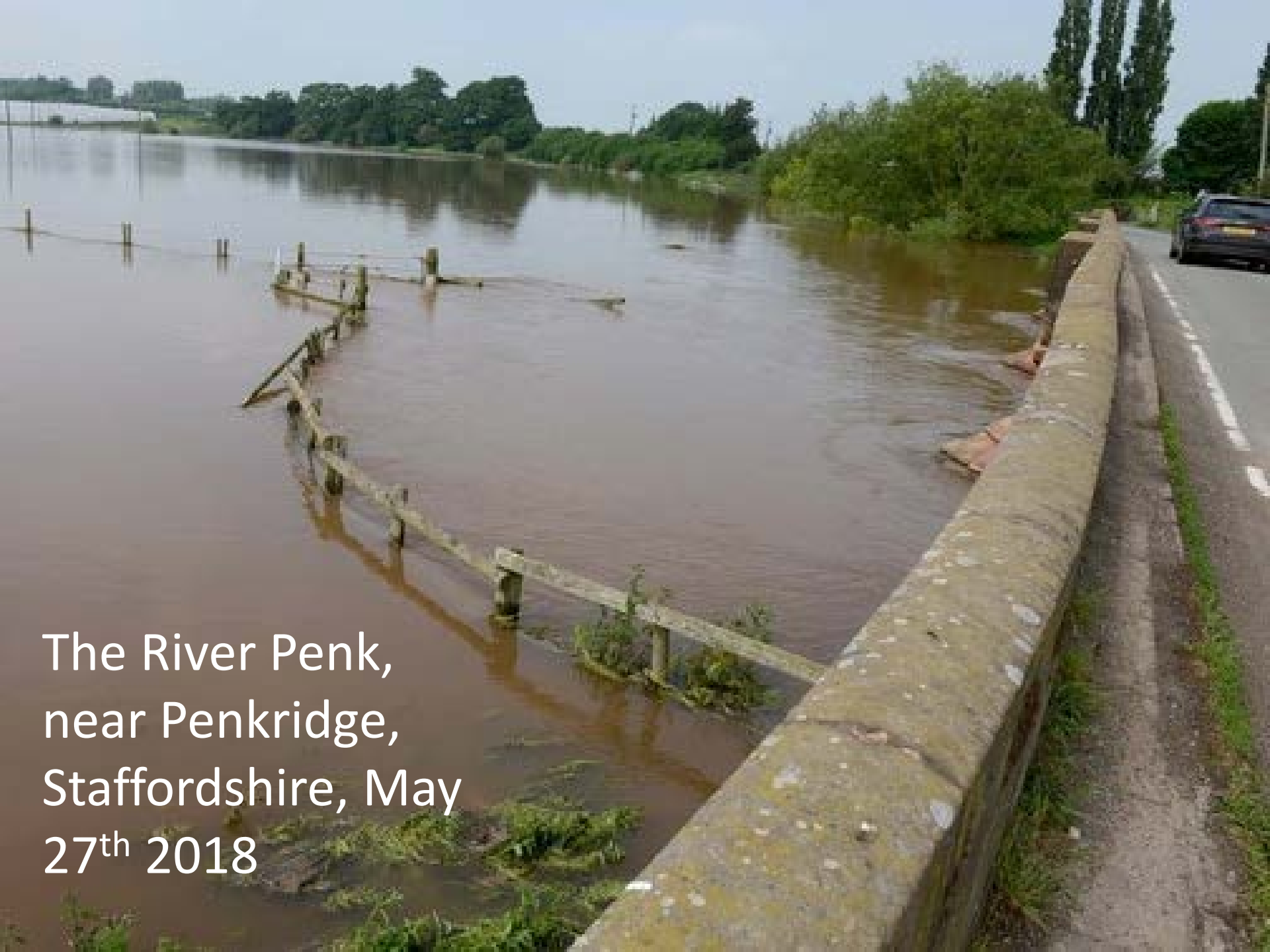
GRESHAM COLLEGE

Who's to blame for Britain's floods?

Carolyn Roberts

Frank Jackson Professor of Environment, Gresham College,
Environment and Water Consultant



The River Penk, near Penkridge, Staffordshire, May 27th 2018

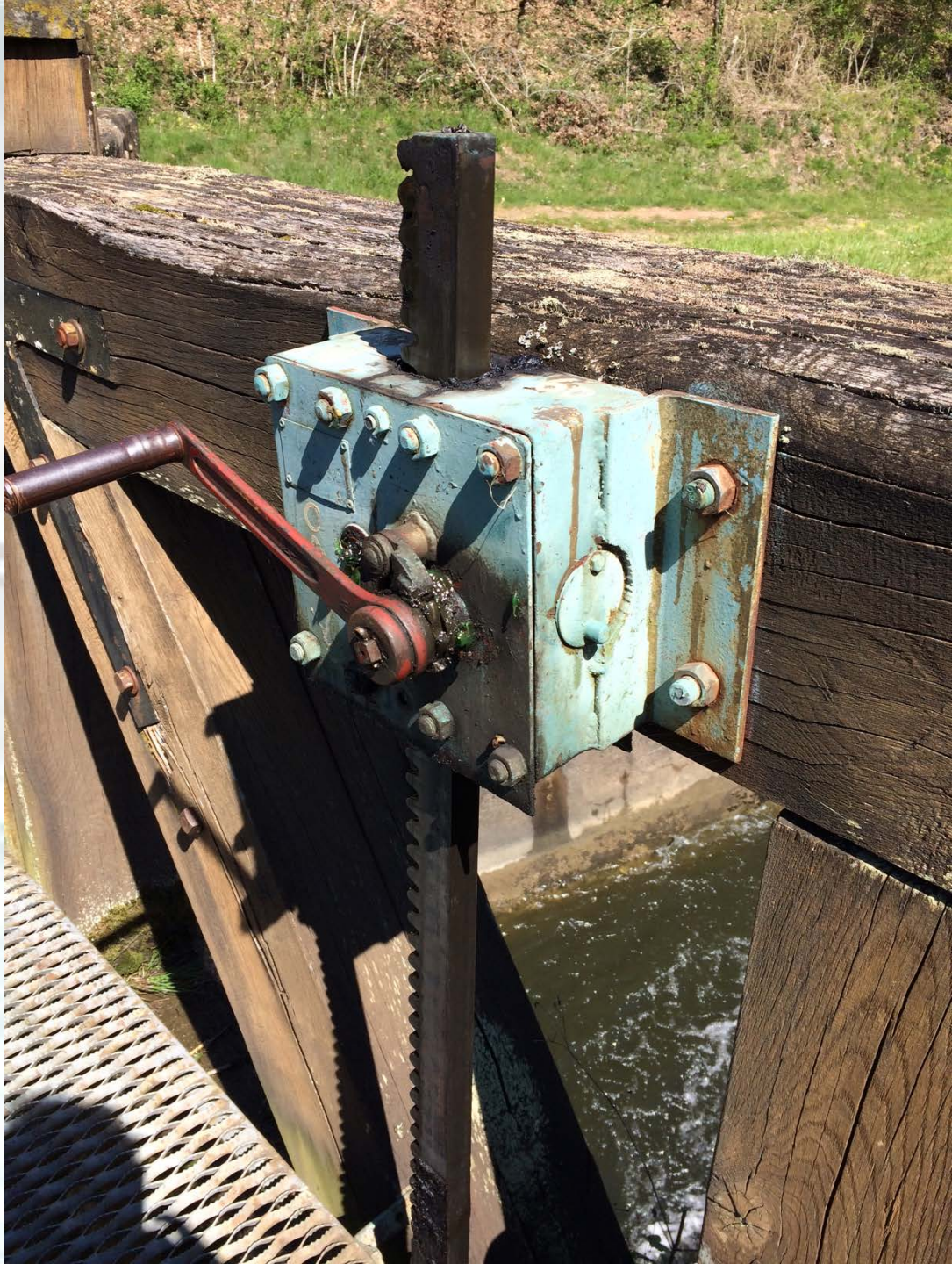
Road near Wolverhampton, May 27th 2018. Photo @stephenlapper

Tipton, Staffordshire, 27th May 2018.
Photo: @KennettPhoto

Albrighton, near Wolverhampton,
May 27th 2018. Photo: Express and Star

Small Heath, Birmingham, May 27th 2018.
Photo: Express and Star

“Someone altered the flood gates and sluices, in error, and flooded our house”



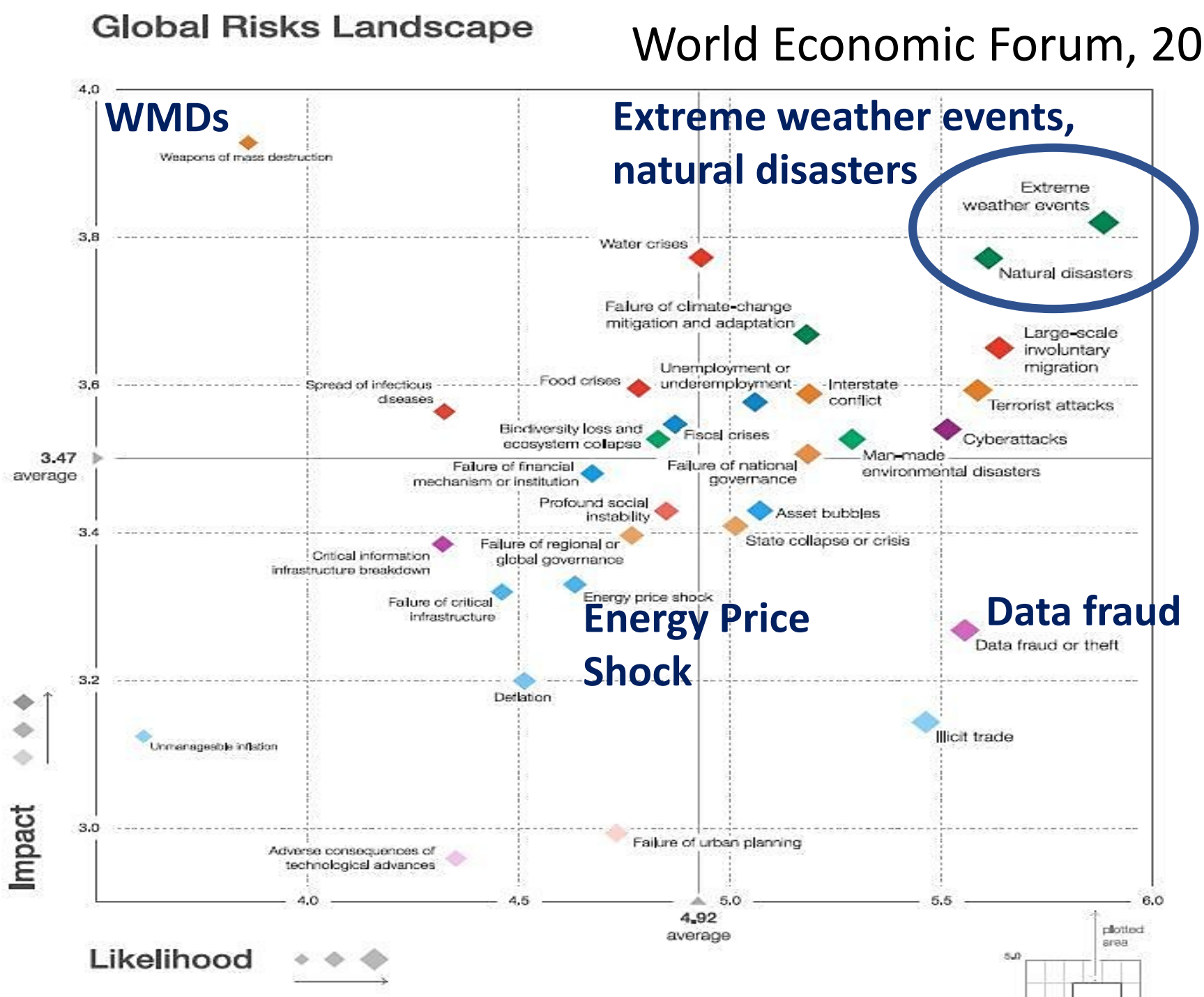
Global Risks Report

The 5 risks most likely to happen in the next 10 years

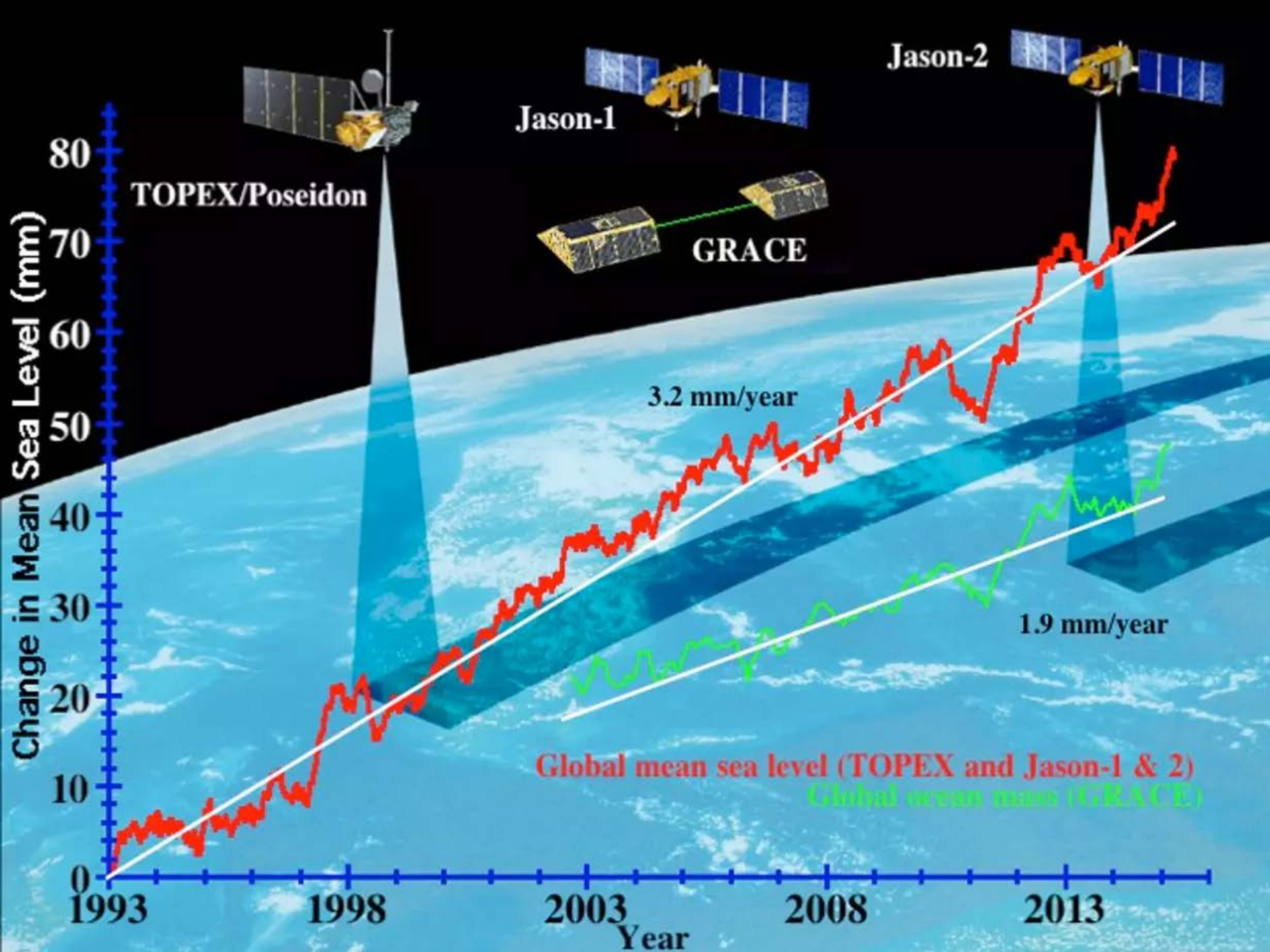
	rank
Extreme weather events	1
Natural disasters	2
Cyber attacks	3
Data fraud or theft	4
Failure of climate change mitigation & adaptation	5

