Natural Flood Management: the Scientific Evidence

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River Flooding in the UK

Winter 15/16 Floods

£1.5 bn insured losses

>£5 bn total cost

2003 Floods, Wallingford
2007 Floods, Tewkesbury
2015 Storm Desmond
2015-16 York

Fluvial, Pluvial, Groundwater, Coastal…

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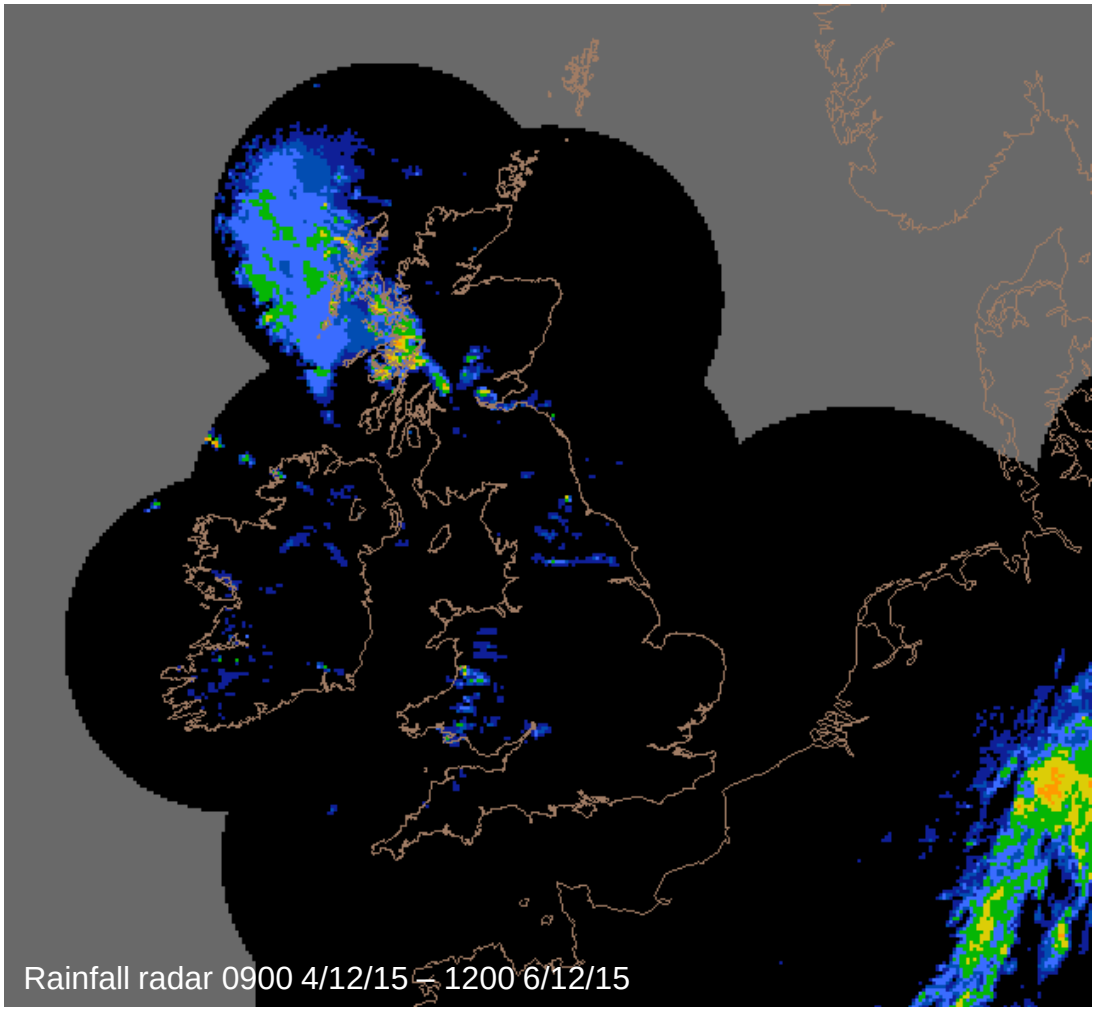
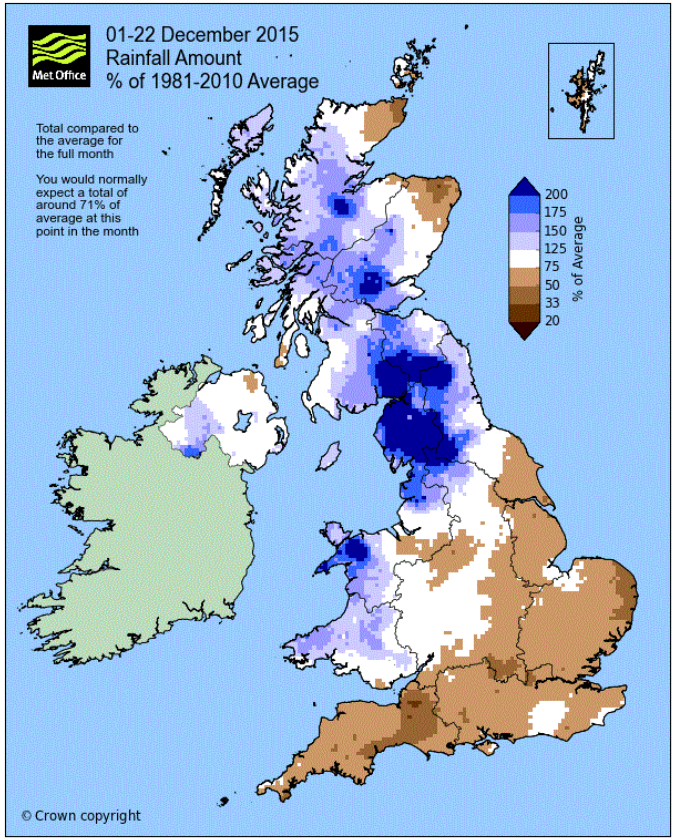
Storm Desmond (December 2015)





