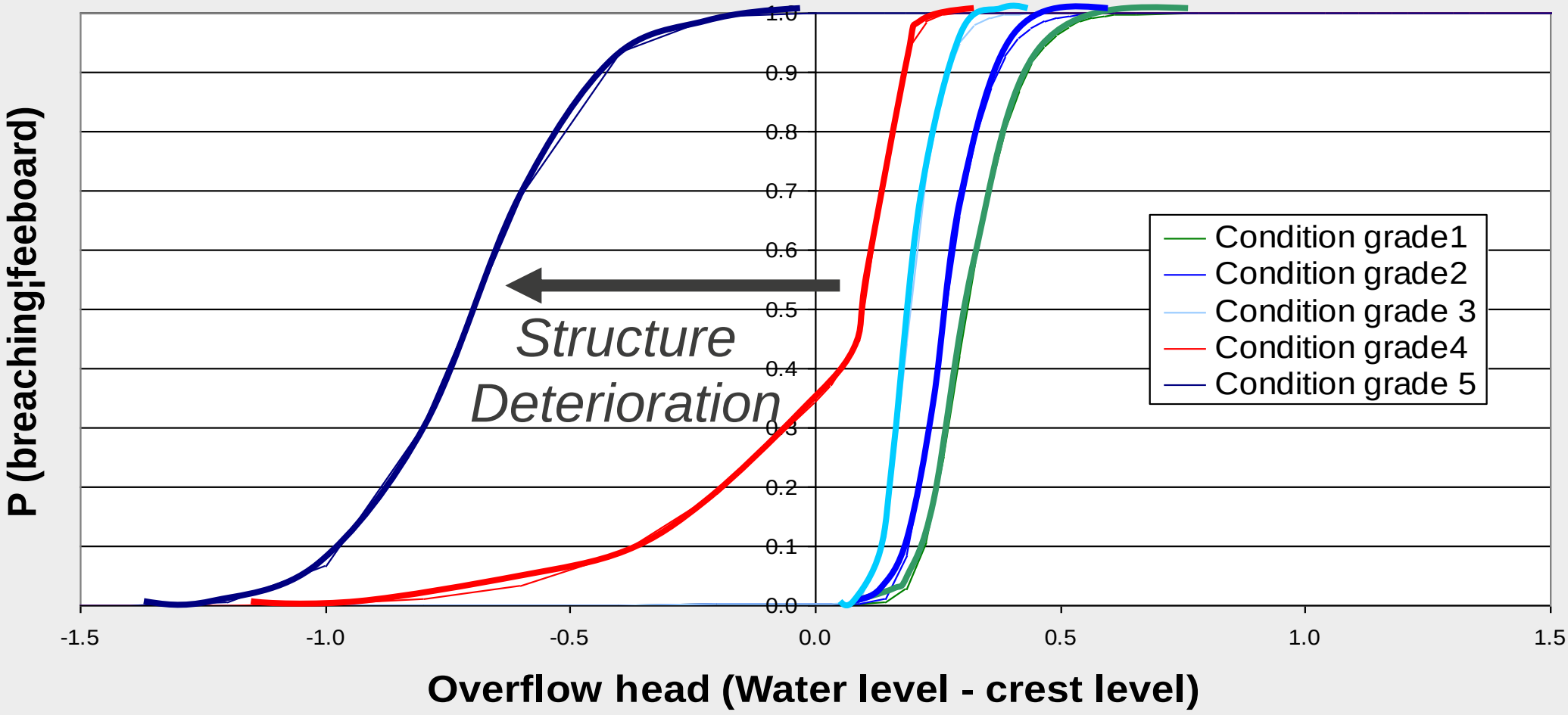




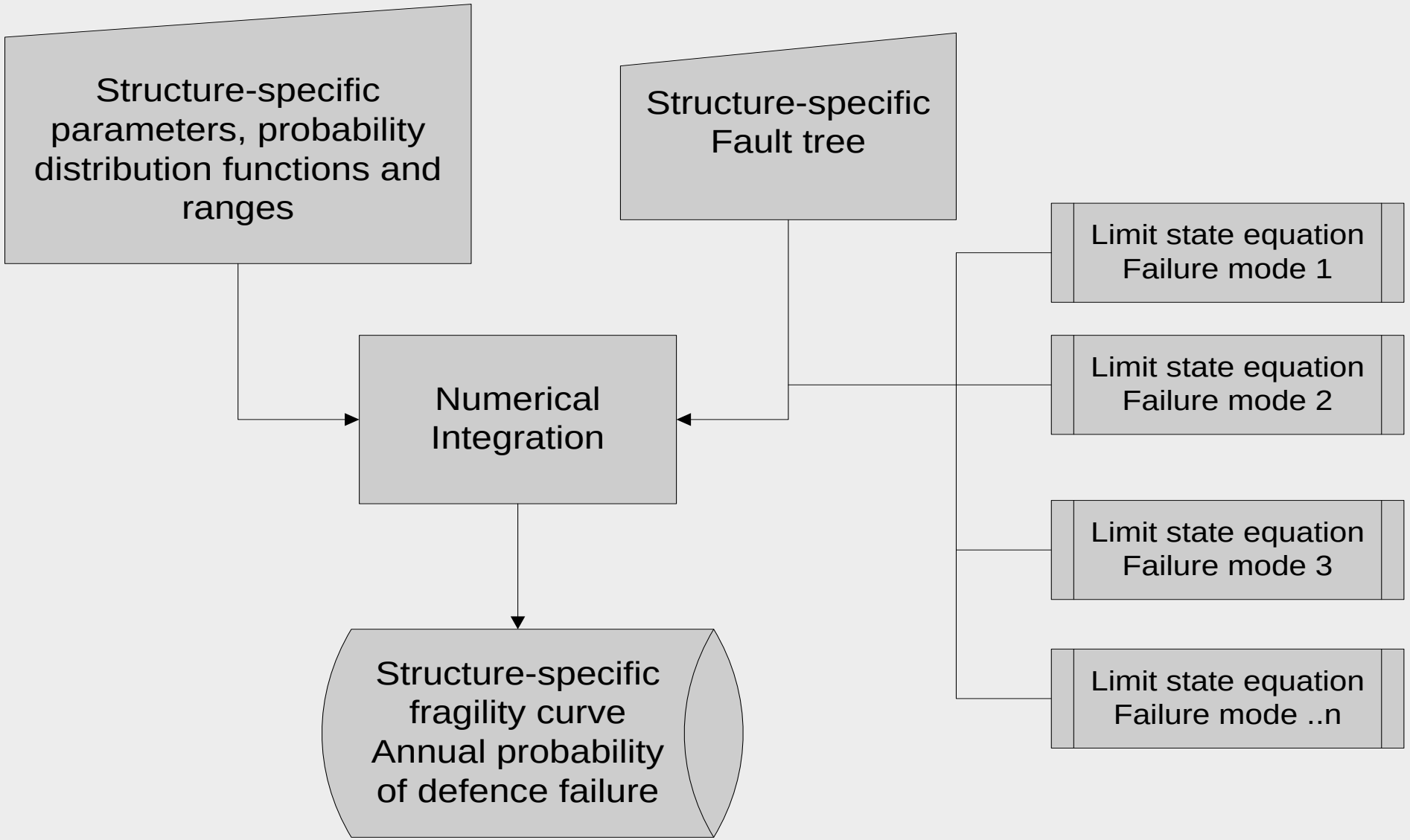
National Generic Curves

Typical generic fragility curves

- Linked to visual condition grade
- Capture reduction in performance as levee deteriorates