Source: Executive Opinion Survey 2017, World Economic Forum

World Economic Forum, 2017

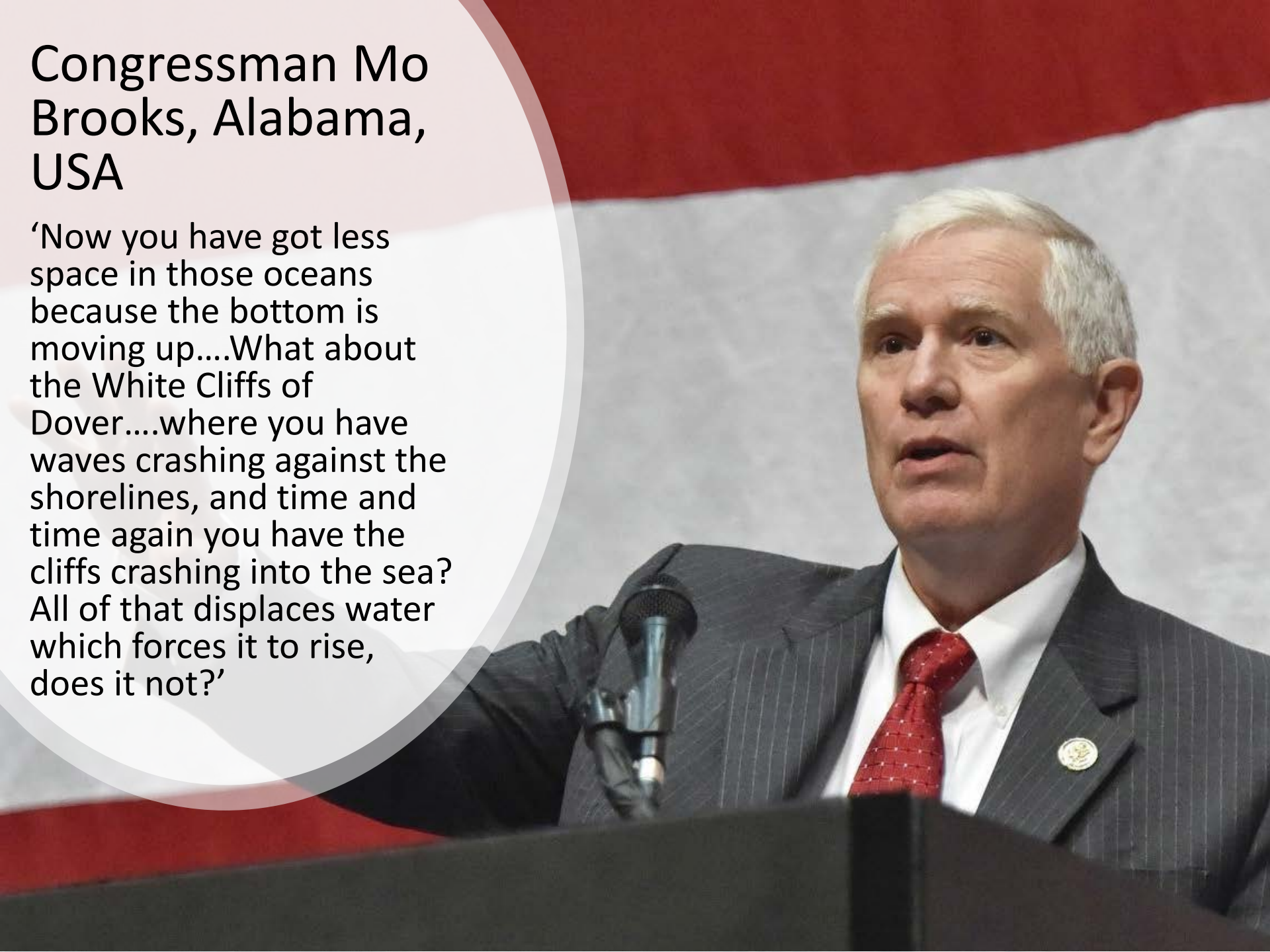


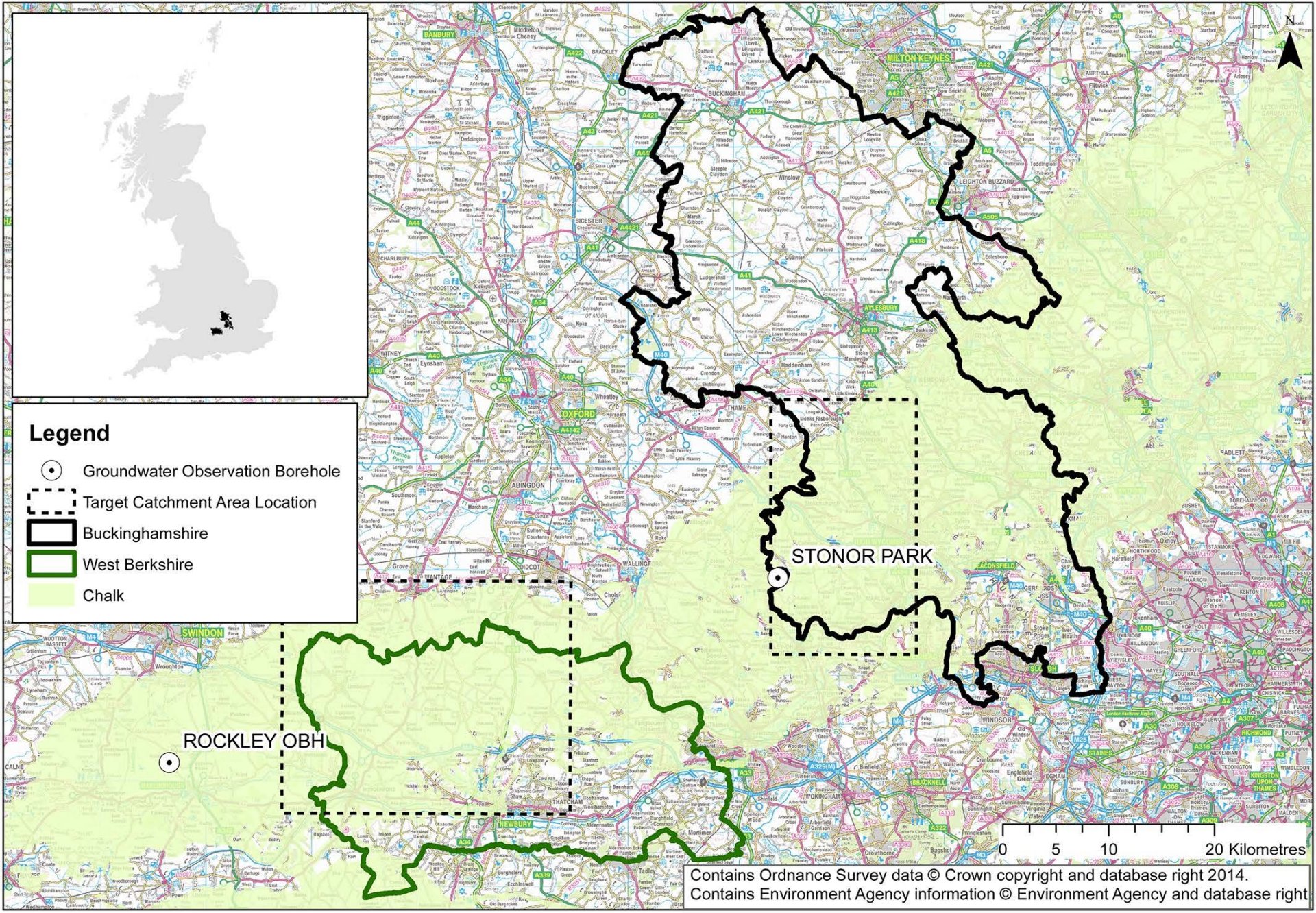
Harmsworth Magazine, 1899. London as Venice


Jason-2
Jason-1
TOPEX/Poseidon
GRACE
80
70
60
50
40
30
20
10
0
Change in Mean Sea Level (mm)
3.2 mm/year
1.9 mm/year
Global mean sea level (TOPEX and Jason-1 & 2)
Global ocean mass (GRACE)
1993
1998
2003
2008
2013
Year

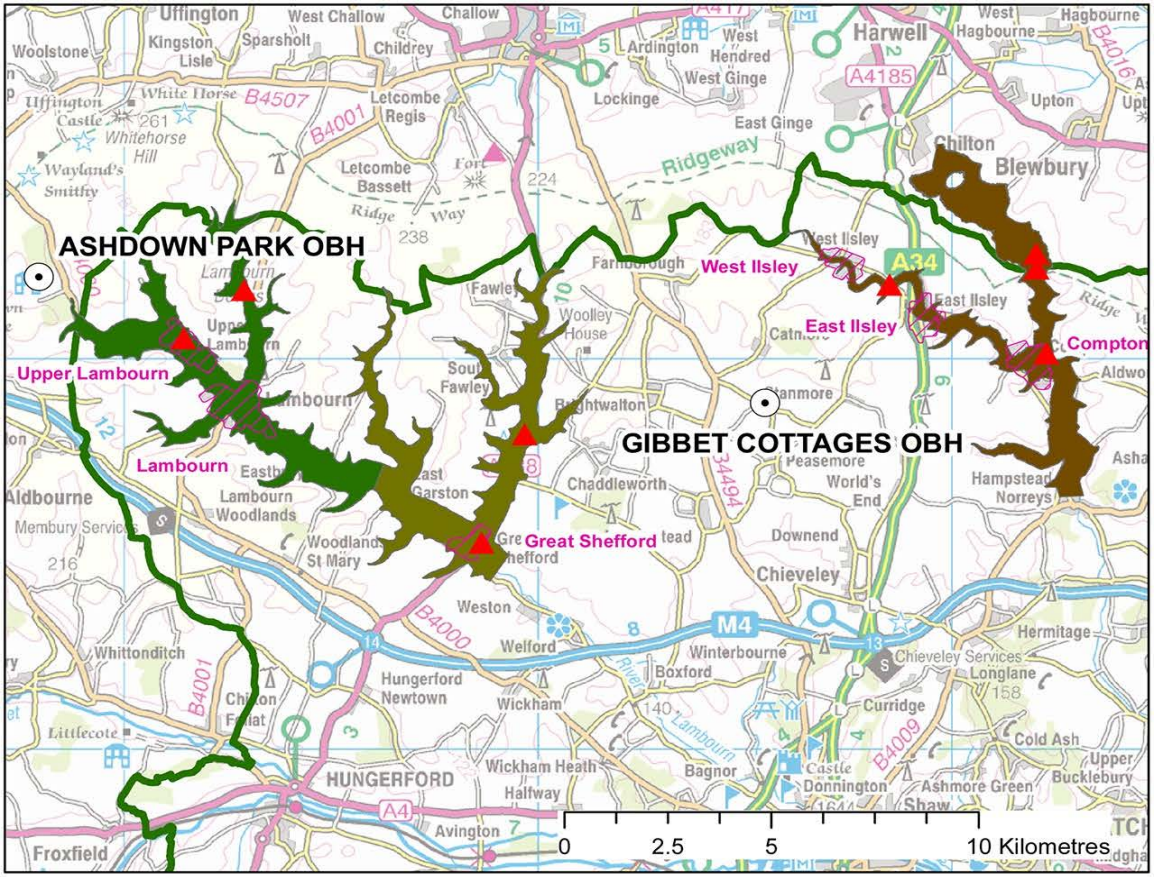
Congressman Mo Brooks, Alabama, USA

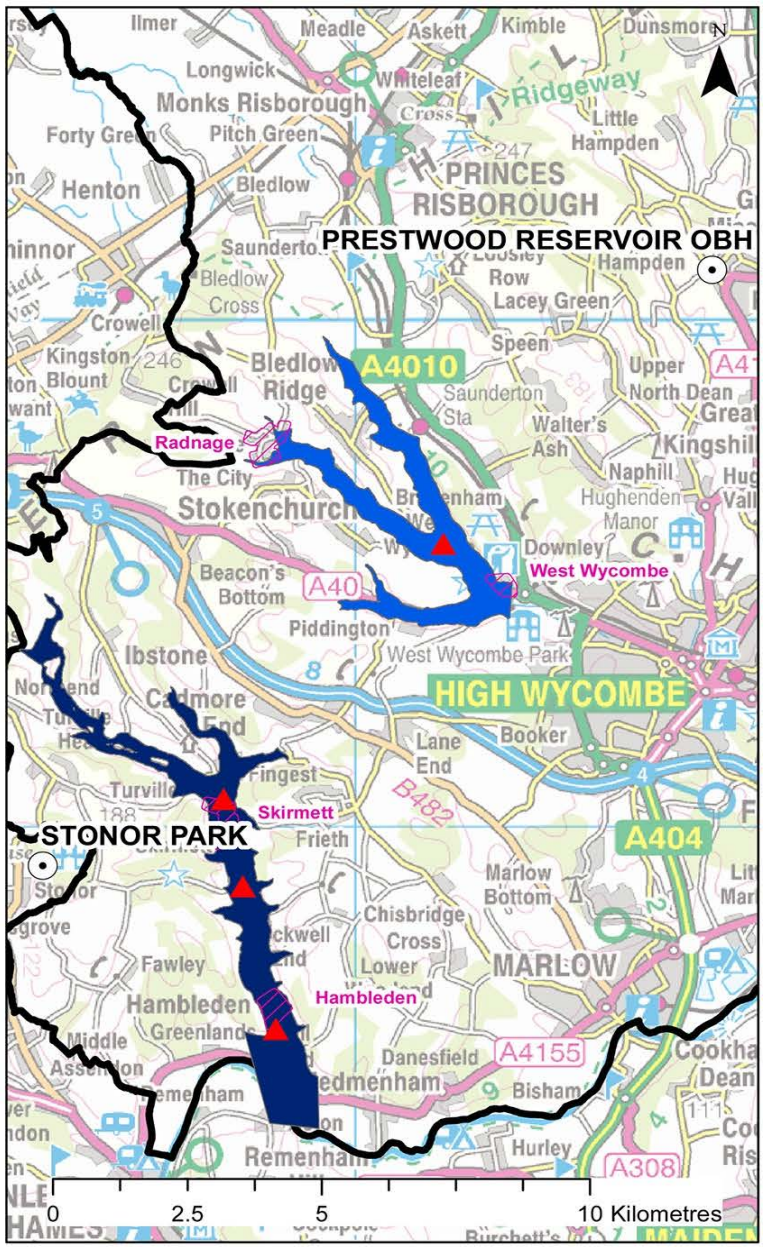
‘Now you have got less space in those oceans because the bottom is moving up….What about the White Cliffs of Dover….where you have waves crashing against the shorelines, and time and time again you have the cliffs crashing into the sea? All of that displaces water which forces it to rise, does it not?’





Morris *et al*, 2018





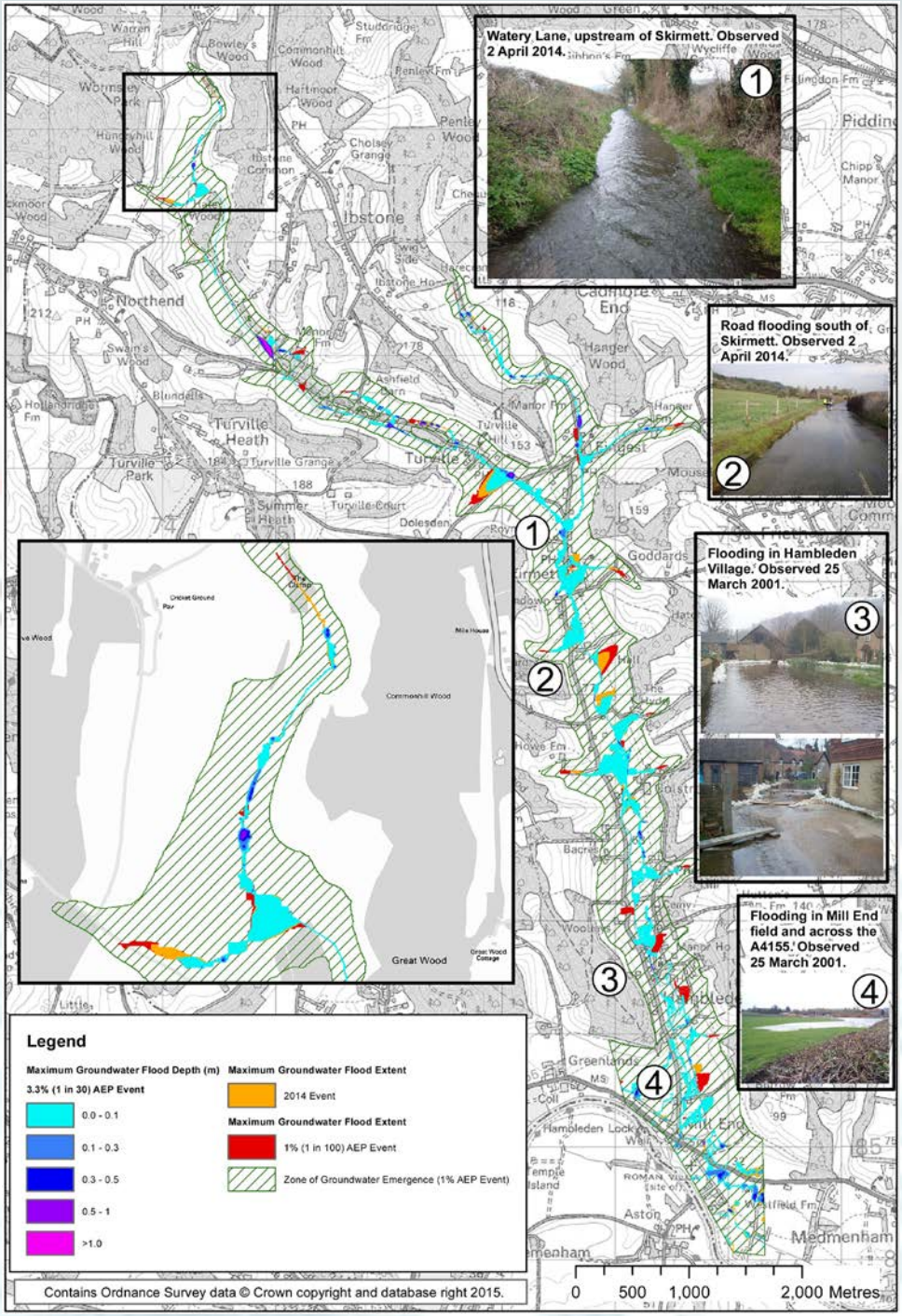
Legend

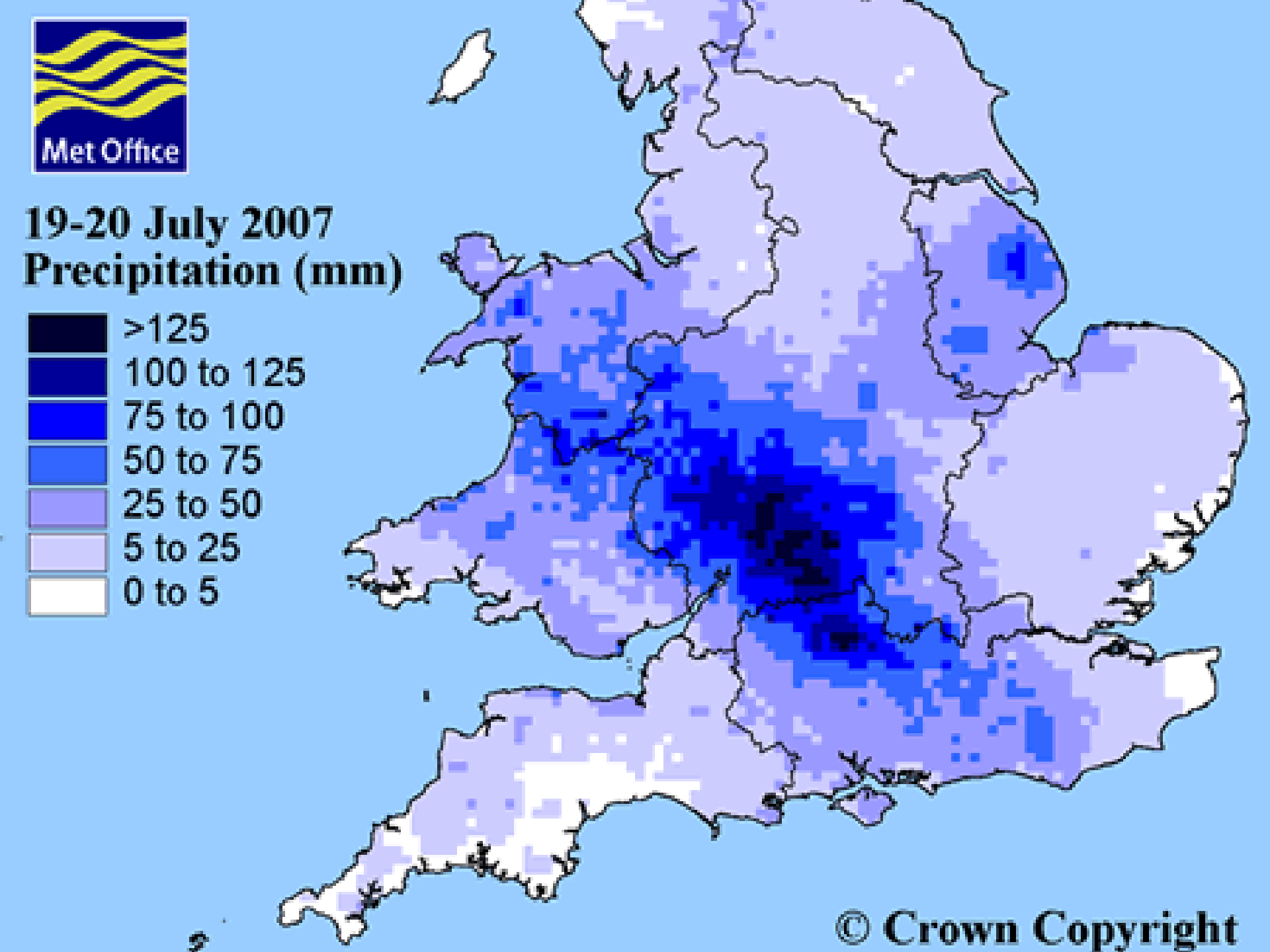
- Hambleden
- Great Shefford
- Upper Lambourn and Lambourn
- West Ilsley, East Ilsley and Compton
- Radnage
- Flow Measurement (Mar - Apr 2014)
- Groundwater Observation Borehole
- Town or Village
- Buckinghamshire
- West Berkshire

Research catchments visited during groundwater flooding in 2012/2013 and 2014, around High Wycombe