- 81 mph winds
- 341 mm / day (AEP 0.08%)
- £400-500m damage

Data: Met Office (http://www.metoffice.gov.uk/uk-storm-centre/storm-desmond)

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2015-16: Role of Land Use and Farming Practices?

Liz Truss is choosing to protect farmers over flood victims

By doing everything the farming lobby asks, the UK environment secretary is using public money to make the flooding of the built environment even more likely

Truss at the Oxford farming conference. Policies announced this week indicate the environment secretary is putting the appeasement of special interests at the expense of the rest of the population. Photograph: David Hartley/Rex/Shutterstock

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UK flooding: How a Yorkshire town worked with nature to stay dry

Pickering pulled off protection by embracing the very opposite of what passes for c wisdom

Geoffrey Iean | Saturday 2 January 2016 | 128 comments

62K shares

FARMERS WEEKLY

Article

Flood-hit farmer sues Environment Agency for £300,000

Tuesday 28 November 2017 14:15 FW Reporter

© Adrian Sherratt/REX/Shutterstock-

DAILY POST

NEWS

Conwy farmer watched in horror as 170 sheep were swept away by floods

Paul Williams lost 66 sheep despite swimming through water-filled fields in a desperate bid to rescue the animals

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Historical Floods on the Thames

Thames at Kingston
(cubic metres per second)

1.	18/11/1894	806
2.	20/03/1947	714
3.	17/09/1968	600
4.	05/01/1915	585
5.	23/11/1974	559
6.	13/12/1929	552
7.	21/02/1900	533
8.	07/01/1928	526
9.	04/01/1925	522
10.	15/02/1904	517
11.	16/02/1883	511
12.	10/02/2014	507
13.	02/01/2003	482
14.	28/02/1933	479
15.	02/01/1936	478
16.	07/11/2000	463

Thames at Shillingford

NRFA Peak Flows

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Outline

- Drivers of Flooding:
  - climate variability,
  - climate change, and
  - land cover
- Catchment-based and Natural Flood Management
- Examples from N. Yorkshire, mid-Wales and Somerset
- No simple answers – solution depends on rainfall intensity and catchment size…