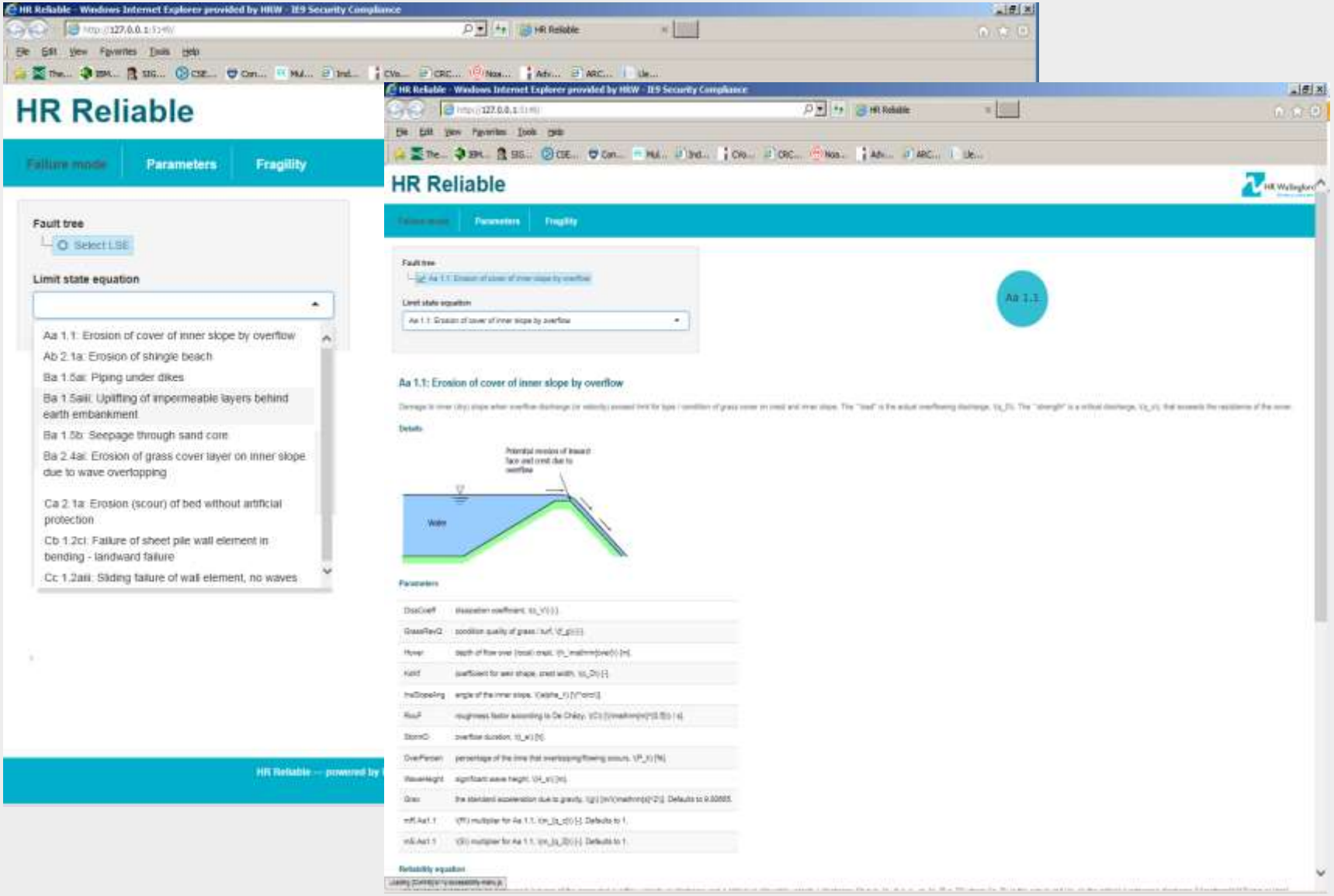


Site-specific analysis: HR Reliable components

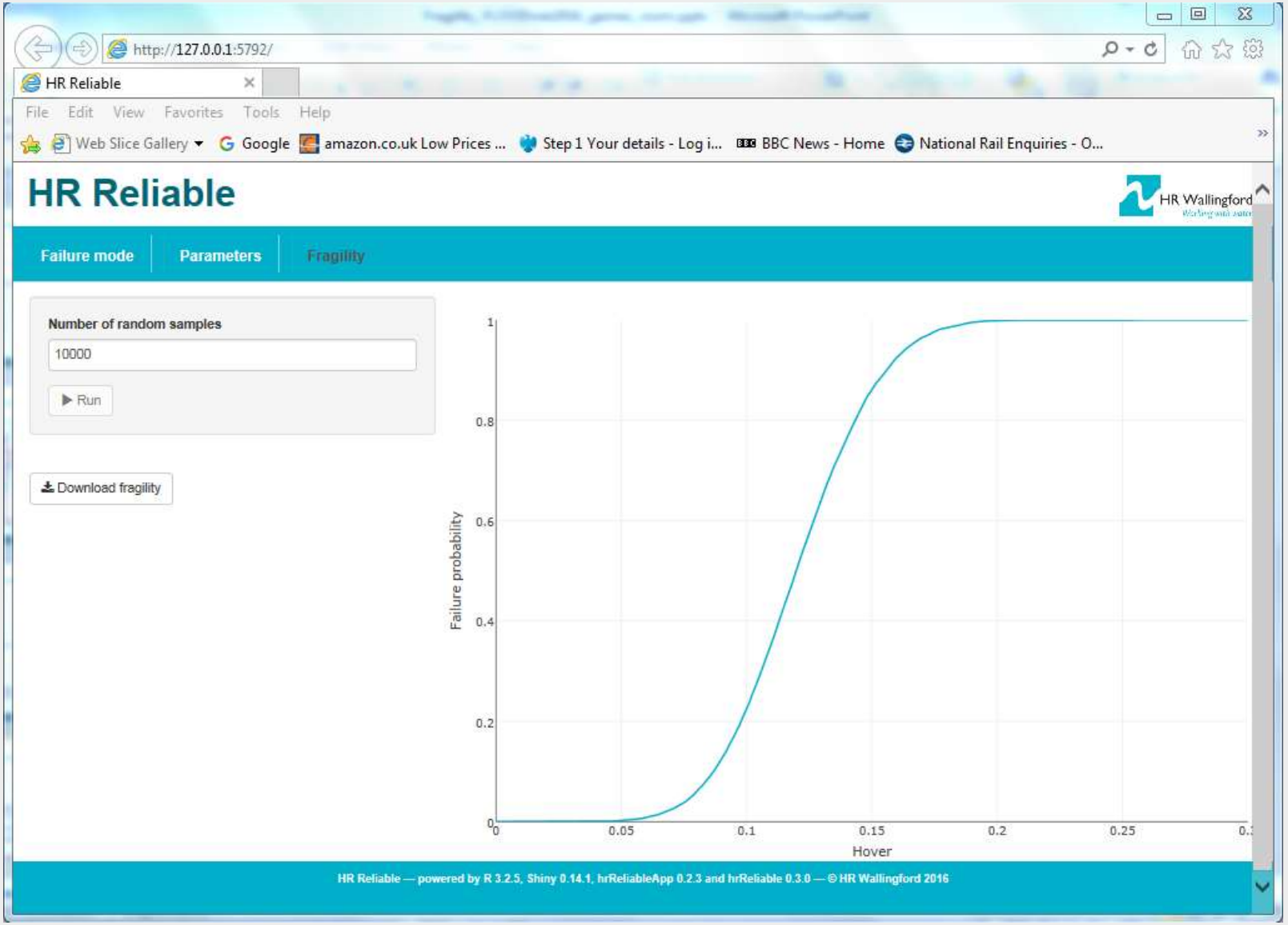