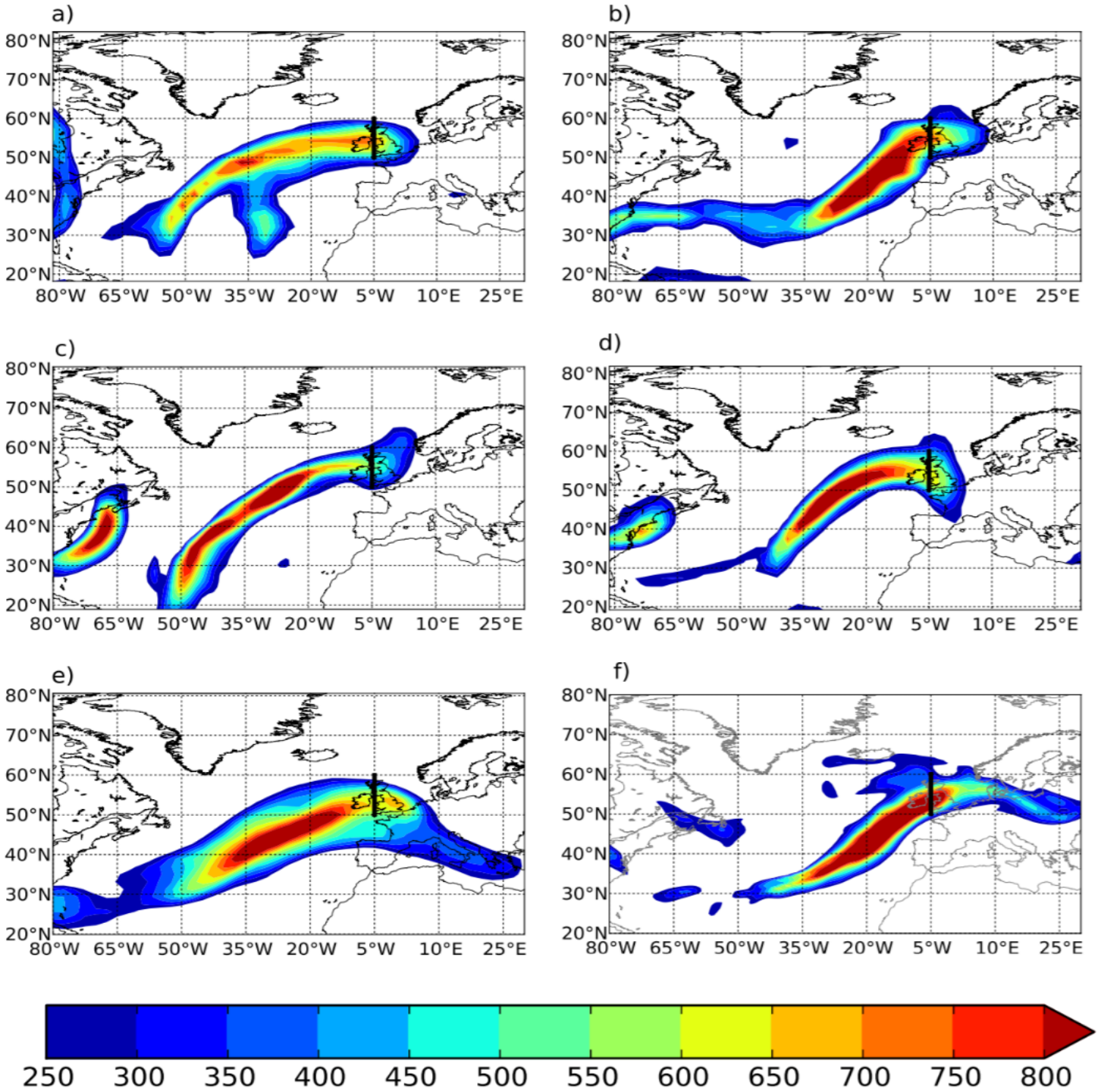
Map of predicted maximum depth of groundwater at the surface in the Hambleden valley in the 3.3% AEP event, as well as the extent of flooding predicted in the 2014 and 1% events.

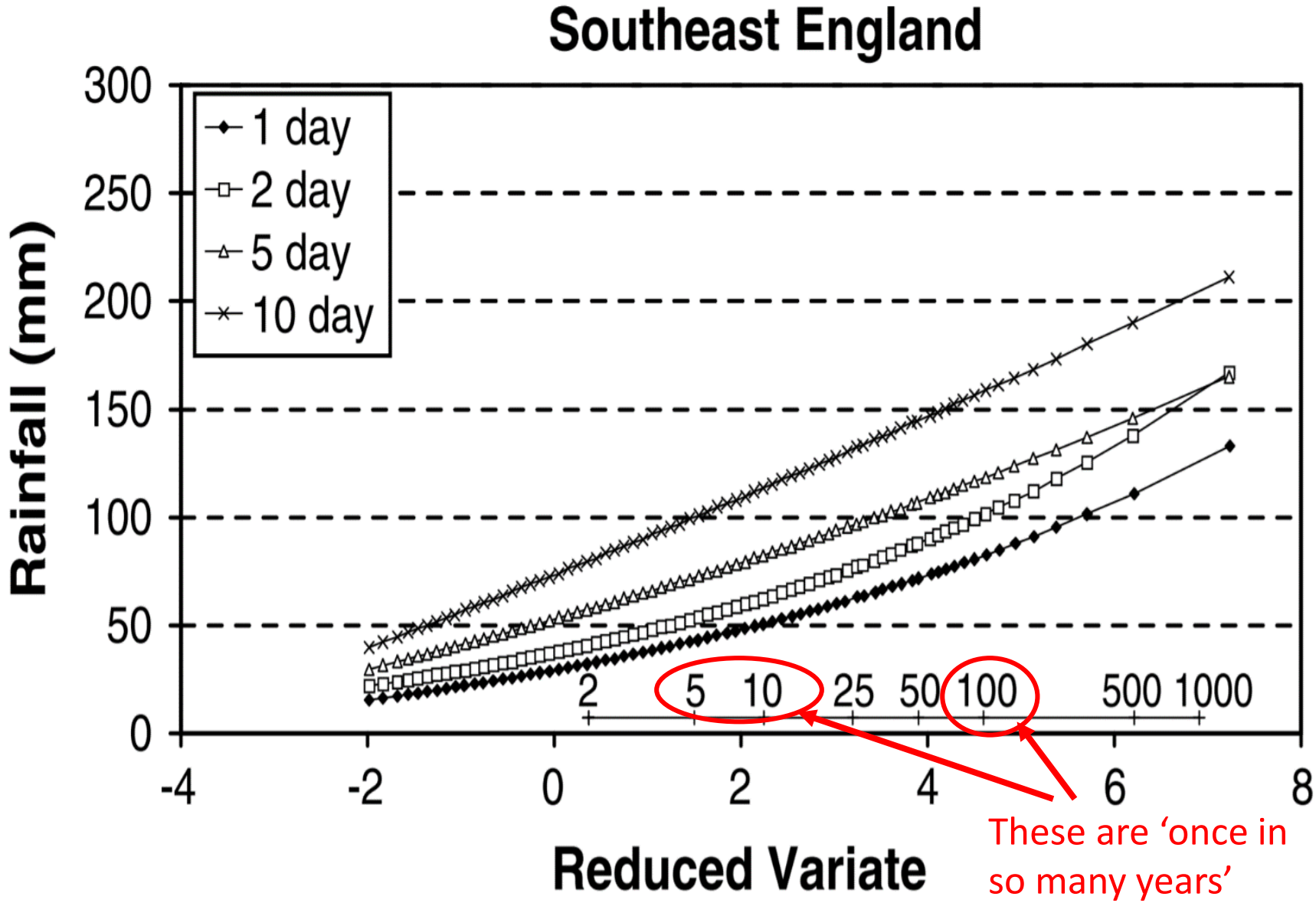
Turquoise shading is c. 10cm, Royal blue is 30cm.



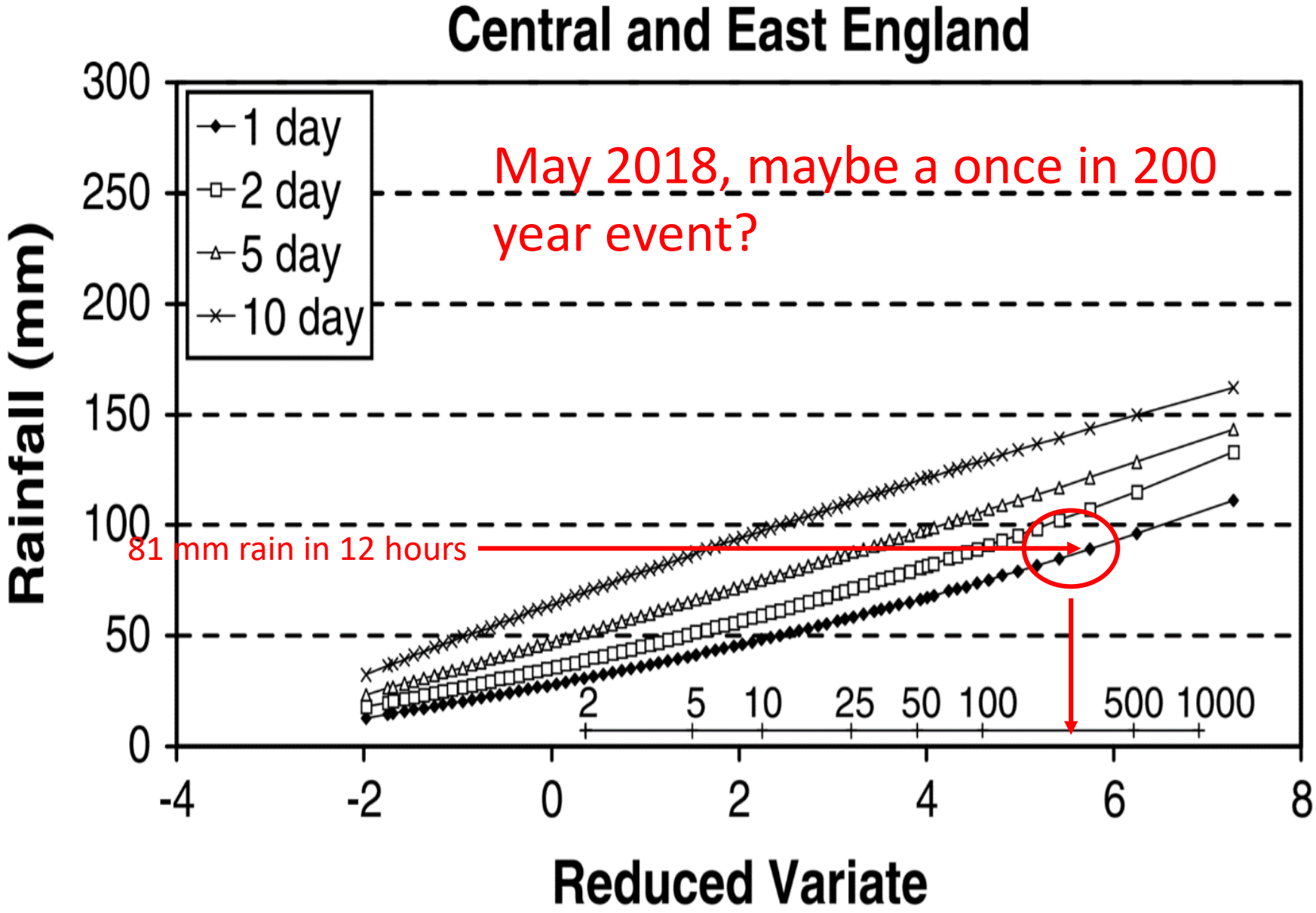

Met Office
19-20 July 2007
Precipitation (mm)
>125
100 to 125
75 to 100
50 to 75
25 to 50
5 to 25
0 to 5
© Crown Copyright

Future changes in **atmospheric rivers** and their implications for winter flooding in Britain, after Lavers *et al* (2013)
Images show modelled water vapour at six hour intervals, in kg/m/s



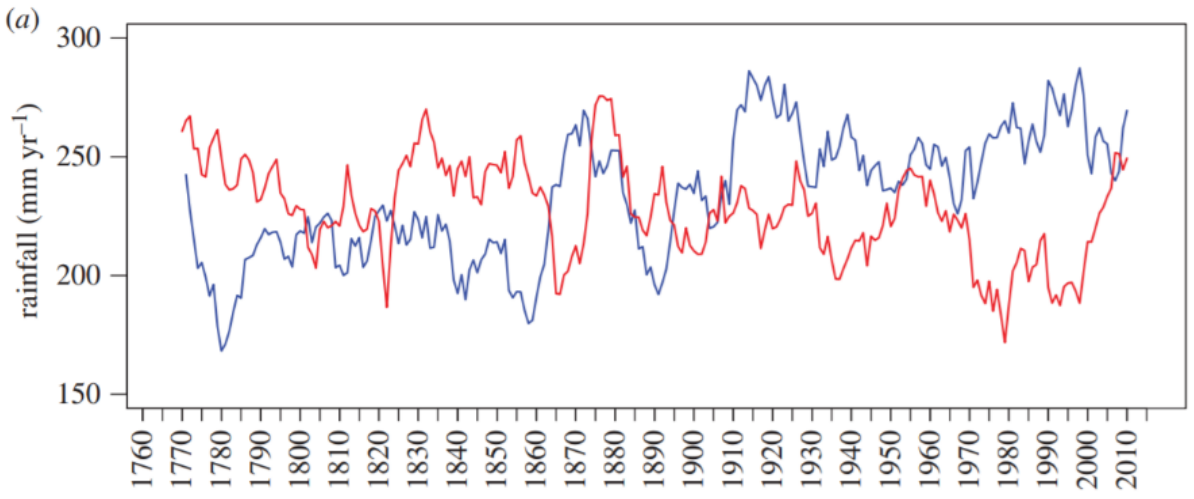


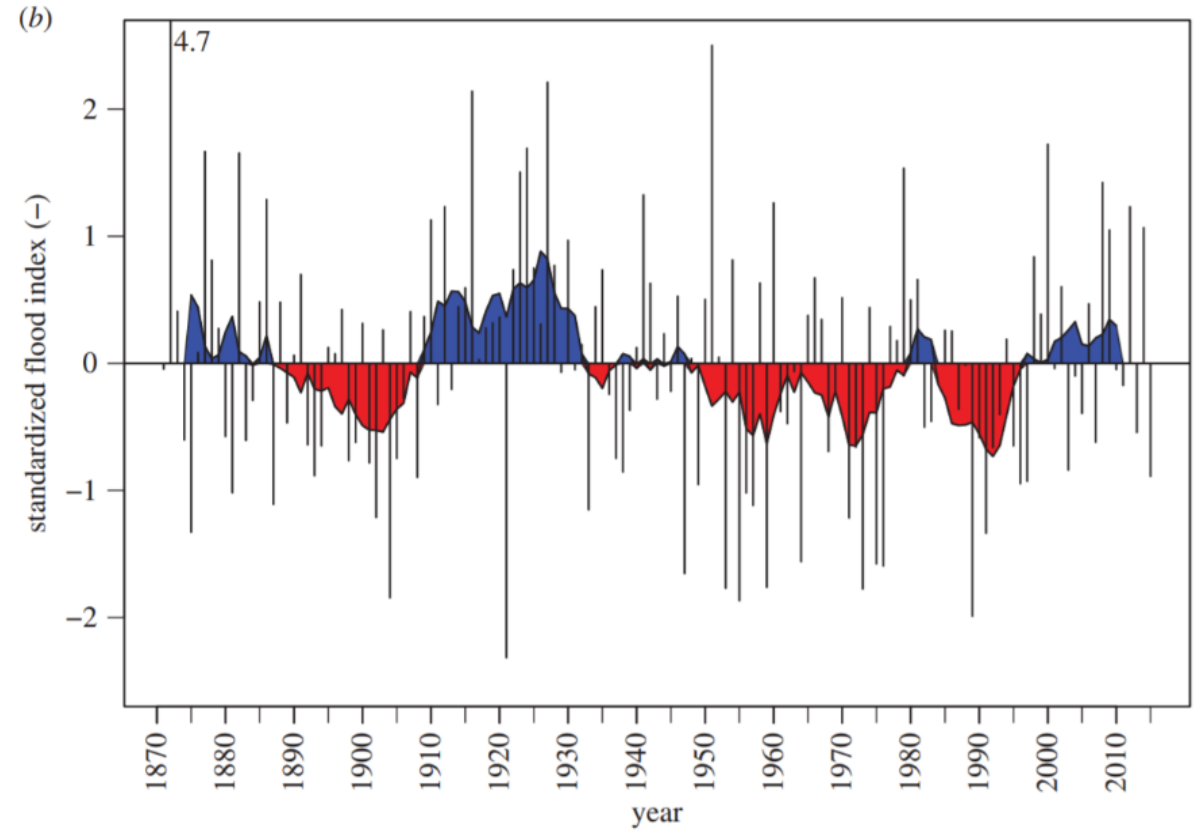
Fowler and Kilsby, 2003, on multi day extreme rainfall events



Fowler and Kilsby, 2003, on multi day extreme rainfall events


Calderdale, 2014, 2015, 2016…..





Climate variability and flooding.

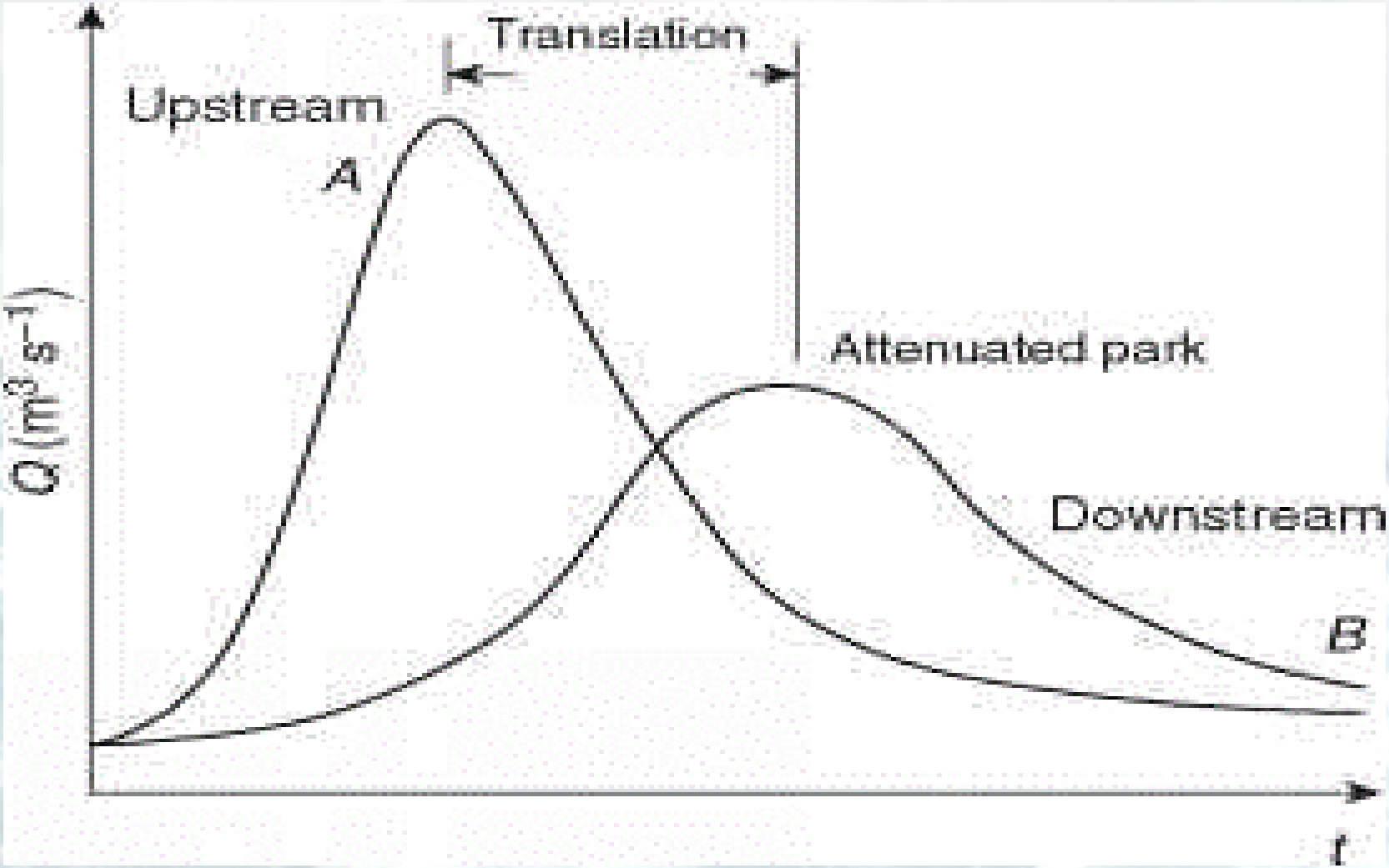
(a) England and Wales precipitation seasonality (1776–2015); blue line is winter precipitation; red summer precipitation.