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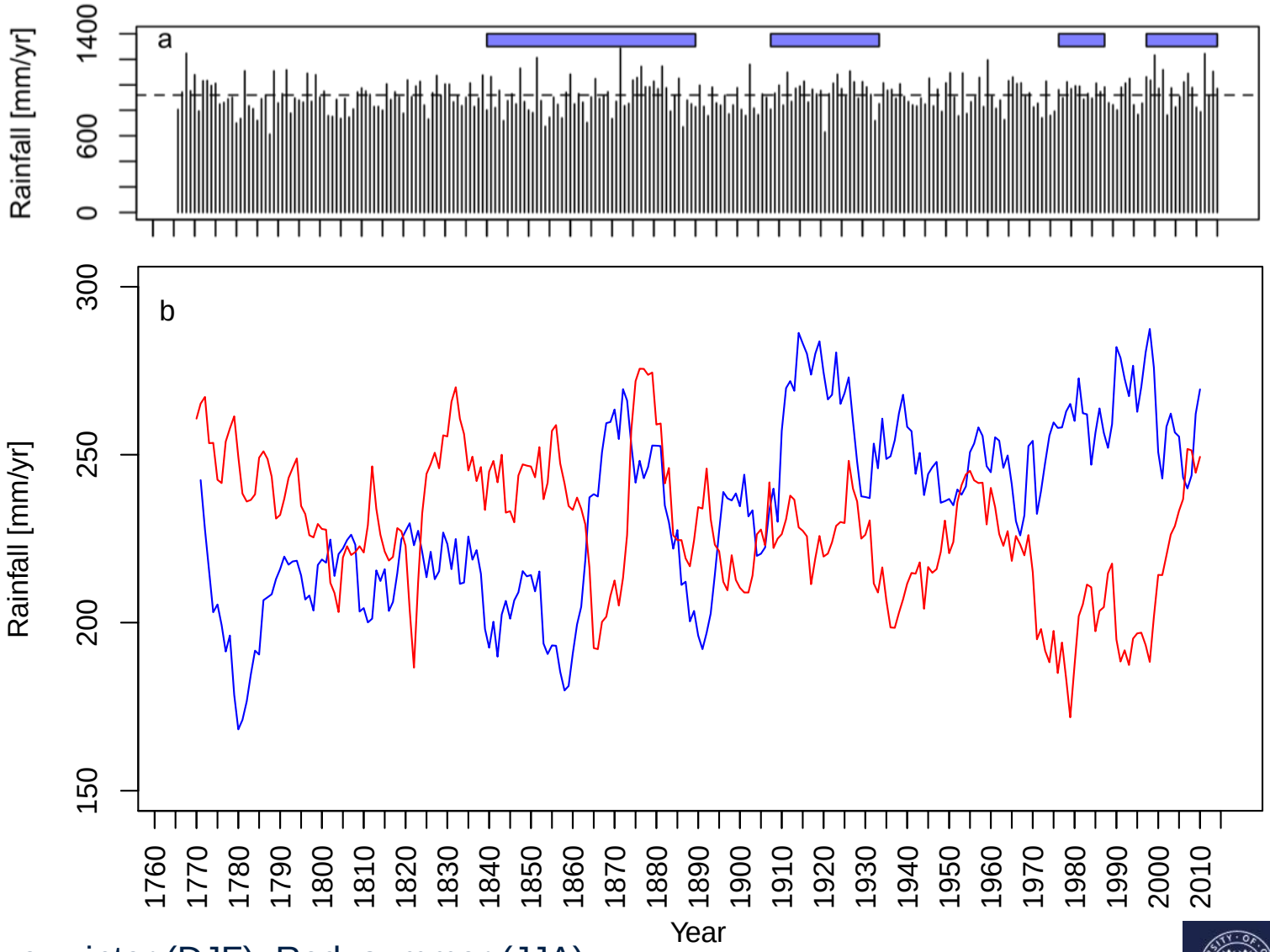
England and Wales precipitation (1776-2015)



Blue, winter (DJF); Red, summer (JJA)

Data: Alexander and Jones (2001);
http://www.metoffice.gov.uk/hadobs/hadukp/.