HR Wallingford
Working with water

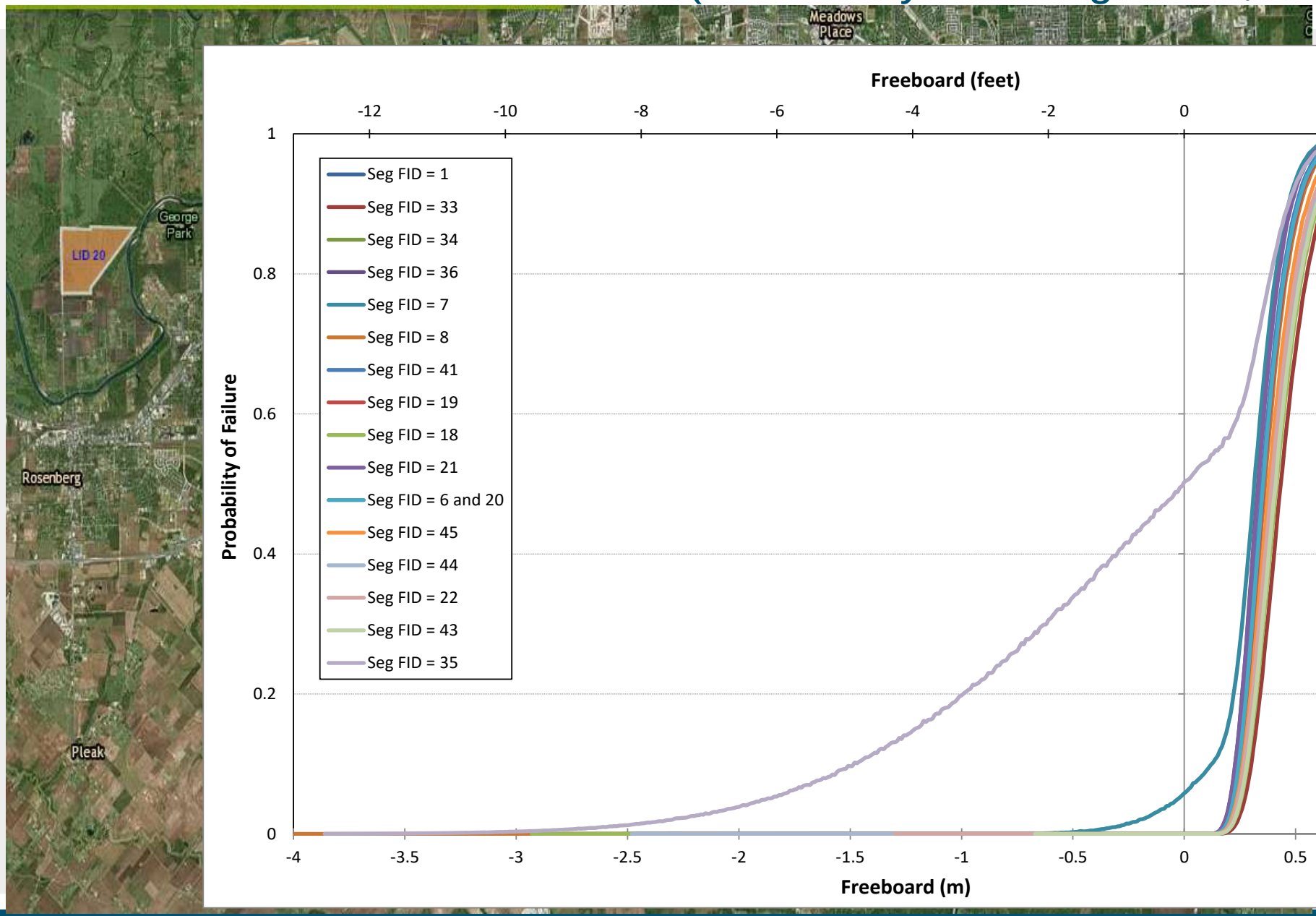
HR Reliable