(b) Annual mean flood index (1871–2015). The blue and red shading shows flood-rich and flood-poor periods

Royal Society, 2017

Carlisle after Storm Desmond, December 2015.
Met Office records show that since 1910 there have been 17 record breaking rainfall months or seasons – nine since 2000

Downstream attenuation of flood peak




US Terra Satellite image of London, NASA, October 2001

US Terra Satellite image of Isle of Dogs development in the floodplain, NASA, 2007


Flood

The Farmer Myth

Brecon Beacons, May 2018

Farmers do not enhance flooding deliberately. They have been incentivised since WWII to produce cheap food. Technological developments such as chemical fertilisers and larger tractors have compacted and reduced organic matter in the soil, decreased infiltration, and generated runoff over the ground, eroding out gulleys and reducing soil depth. This increases flooding downstream. After BREXIT, will the CAP be replaced by policies giving increased environmental protection?

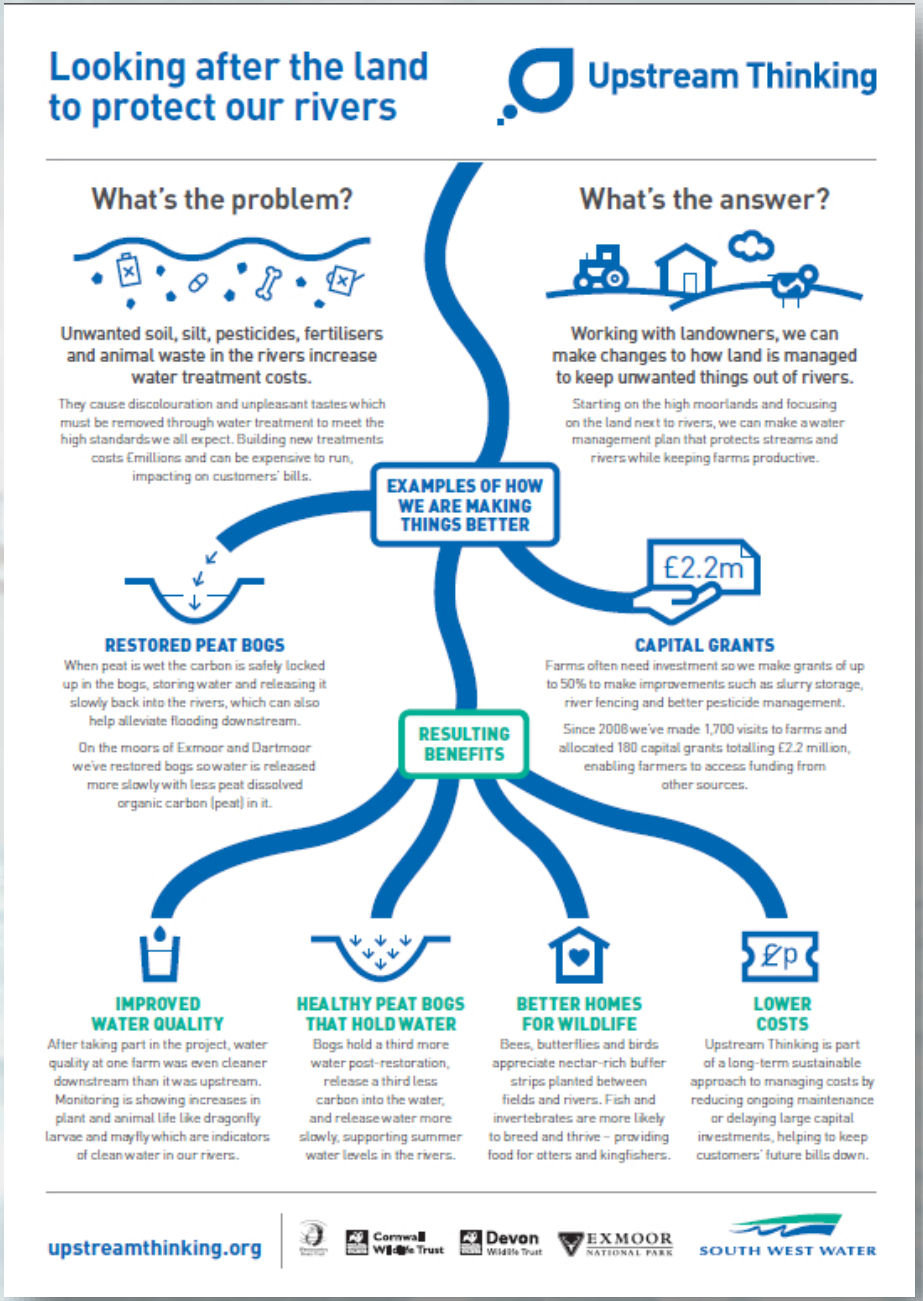
Loss of topsoil reduces soil depth and enhances runoff. Deposited soil blocks drains, and silts up river channels if excessive, again enhancing flooding further down the catchment area.


Not us, surely?

UPSTREAM THINKING

A South West Water Initiative

Upstream thinking can involve blocking drains and grips, to hold water back. How effective is this at reducing flooding?



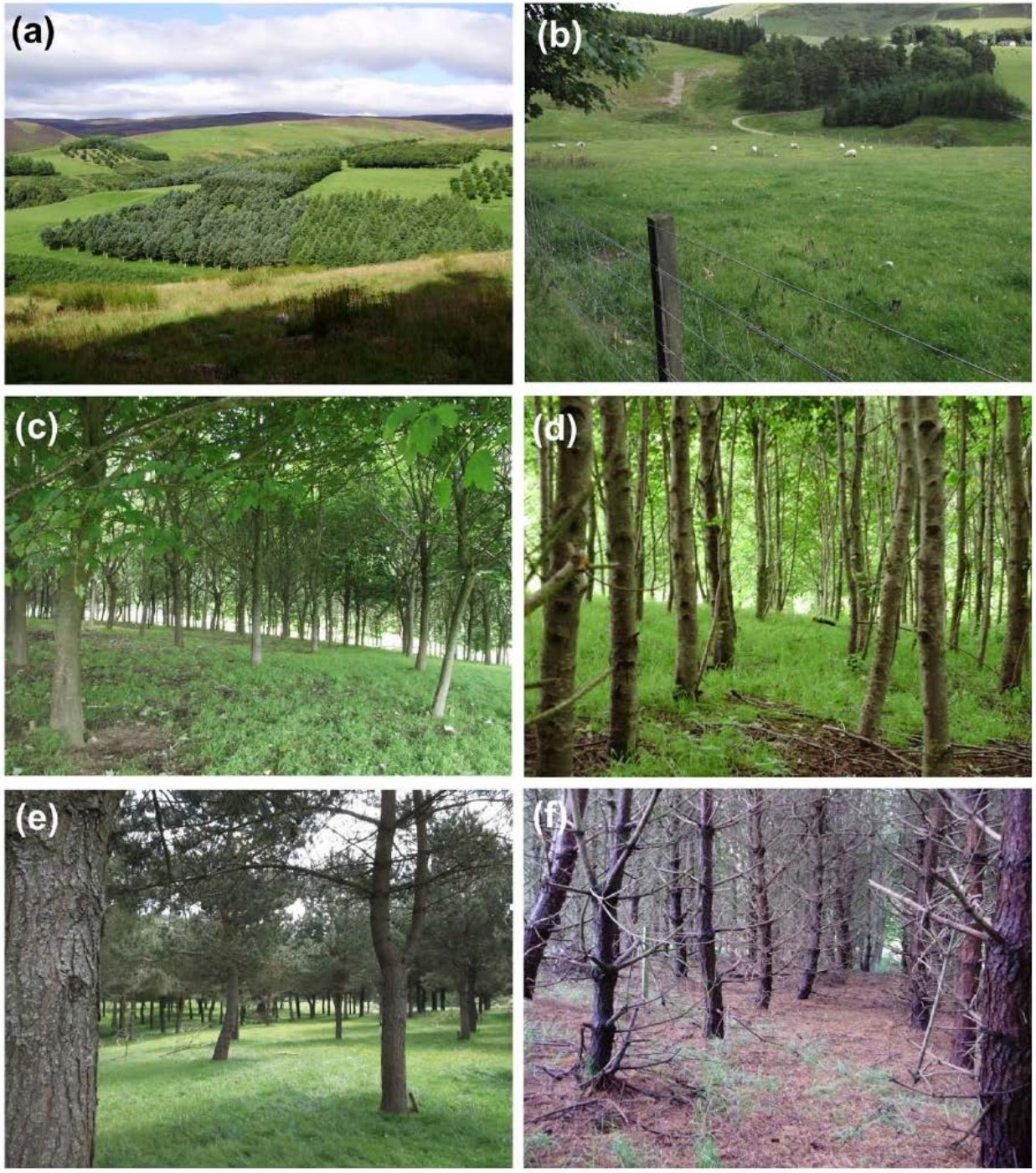


Fig. 2. Photographs of (a) the Glensaugh experimental site, and examples of (b) grazed pasture, (c) sycamore grazed forest, (d) sycamore ungrazed forest, (e) Scots pine grazed forest, and (f) Scots pine ungrazed forest. All examples of experimental treatments are taken from the Redstones block.

Chandler *et al*, 2018.

Some tree species reduce surface runoff in Scotland, but not alone. Even recreational access and grazing can reduce infiltration by half. Ditching amongst trees can enhance flooding, as seen in earlier experiments in Wales.

The Engineer Myth and its variant, the Highways Agency Myth

Streams and storm drains flowing into the River Severn near Newtown. Photo: Custodians of the River Severn

Defford Bridge, Hereford and Worcester.
Photo: Peter Edgson

Dredge the channel bigger, here in Kent

Somerset Levels, 2014

The Environment Agency says it spent £45m in the last financial year on improving river flow

BBC environment correspondent Roger Harrabin says it is a complex and controversial issue - and critics say it cannot be the total answer when more intense rainfall is anticipated if the climate changes as predicted.

He adds that it is a particularly thorny problem because the Environment Agency is facing big cuts in the staff that might deal with flood policy - there are difficult decisions to be made over how much is spent and how much priority should be given to farmland compared with homes.

Somerset Levels, 2014

James Winslade, who runs a farm near Taunton is urging the Environment Agency to dredge to help alleviate flooding.

"This is the second year in a row now and we've been banging on to the agency cleaning the rivers out. They're 42% silted up,"

He is backed by NFU, which has called for the re-introduction of "significant and consistent" river maintenance. "We must see urgent action by the EA, backed by Defra ministers, to allocate sufficient resources - or the situation, not simply in terms of the damage done to land and property, but also to trust in central government and its agencies, will be irreversible," regional director Melanie Squires said.

Somerset Levels, 2014

Alastair Chisholm, policy manager at the Chartered Institution of Water and Environmental Management, said it would not carry enough water when compared to the size of the flood plain - even if the capacity of the river were increased by 50%, it is a relatively small amount when compared to the amount of flooding in the area.

"Building up huge river banks and dredging is a very old-fashioned approach which experience shows work to a point, but when we get these extreme weather events it's not enough."

Authorities should give farmers incentives to help the wider area by keeping a portion of their land as a flood plain.

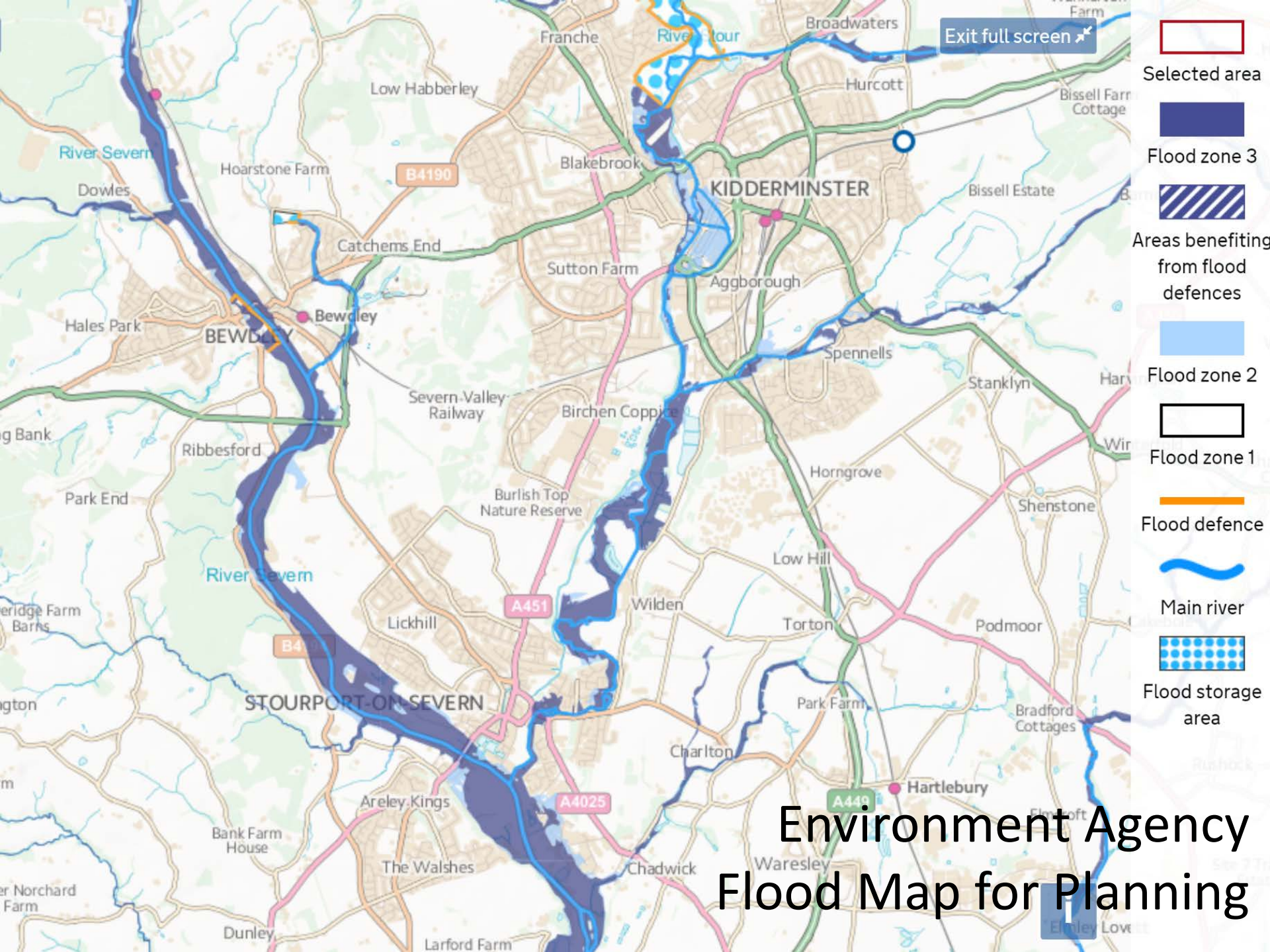
Somerset Levels, 2014

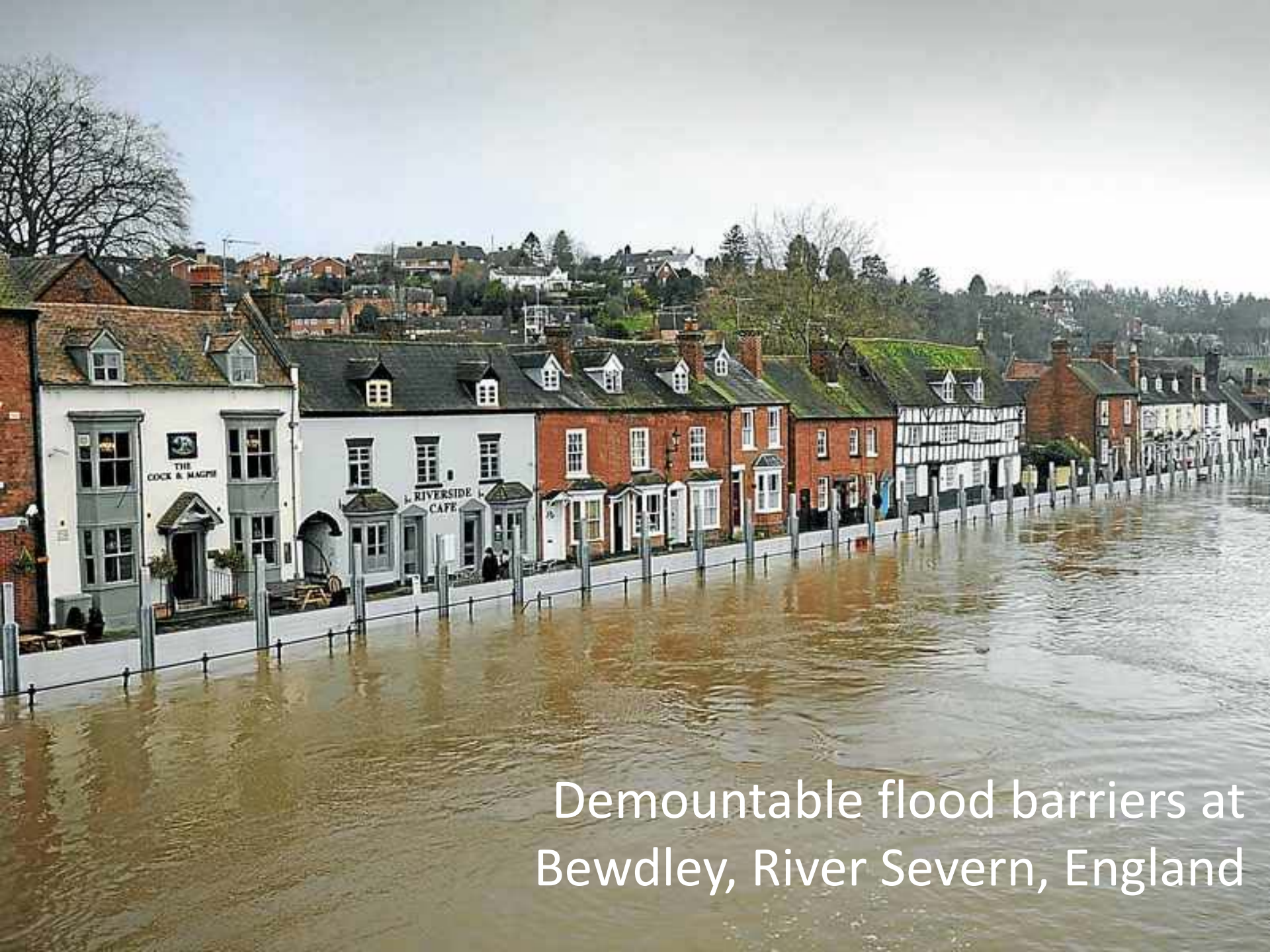
Bridgwater and West Somerset MP Ian Liddell-Grainger dismissed the claims that the rain would have overwhelmed the river system even if it had been dredged as "pathetic".

"It is an absolutely ridiculous excuse," he said. "This never flooded to this level ever in living memory, and we've got people who have been here for a long time. If you look back into the mists of time you don't have this."