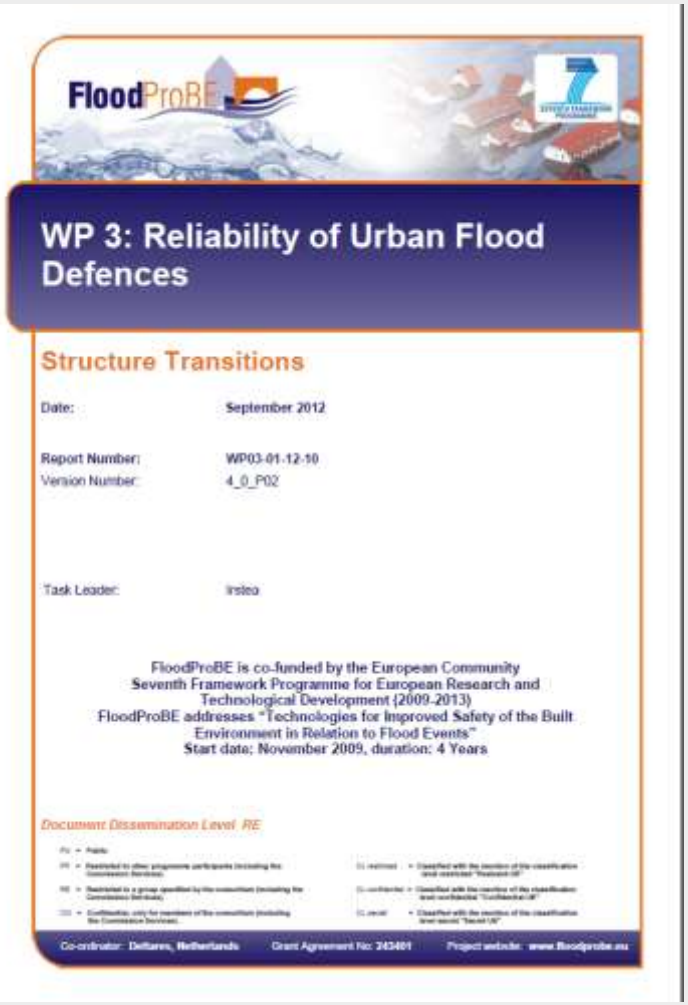
HR Reliable fragility curve

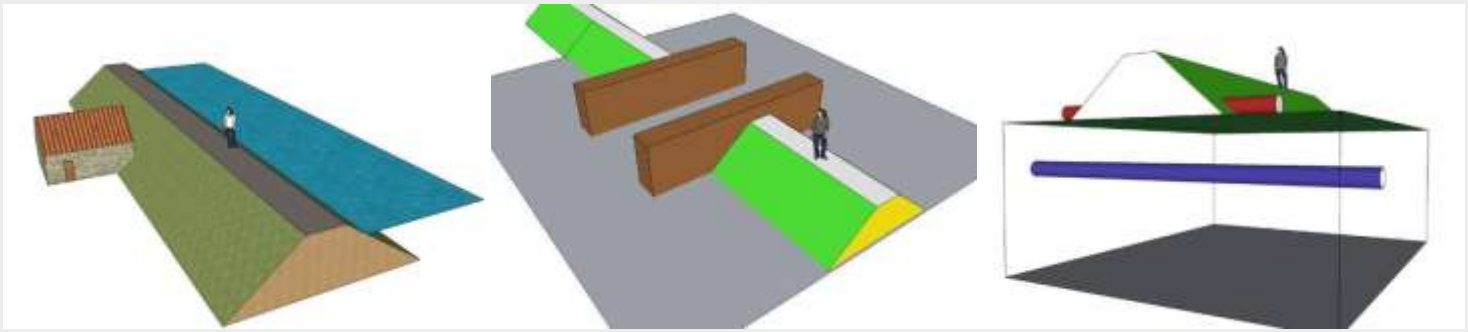


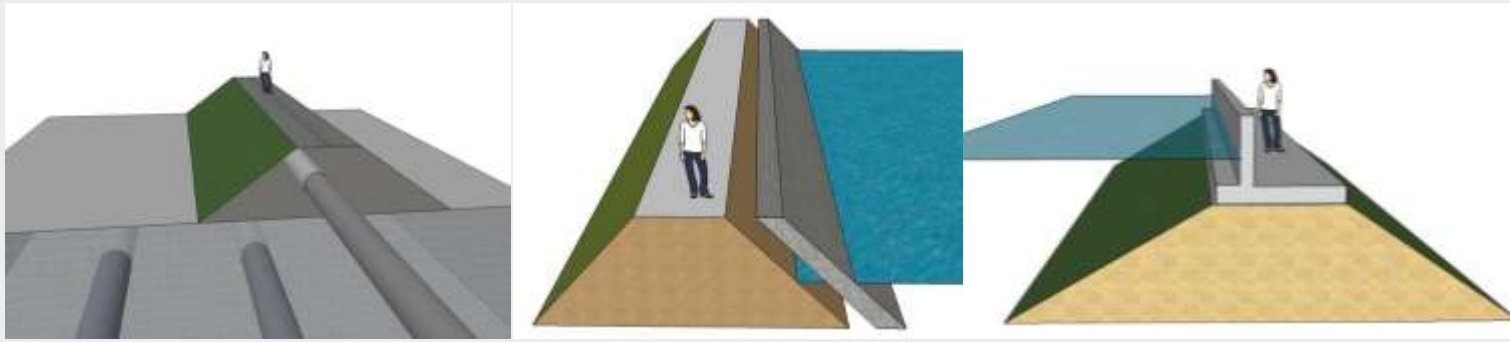
Full site specific assessments
(LID2 analysis – Sugarland, Houston, TX)