Warrington's £34 million Mersey flood defences from the opened in January 2018. 2000 houses and other critical infrastructure such as electricity substations protected from high tides and river flow. 5 km walls, 2.2 km embankments. 500 m of Padgate Brook realigned to look more natural, and 5 ha of new reedbeds.

£29m from Grant-in-Aid, £4m from Warringon Borough Council, £2m from Scottish Power and the rest from the Environment Agency.


Exit full screen
Selected area
Flood zone 3
Areas benefiting from flood defences
Flood zone 2
Flood zone 1
Flood defence
Main river
Flood storage area
Environment Agency
Flood Map for Planning
KIDDERMINSTER
BEWDLEY
STOURPORT-ON-SEVERN
Bewdley
River Severn
Severn Valley Railway
Broadwaters
Franche
Low Habberley
Hurcott
Blakebrook
Bissell Estate
Catchems End
Sutton Farm
Aggborough
Hales Park
Spennells
Stanklyn
Ribbesford
Park End
Birchen Coppice
Burlish Top Nature Reserve
Horngrove
Shenstone
Low Hill
Wilden
Lickhill
Torton
Podmoor
Park Farm
Bradford Cottages
Charlton
Hartlebury
Areley Kings
Bank Farm House
The Walshes
Chadwick
Waresley
Dunley
Larford Farm
Dowles
Hoarstone Farm
B4190
A451
A4025
A449

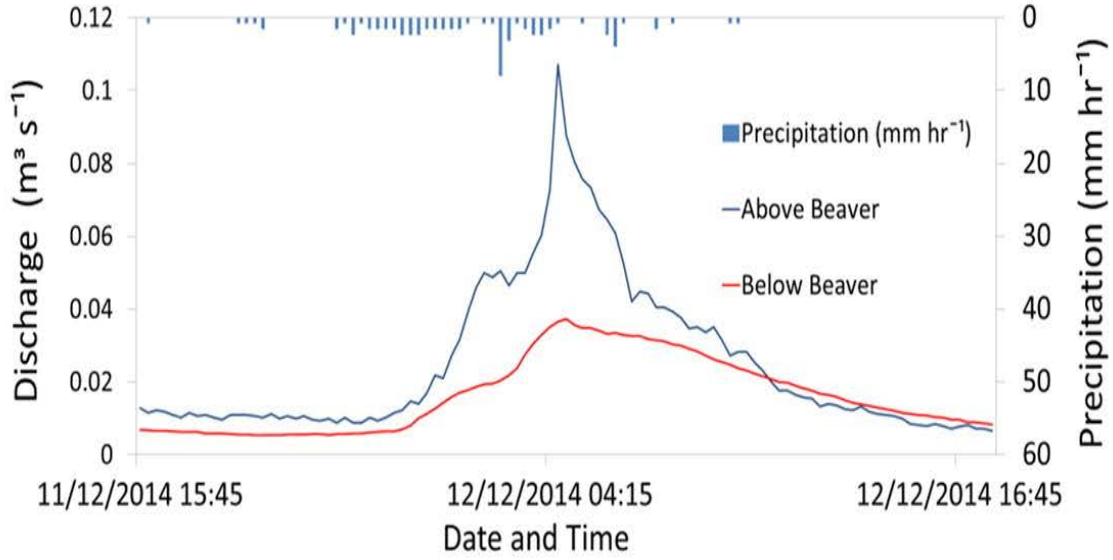


Demountable flood barriers at Bewdley, River Severn, England

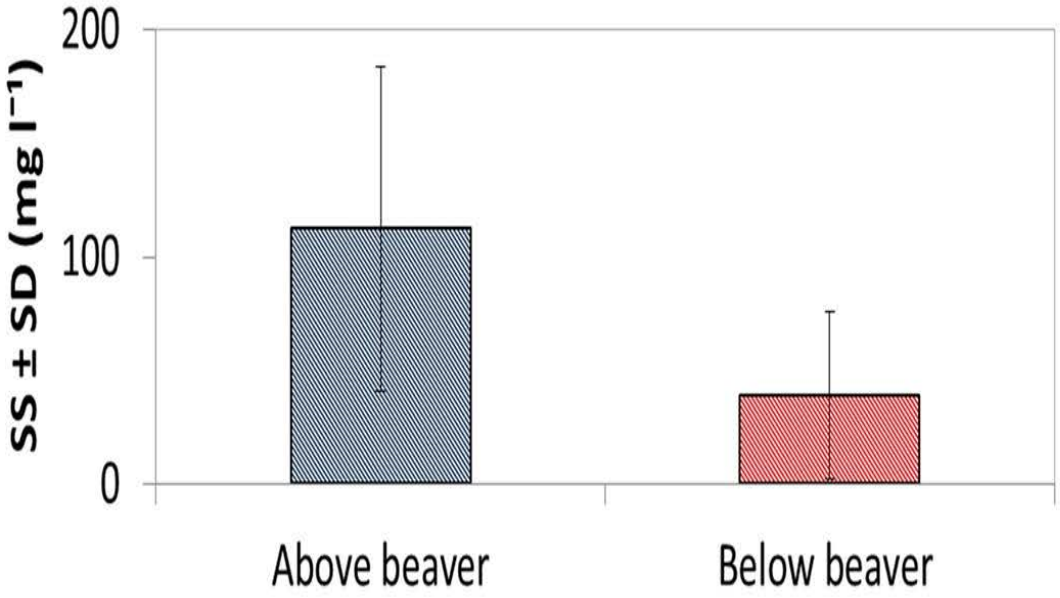

DN04 MZU

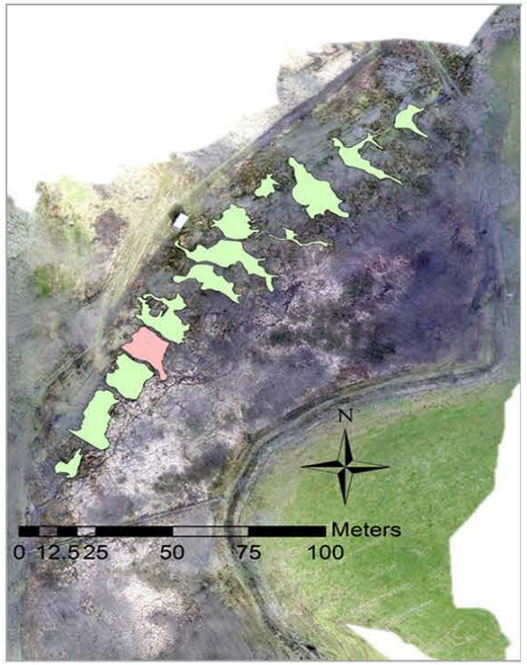
The Beaver Myth

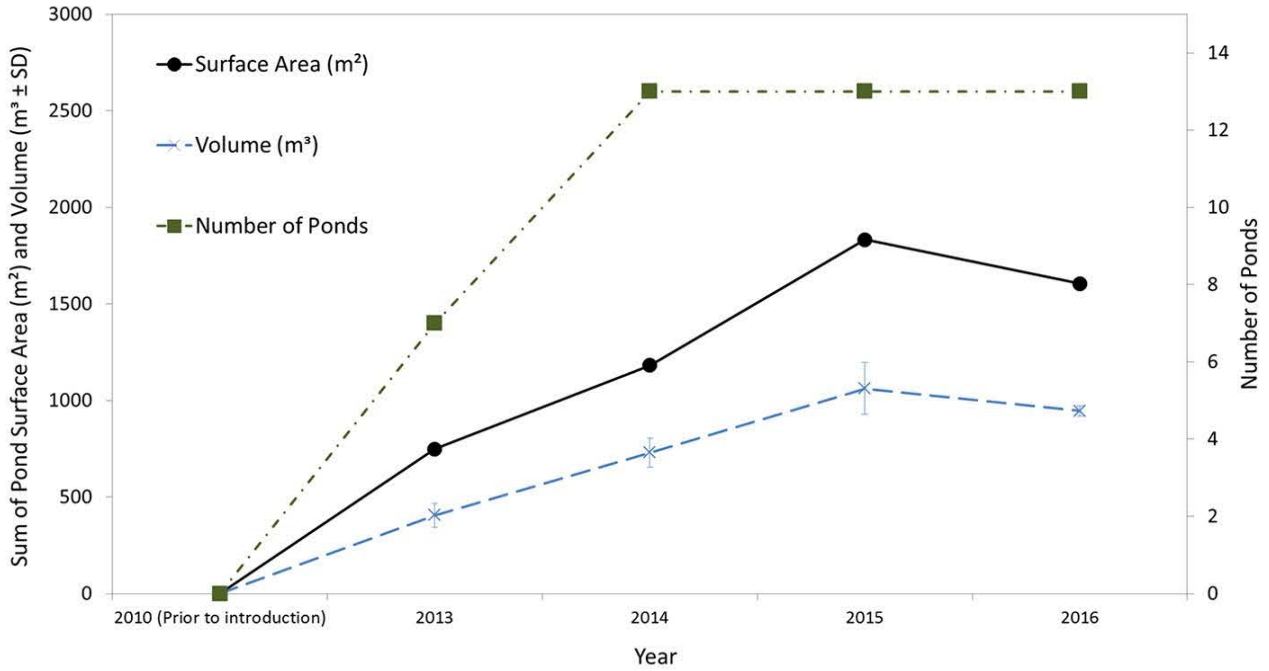
Flow In and Out of Beaver Site

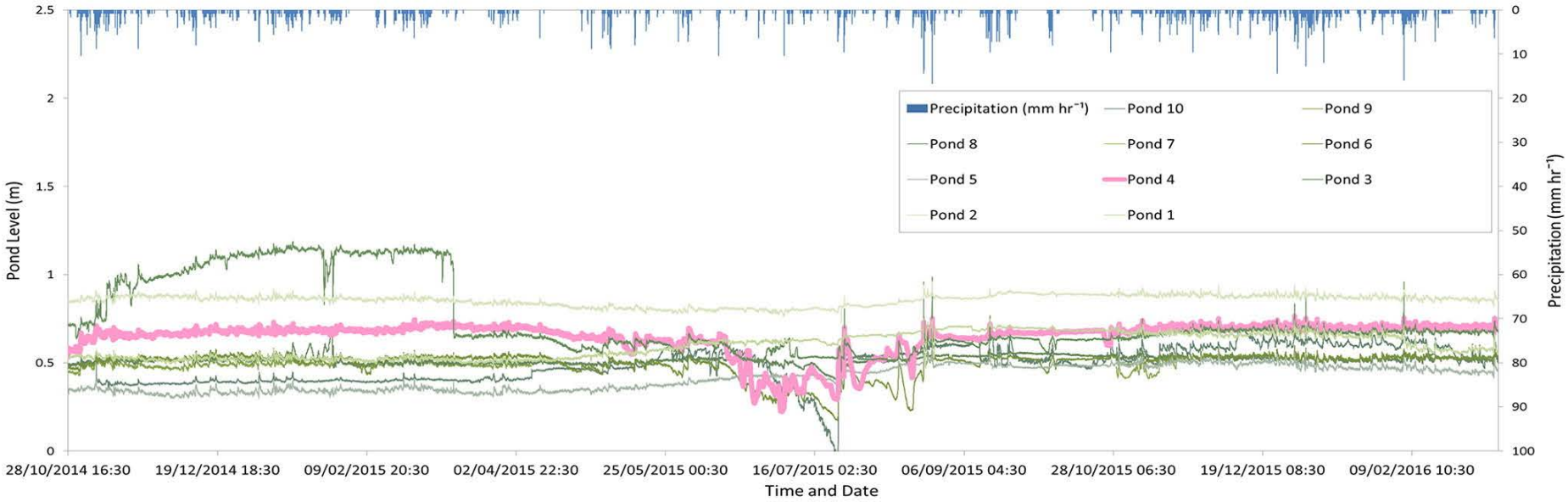


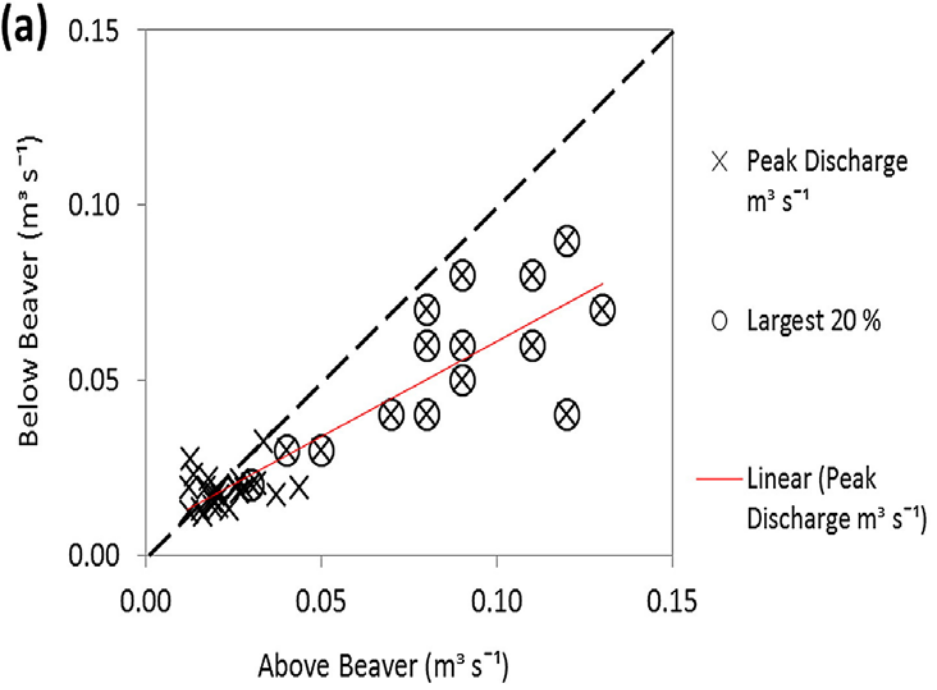
Suspended Sediment Above and Below Beaver Site

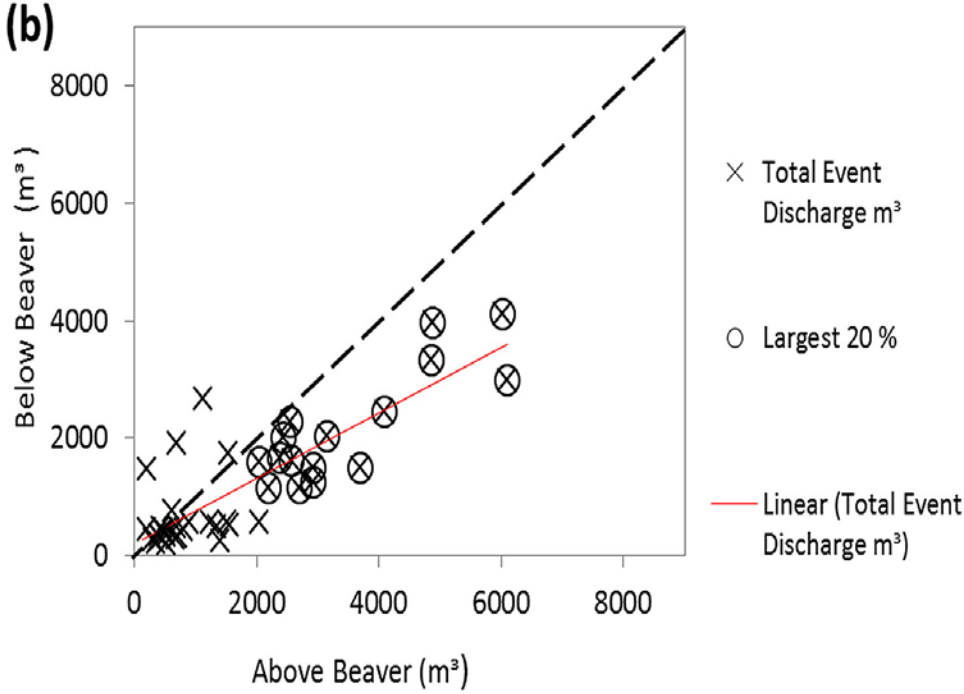


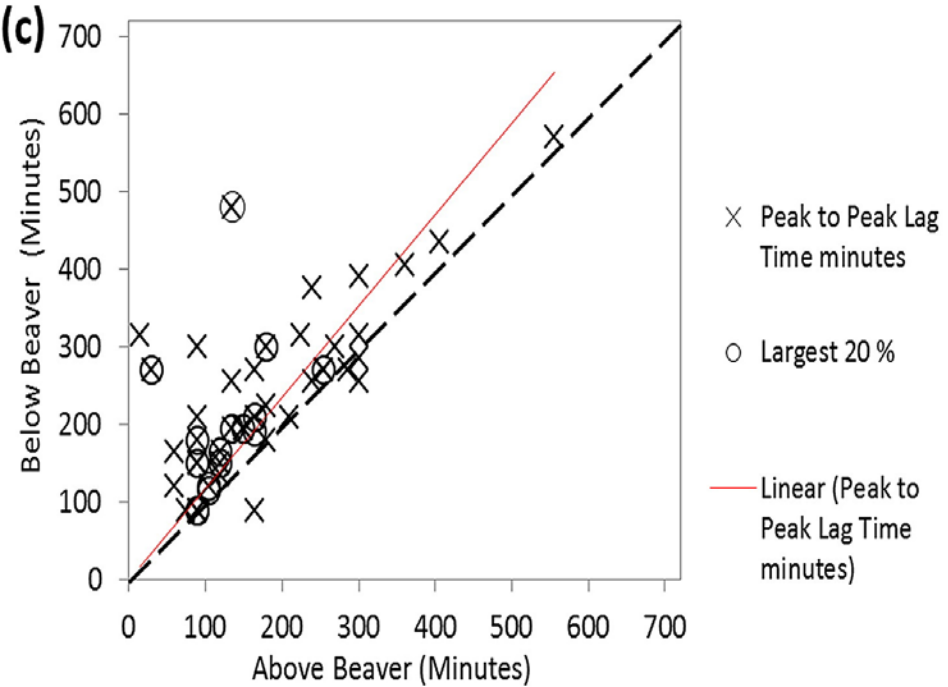

N
Meters
0 12.5 25 50 75 100


Surface Area (m²)
Volume (m³)
Number of Ponds
Sum of Pond Surface Area (m²) and Volume (m³ ± SD)
Number of Ponds
Year
2010 (Prior to introduction)
2013
2014
2015
2016
0
500
1000
1500
2000
2500
3000
2
4
6
8
10
12
14


Precipitation (mm hr⁻¹)
Pond 10
Pond 9
Pond 8
Pond 7
Pond 6
Pond 5
Pond 4
Pond 3
Pond 2
Pond 1
Pond Level (m)
Precipitation (mm hr⁻¹)
Time and Date
28/10/2014 16:30
19/12/2014 18:30
09/02/2015 20:30
02/04/2015 22:30
25/05/2015 00:30
16/07/2015 02:30
06/09/2015 04:30
28/10/2015 06:30
19/12/2015 08:30
09/02/2016 10:30







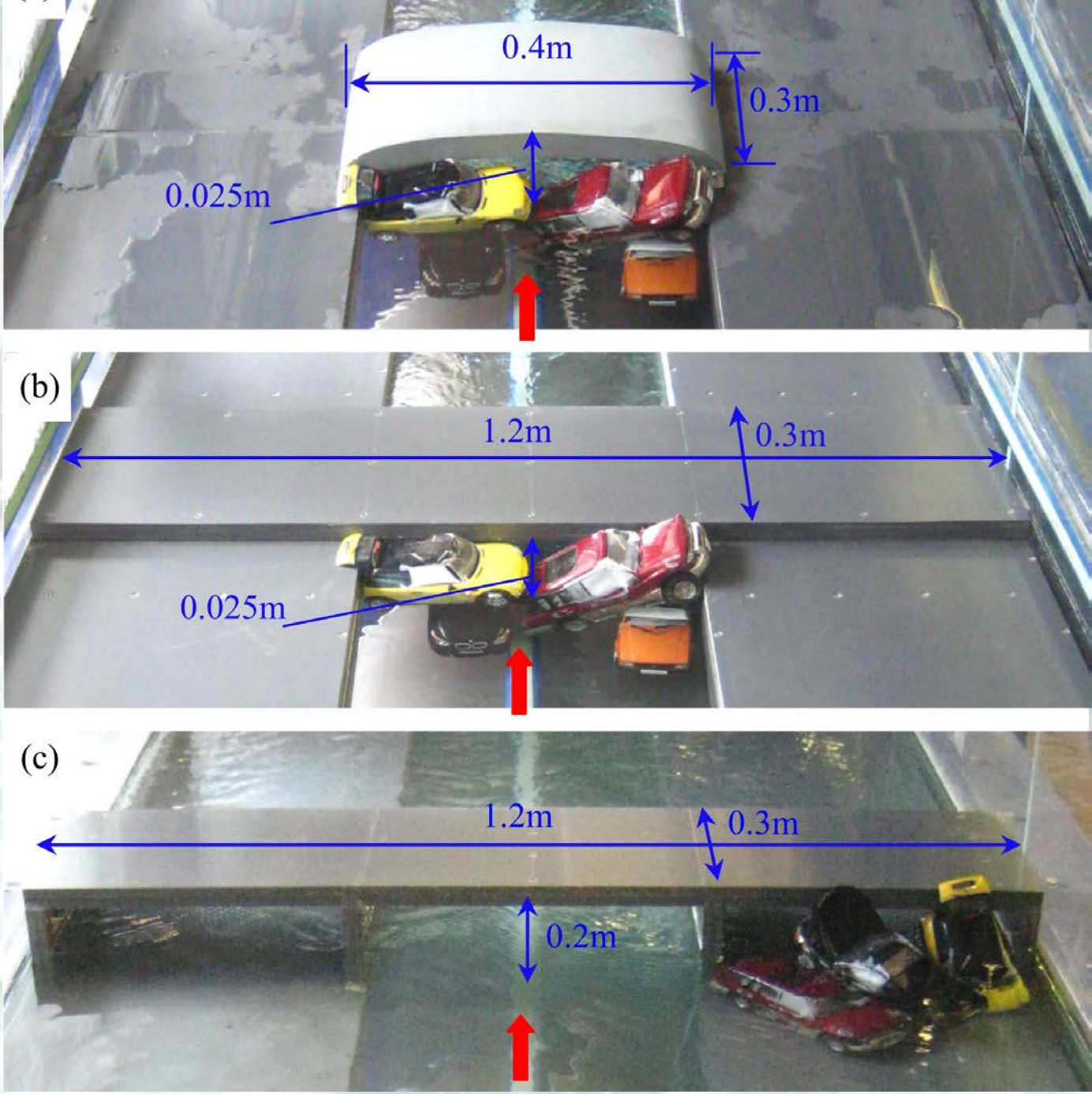
The dotted line represents equivalence between 'above beaver'(x-axis) and 'below beaver' (y-axis) sites.
Beavers reduce peakflow, may reduce overall flow, and delay runoff.

The Council Myth

Brook Street Syston, Leicestershire, flooded, 6 July 2012

A bridge blocked by vehicles and debris during the 2004 Boscastle flood (http://www.tintagelweb.co.uk).

Physical river model with vehicle blockage for three designs of scaled model bridge:
(a) a single opening arch bridge;
(b) a straight deck bridge; and
(c) a three-opening straight deck




BYU
IDAHO

The Architect and Landscape Architect Myth

Designing to maximise infiltration and minimise runoff

Green roofs in Western Paris suburbs

Seine, Paris in January 2018. Dec-Jan is the third wettest period since records began in 1900. Parts of Metro flooded. 1.75 rats per person flushed from

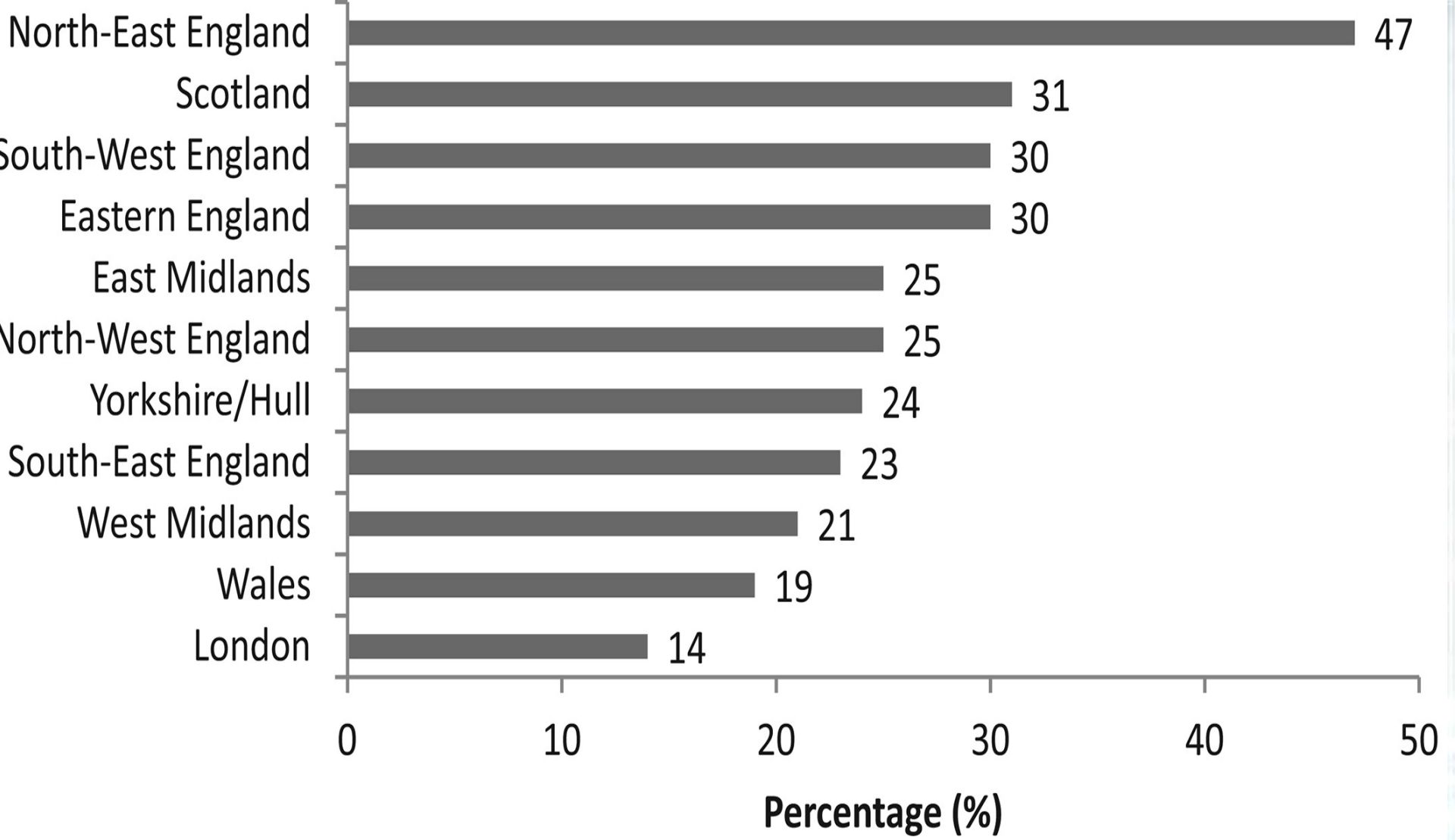
SuDS. Photo: Unda Consulting

Soft permeable paving and planting, Arup project

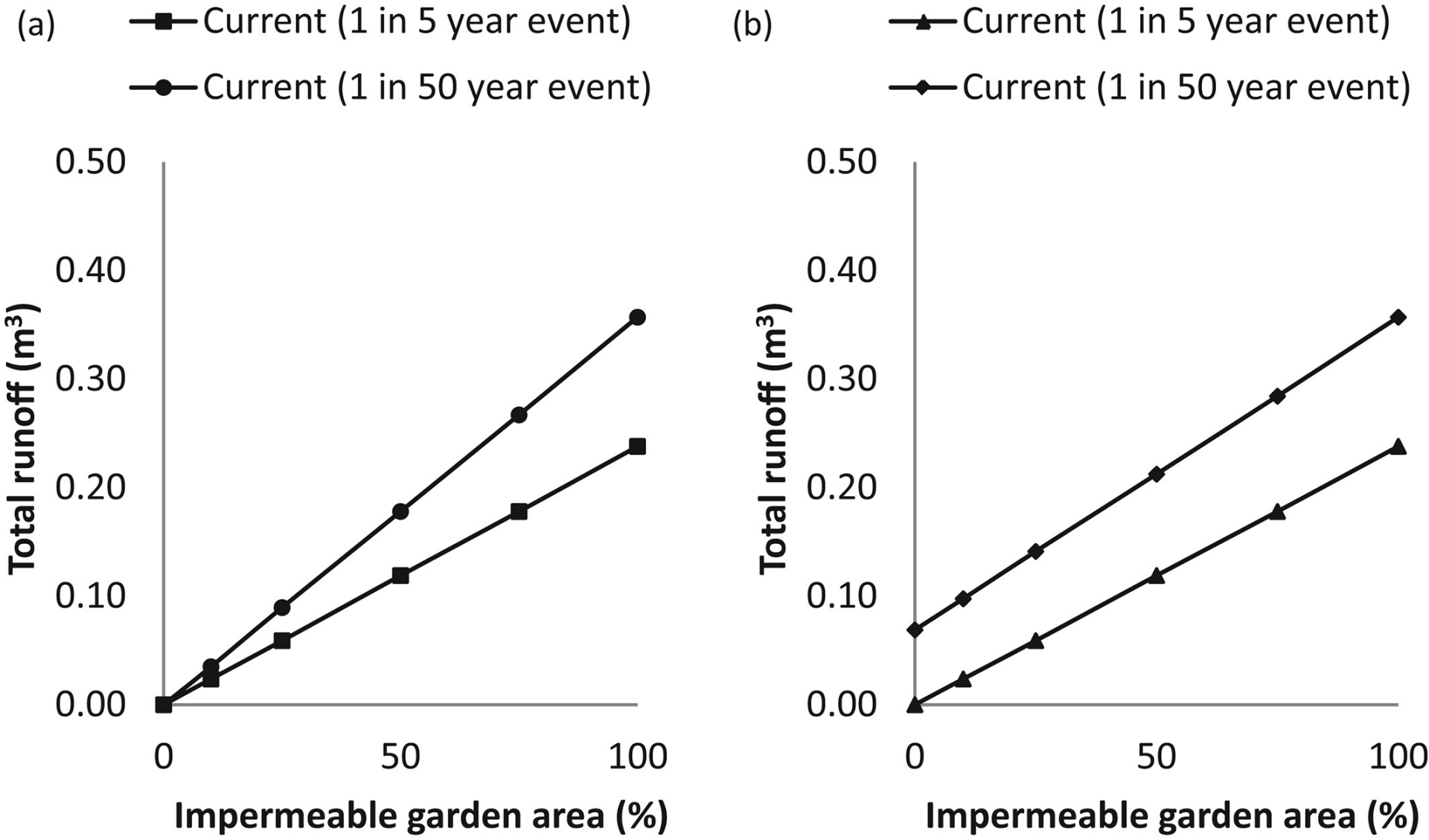
The Myth of the Front Drive



Front gardens covered with impermeable paving to provide off-street parking in residential areas of Edinburgh (Source: D.A. Kelly).

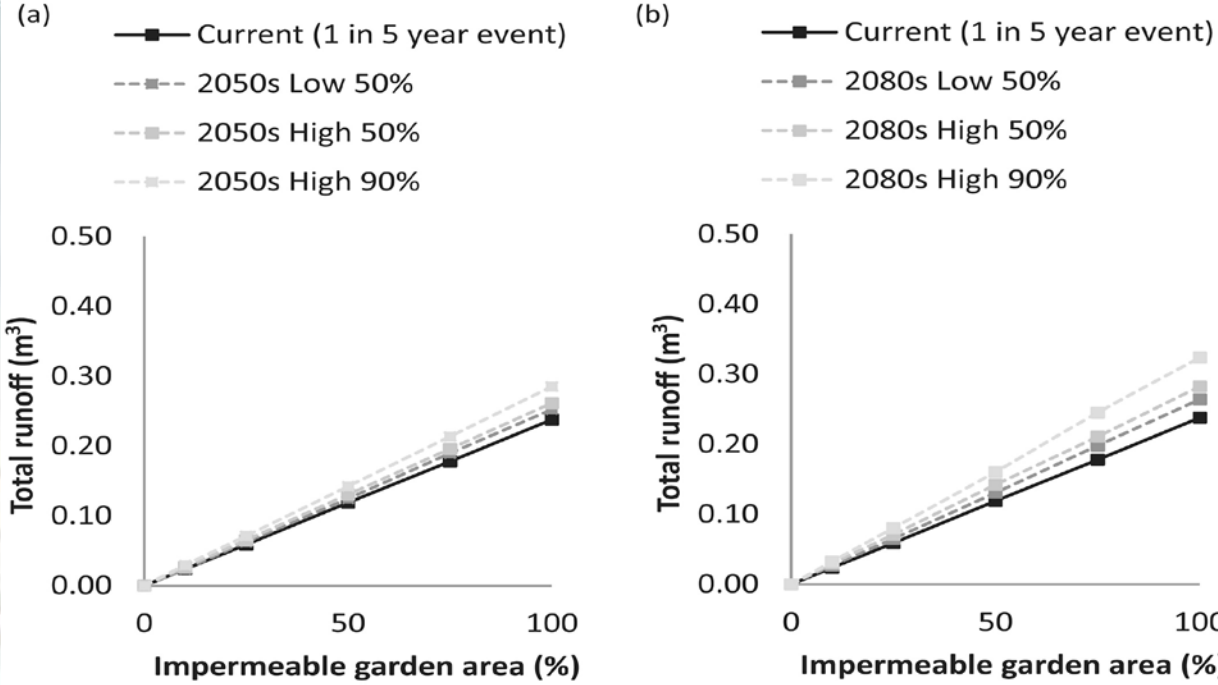


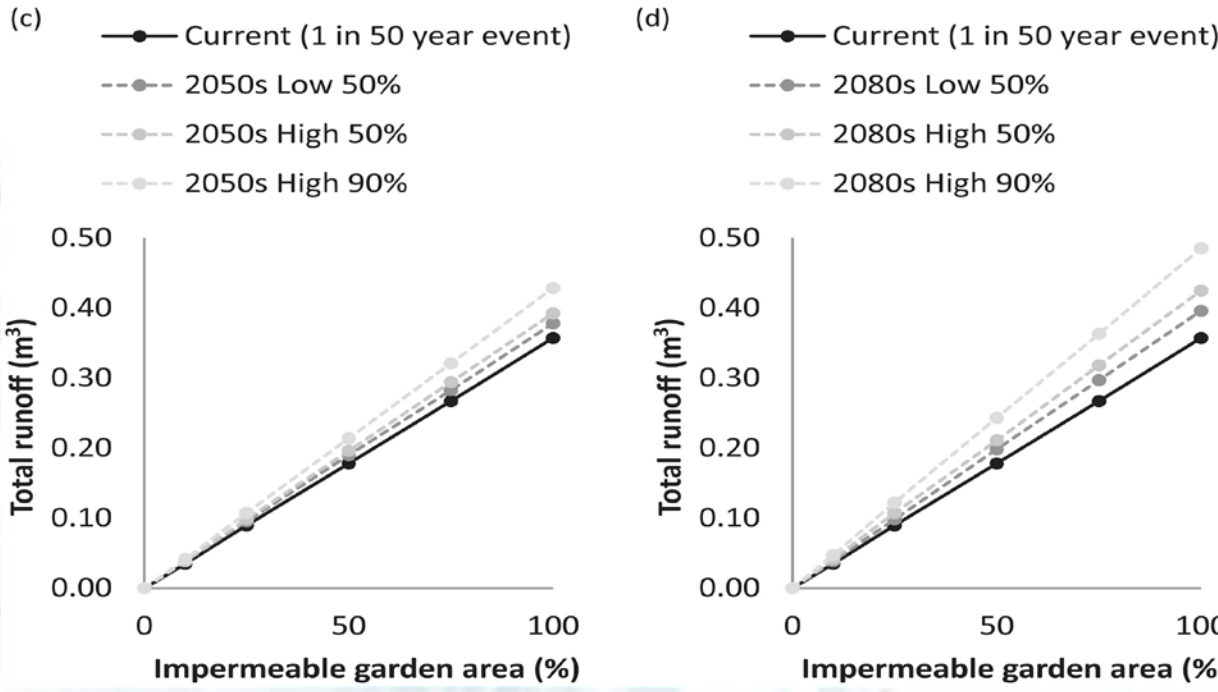
Proportion of front gardens across the UK which are at least 75% covered with impermeable paving (Royal Horticultural Society, 2006).



Simulated runoff volumes from the typical front garden for different impermeable areas in response to current design rainfall intensities of both the 1 in 5 and 1 in 50 year events for (a) soil type A and (b) soil type D. In Kelly

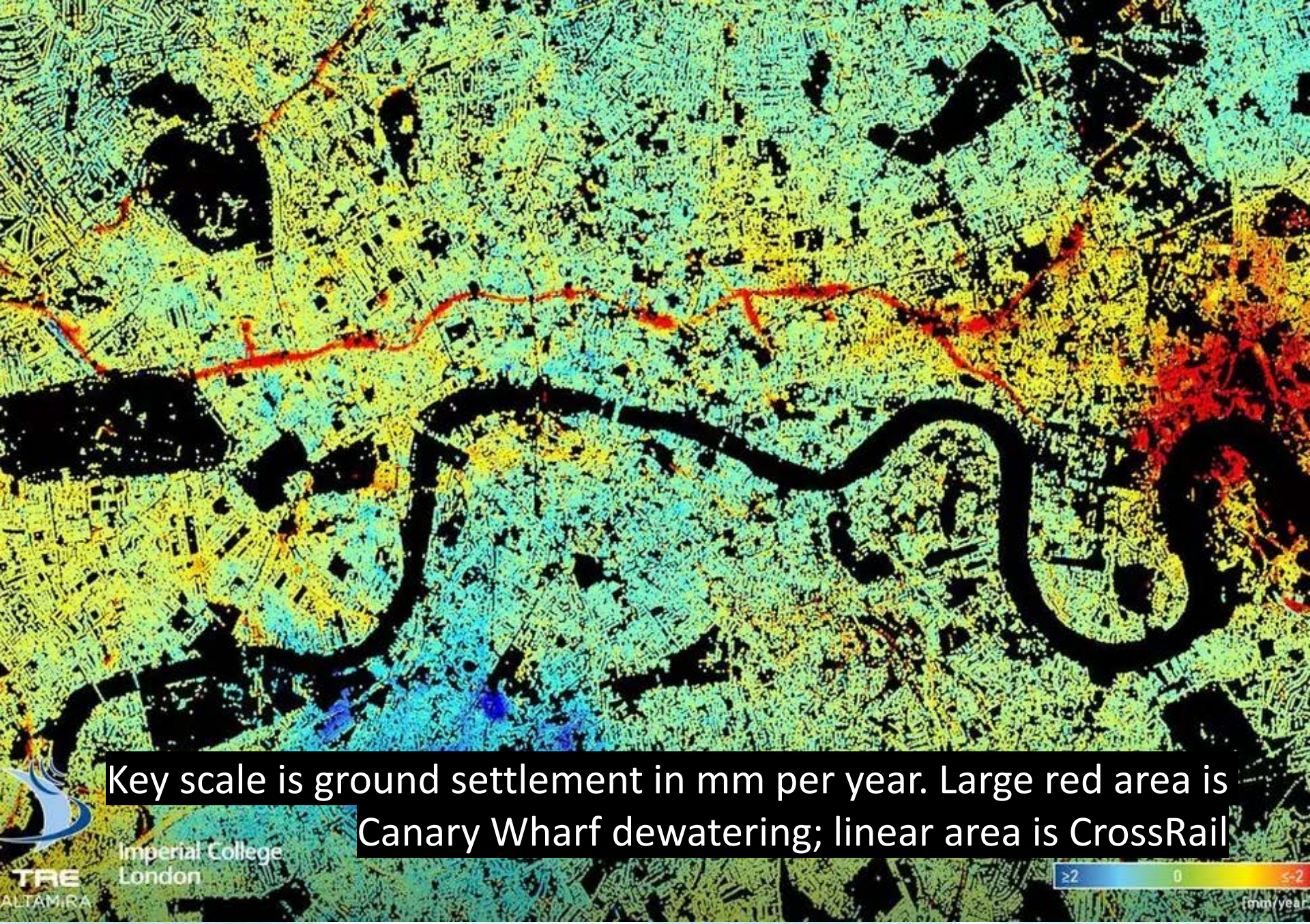
For soil type A, simulated runoff volumes from the typical front garden for different impermeable areas in response to increased future rainfall based on the 1 in 5 year event for (a) the 2050s and (b) the 2080s, and on the 1 in 50 year event for (c) the 2050s and (d) the 2080s.