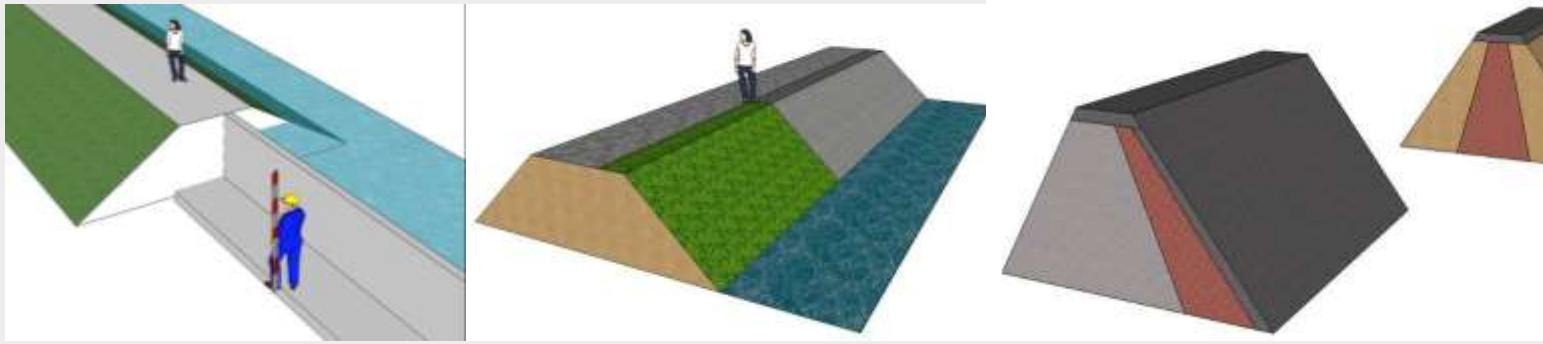


Next steps (1): Dealing with Transitions

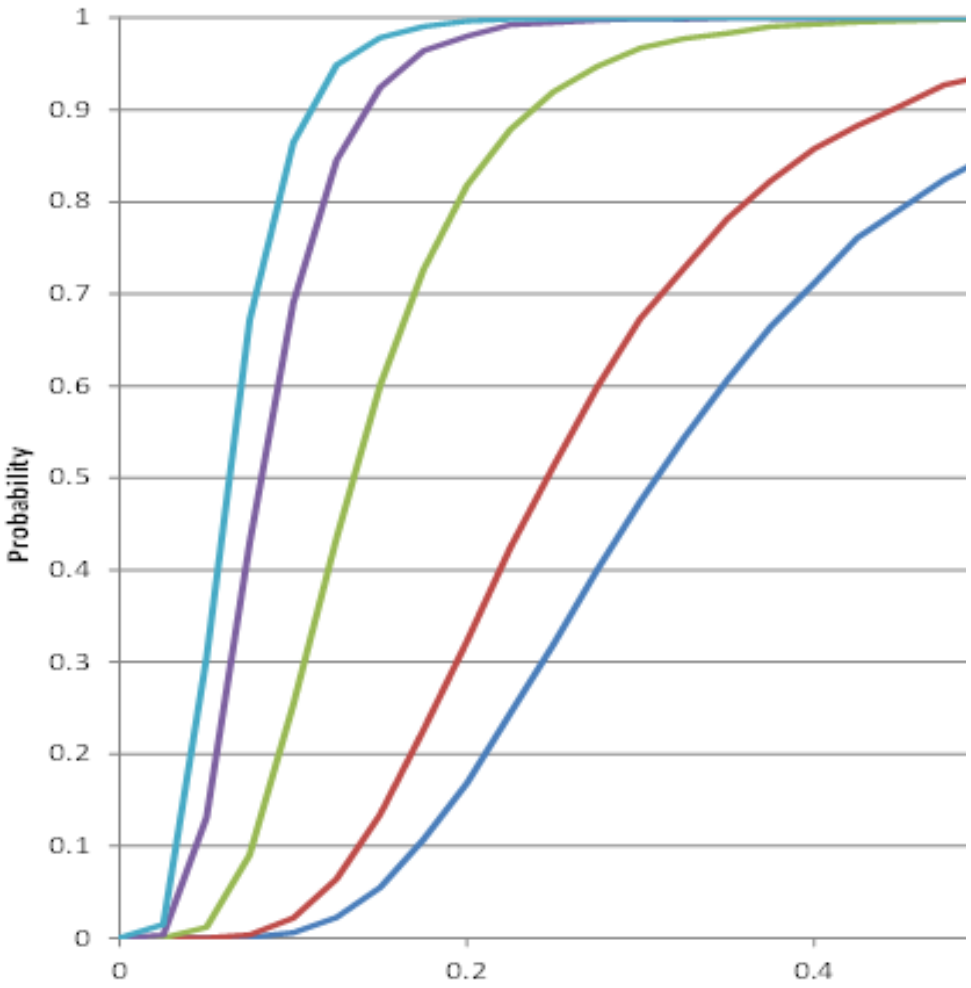


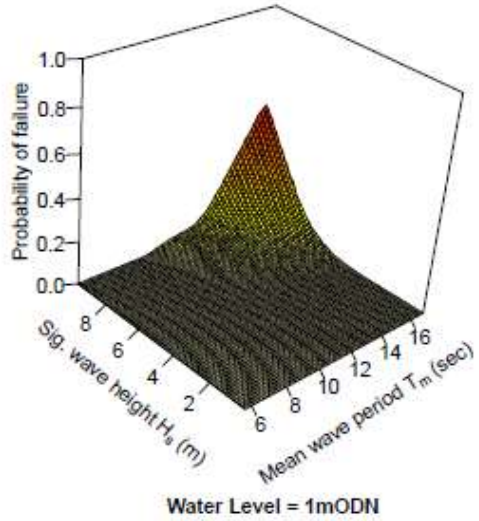


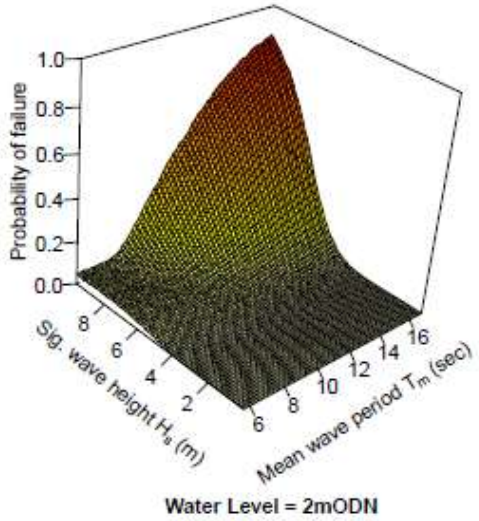


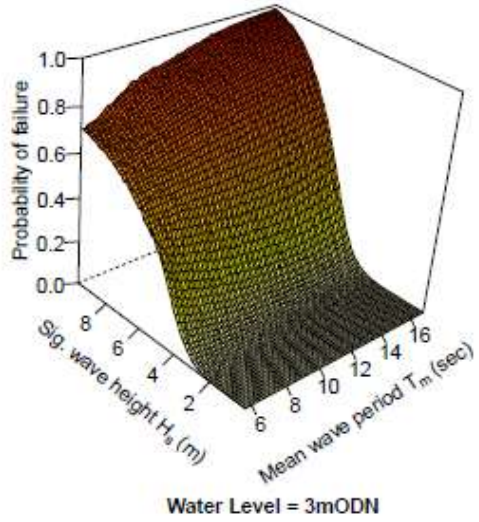


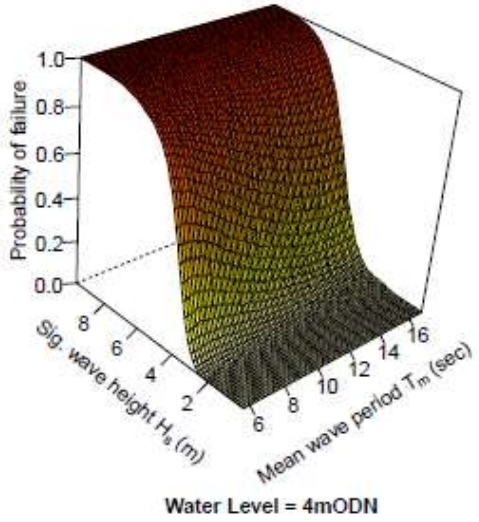
Next steps (2): introducing multi-variate fragility for coastal levees











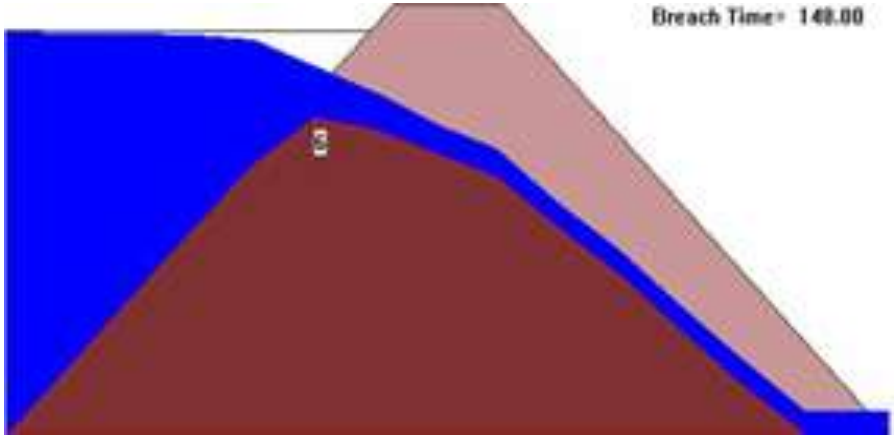
Next steps (3): dealing (properly) with time-dependent failure mechanisms