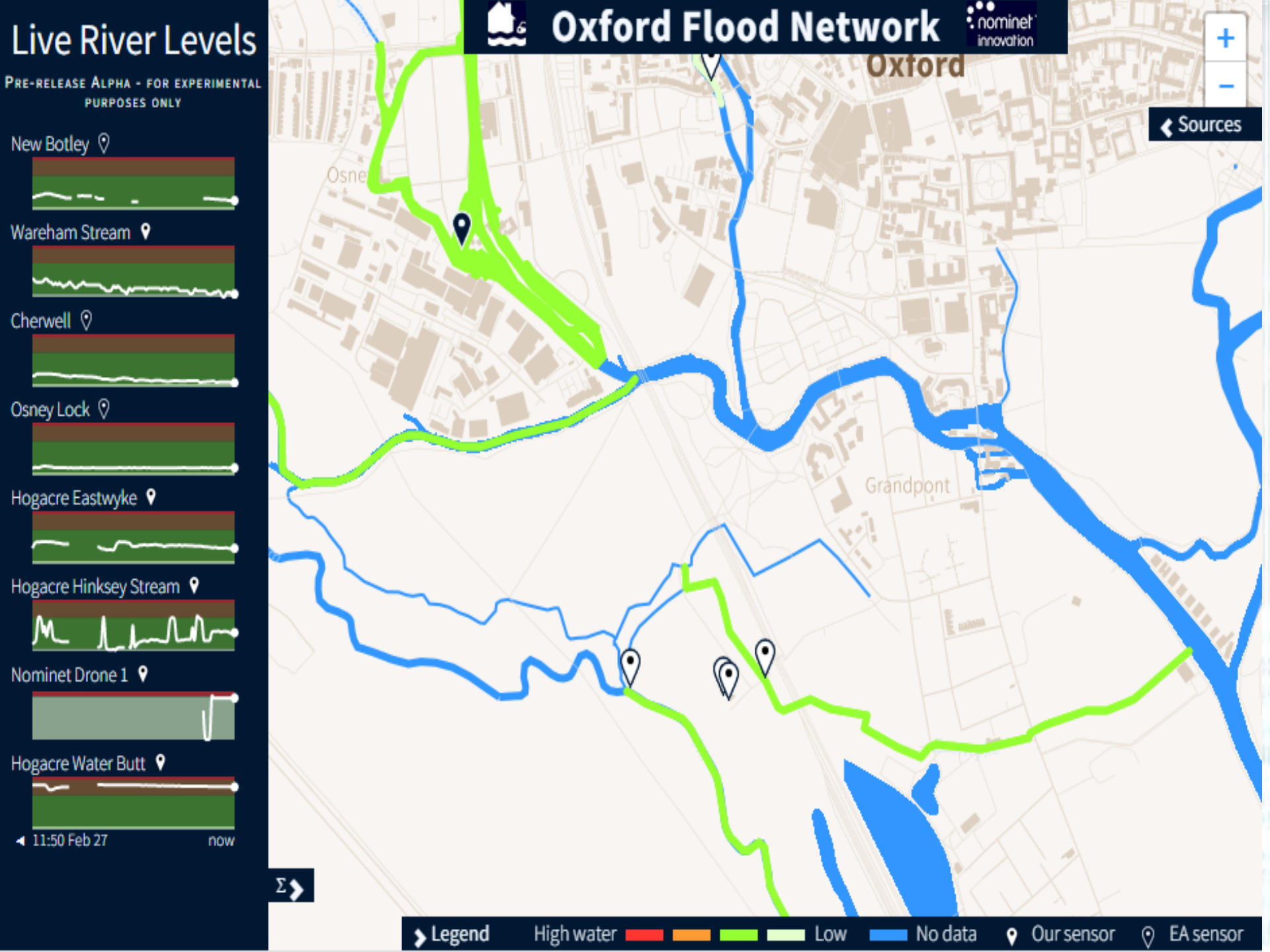




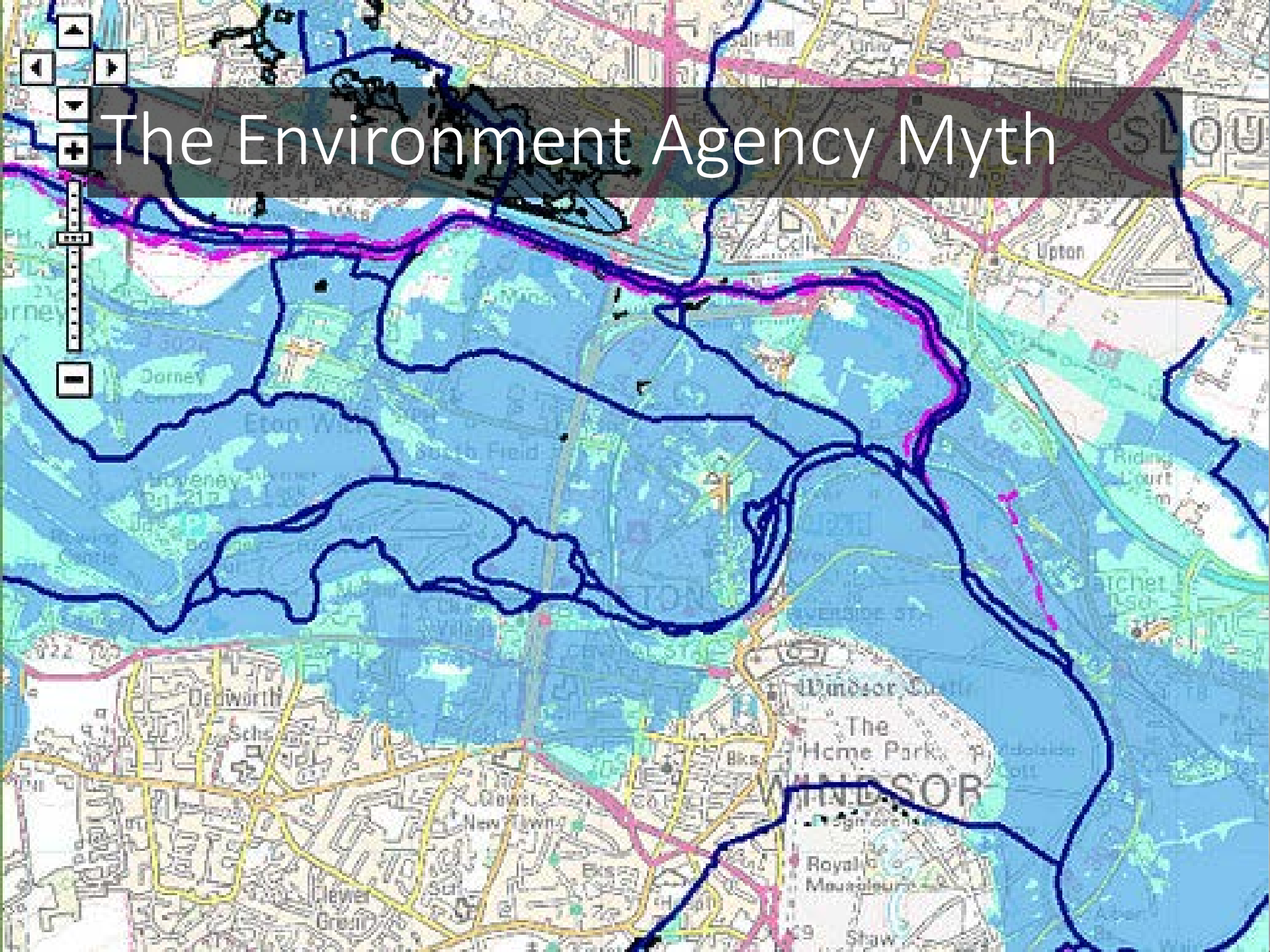
River Ouse in York, Boxing Day 2015. Closing flood barriers direct water from the Ouse to the Foss, for periods of days

The Scientist Myth


Key scale is ground settlement in mm per year. Large red area is Canary Wharf dewatering; linear area is CrossRail
Imperial College London
TRE ALTAMIRA
≥2
0
≤-2
(mm/year)


Live River Levels
Pre-release Alpha - for experimental purposes only
New Botley
Wareham Stream
Cherwell
Osney Lock
Hogacre Eastwyke
Hogacre Hinksey Stream
Nominet Drone 1
Hogacre Water Butt
11:50 Feb 27
now
Oxford Flood Network
nominet innovation
Oxford
Sources
Grandpont
Legend
High water
Low
No data
Our sensor
EA sensor

The Environment Agency Myth

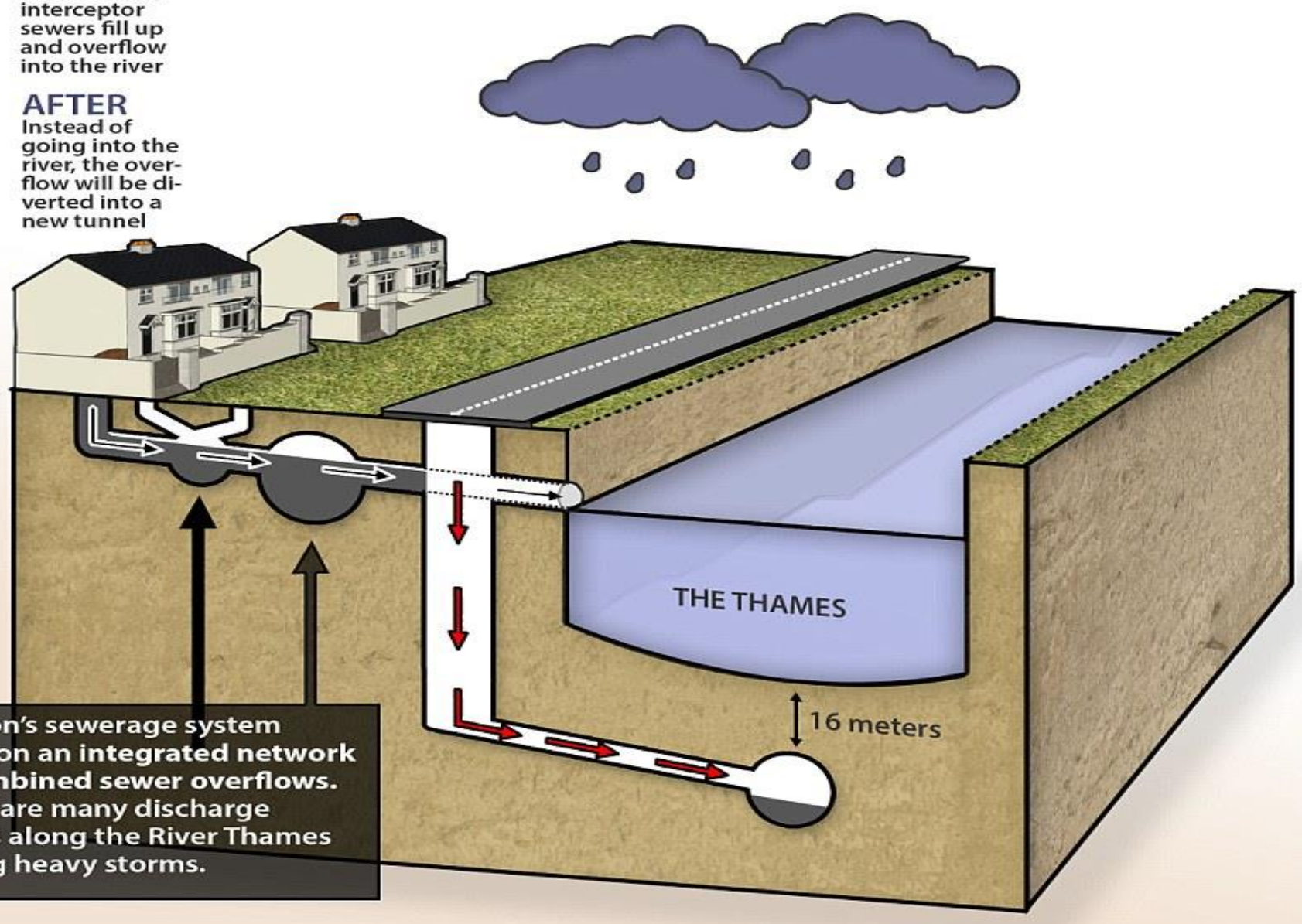


The Water Company Myth

THAMES TUNNEL - How it will work

NOW
The low level interceptor sewers fill up and overflow into the river

AFTER
Instead of going into the river, the over-flow will be di-verted into a new tunnel



London's sewerage system relies on an integrated network of combined sewer overflows. There are many discharge points along the River Thames during heavy storms.

Thames Tideway tunnel – an expensive vanity project?

The Thames Tideway Tunnel, at Beckton

Thames Water is responsible for flooding from public sewers in their area

- Thames Water has a £1.8 billion turnover, and has banked £1.2 billion in the last ten years
- Thames Water has not paid corporation tax in the UK

From the Observer, 27th May 2018

The Politician Myth

River Derwent, Cockermouth, Cumbria, December 2015 after Storm Desmond. Fourth major flood since 2005, with 500 properties repeatedly flooded

How can technology contribute to resilient flooding solutions?

SuDS tank installation, using Ecobloc. Photo: Geogreen solutions

Wet testing of a door guard. Source: Flood Angel®

Market Harborough, Leicestershire, 27 July 2013


Climate Science Myth
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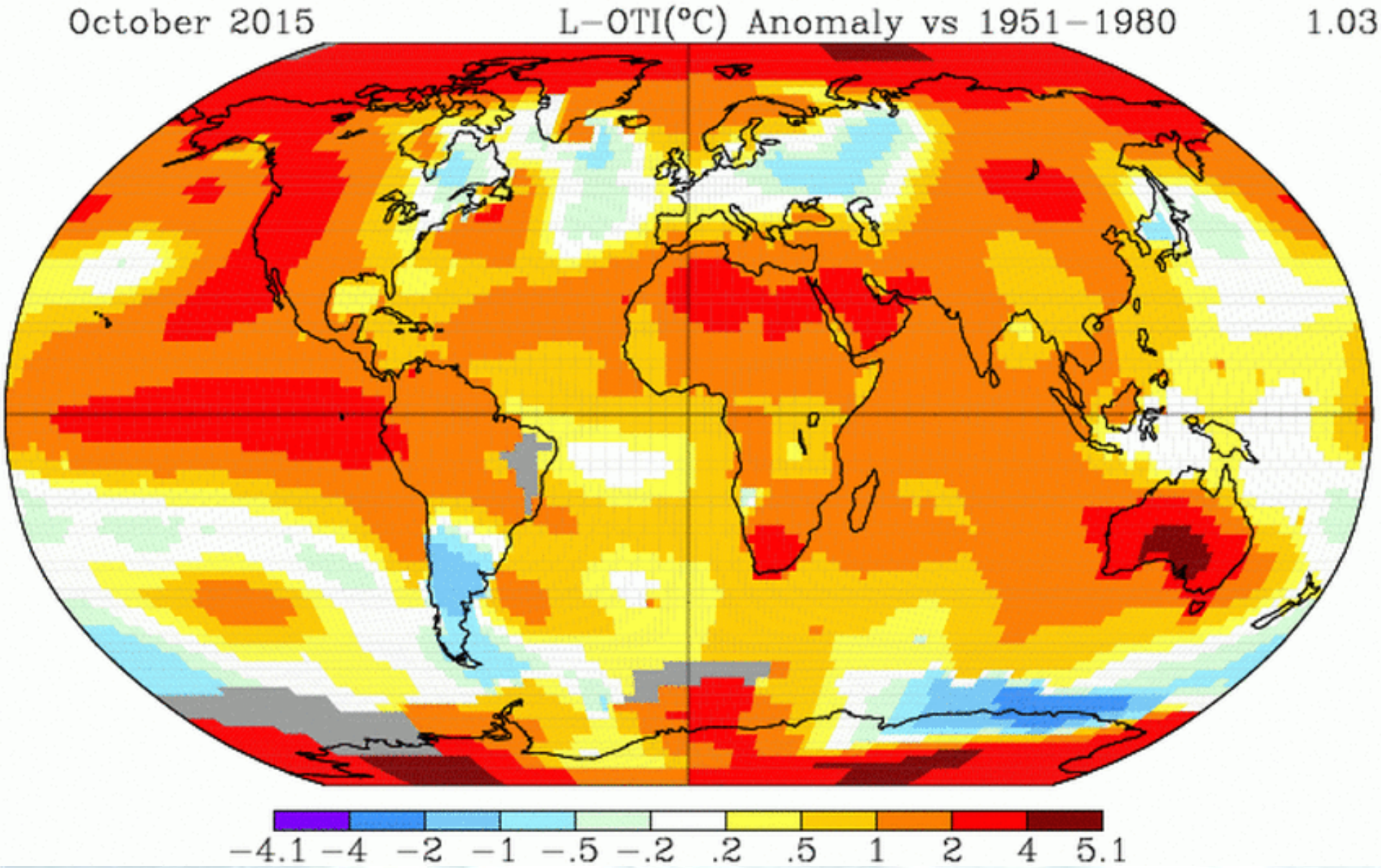
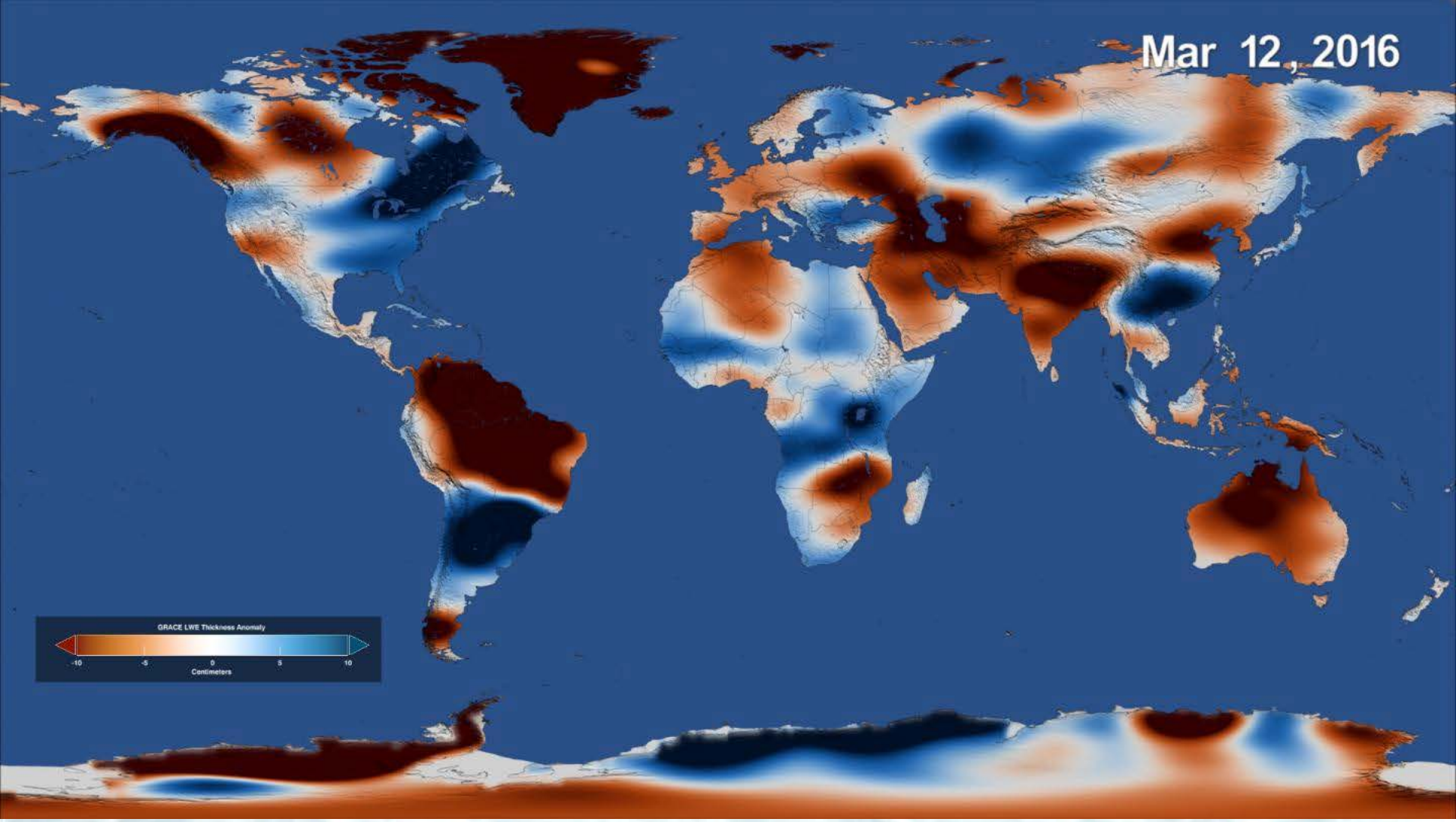


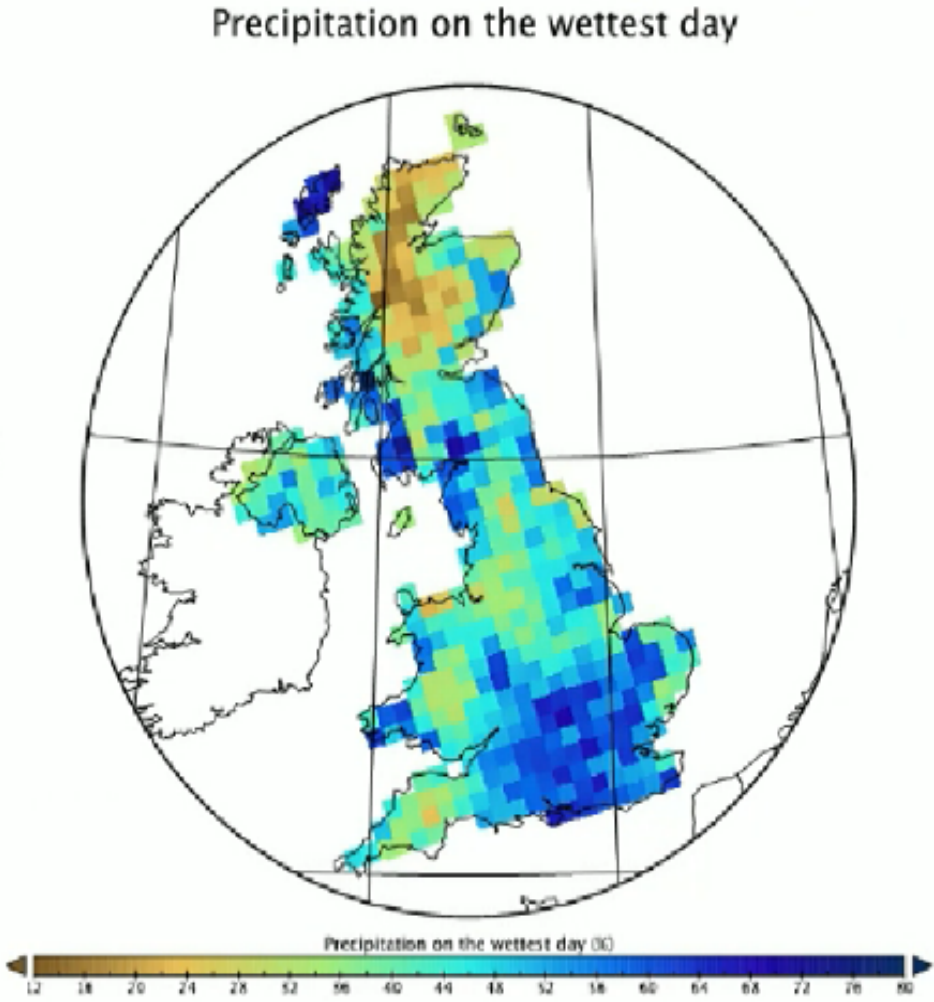
Temperature anomaly (difference) for October 2015 compared with 1951-1980 baseline. Image: NASA GISS

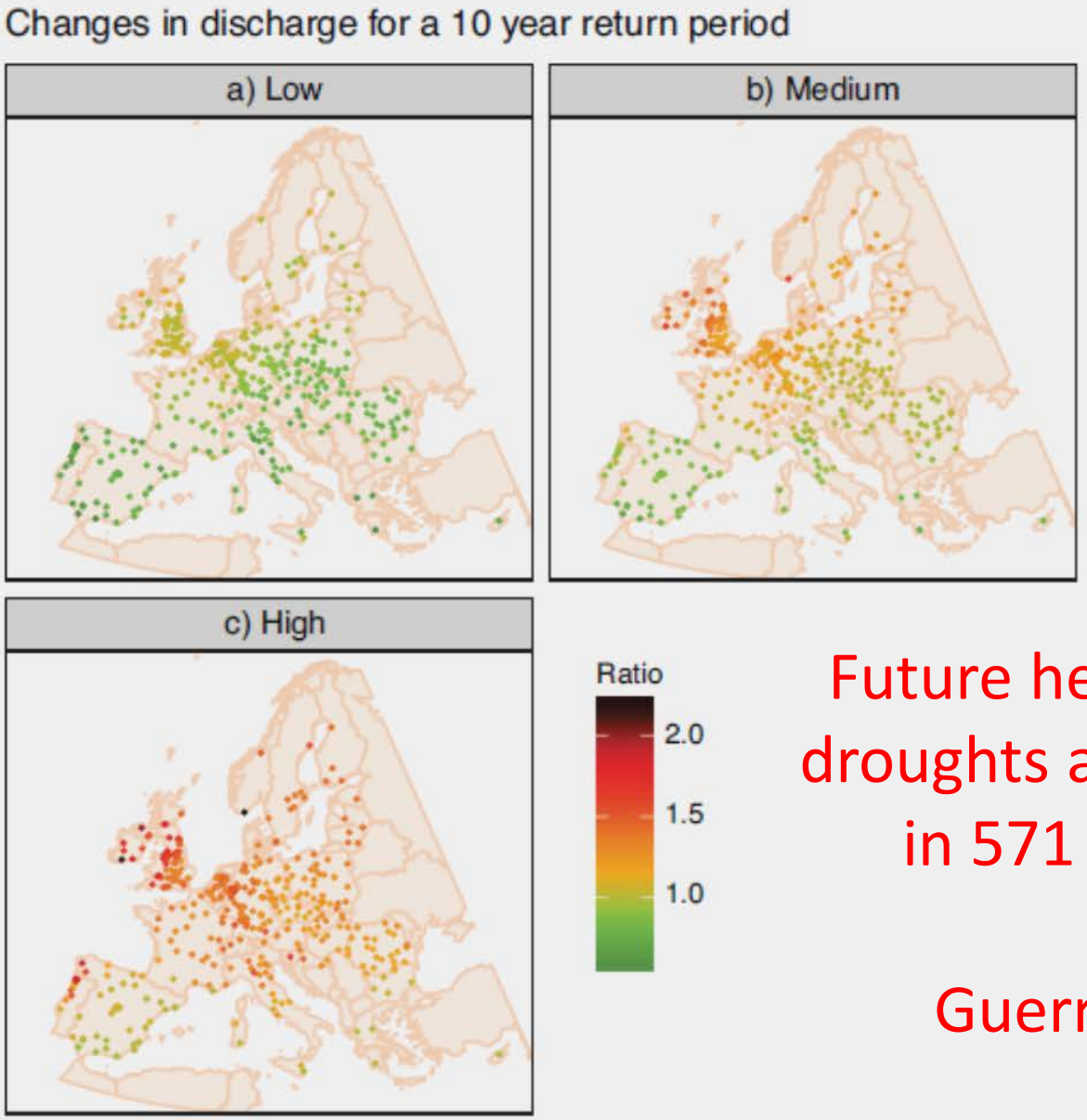


Global map of freshwater stored on land for February 2016 using data from the Gravity Recovery and Climate Experiment. (Courtesy: NASA)

Changes to Rainfall

- Shifting rainfall patterns – more winter rain may lead to:
  - More intense rainfall and increased runoff
  - More surface and river flooding
  - Decreased percolation due to water saturated ground
  - Current gutter and drain capacities maybe insufficient
  - Increased water stress in the summer months

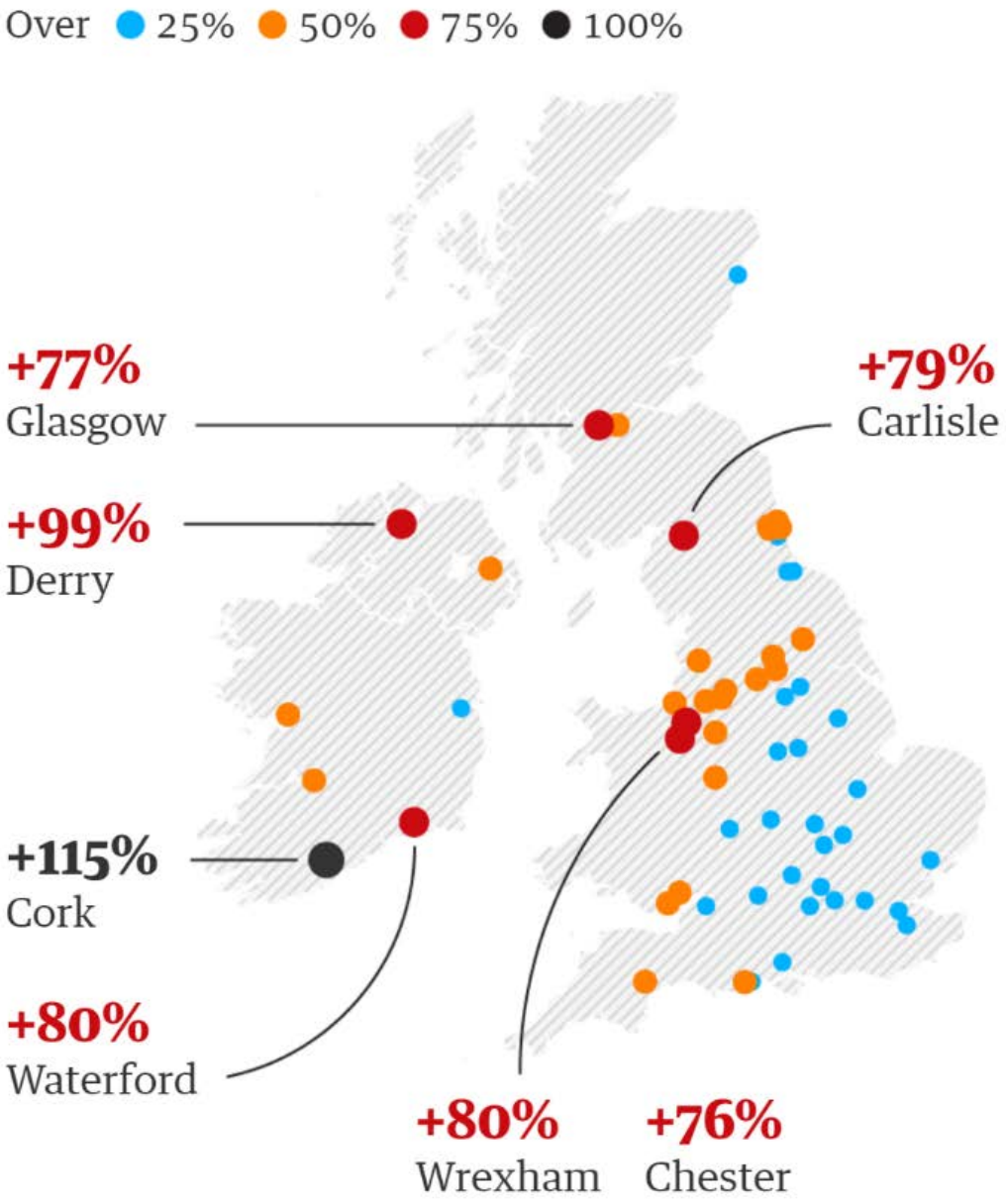




Future heat waves, droughts and floods in 571 European Cities.
Guerreiro *et al*, 2018

Figure 3. Changes in Q10 ratio (future Q10 divided by historical Q10) for each European city with a river basin above 500 km^2. The changes are shown for (*a*) low (10th percentile) impact scenario, (*b*) medium (50th percentile) impact scenario and (*c*) high (90th percentile) impact scenario. The changes are calculated between the historical period (1951–2000) and the future period (2051–2100).

In the high-impact scenario 58 towns and cities in the UK and Ireland can expect 25% or more water per flooding event



Guardian, 21st February 2018, from Newcastle University, UK

‘Wicked Problems’..... Based on Rittel and Webber, 1973

- **Poorly formulated and complex problems**
- **With interconnected physical/scientific and human/sociological dimensions…**
- **Where what happens in one place and time affects what happens somewhere else, at a different time**
- **Involving many different stakeholders…**
- **Who don’t agree about what is important…**
- **And who use the terminology in different ways…**
- **And who cannot agree if the problem has been solved**

Solving 'Wicked' problems

Wicked planning problems defy traditional linear solutions, and require new, more fluid ways of thinking. Solutions are usually 'better' or 'worse' rather than absolute, but decisions must nevertheless be made in the light of these uncertainties

The Prince of Wales tackling wicked flooding problems in 2007

‘Super Wicked’ Problems based on Levin *et al*, 2012

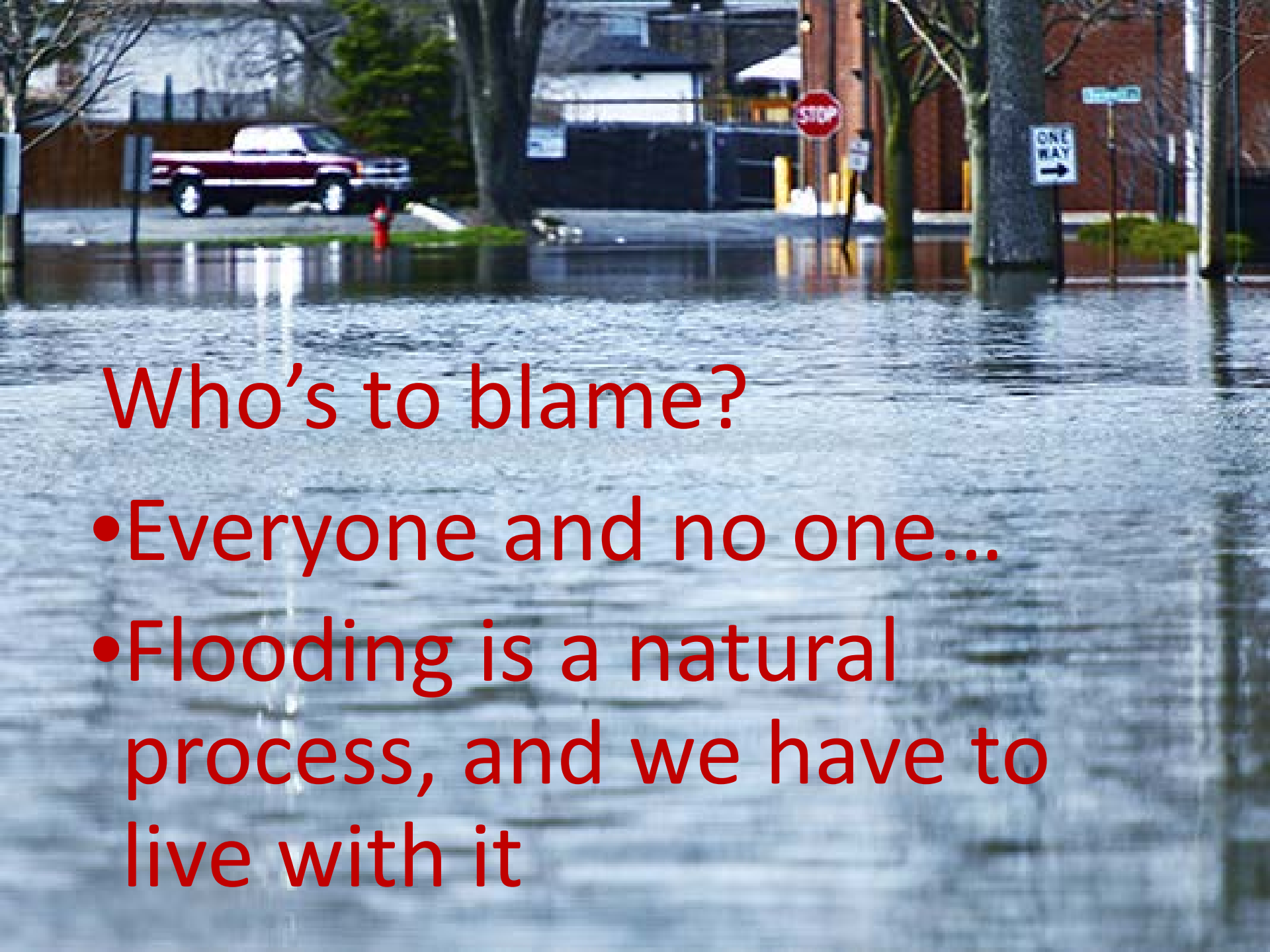
…… and

- **Where time is running out**
- **Those who cause the problem also seek to provide a solution**
- **The central authority needed to address the problem is weak or non-existent**
- **And policy decisions are made that disregard the future and reflect short time horizons**

‘Hyper wicked problems’… based on Roberts 2018

….and

some of the stakeholders manipulate (or are economical with) the facts, for personal or professional gain



Who's to blame?

- Everyone and no one…
- Flooding is a natural process, and we have to live with it

Key elements to include

- Disrupt the flow of water downhill, at every stage
- Think about displaced water and where it goes
- Think about the water cycle holistically: flood and drought
- Include climate change possibilities
- Include all stakeholders
- Evidence-based practice
- Dialogue…dialogue….dialogue

Alfred Sisley, L'Inondation à Port-Marly, 1876, 2me Exposition Impressionniste, 1876