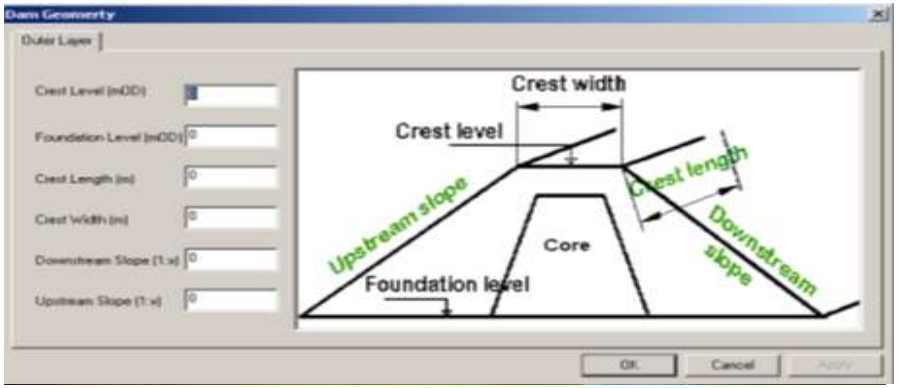
Event tree type thinking needed in thinking about breach:

- Dynamic breach growth e.g. EMBREA
- Rapid assessment breach e.g. AREBA

Features

- Homogeneous or composite structures
- Option for grass/rock surface protection
- Overtopping or piping initiation
- Surface erosion or headcut progression
- Variable erodibility





HR Wallingford
Working with water

Thanks and any questions?

Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom

www.hrwallingford.com