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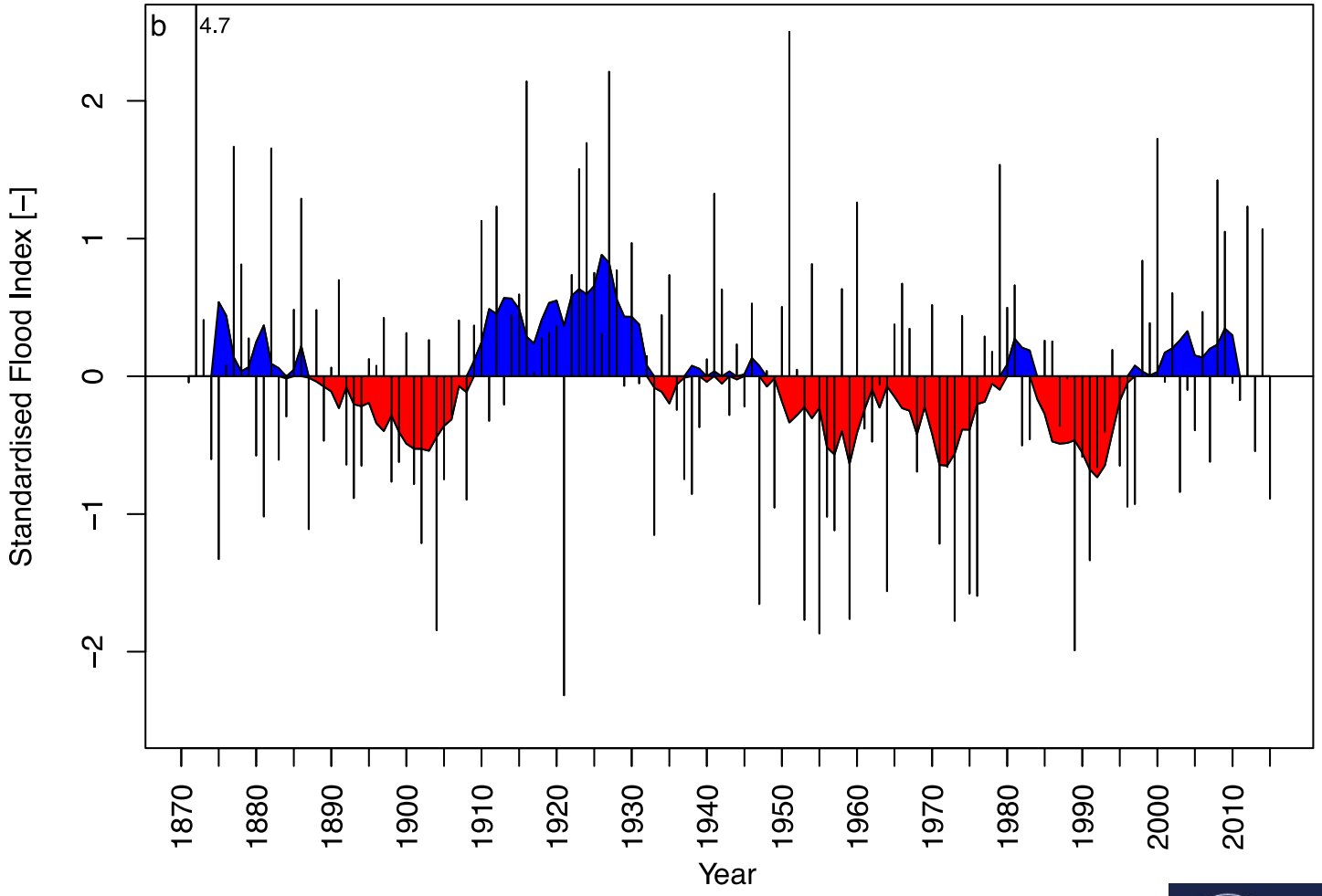
Flood-rich and flood-poor periods in the historical record



Data: Wilby and Quinn (2013); https://crudata.uea.ac.uk/cru/data/lwt/.

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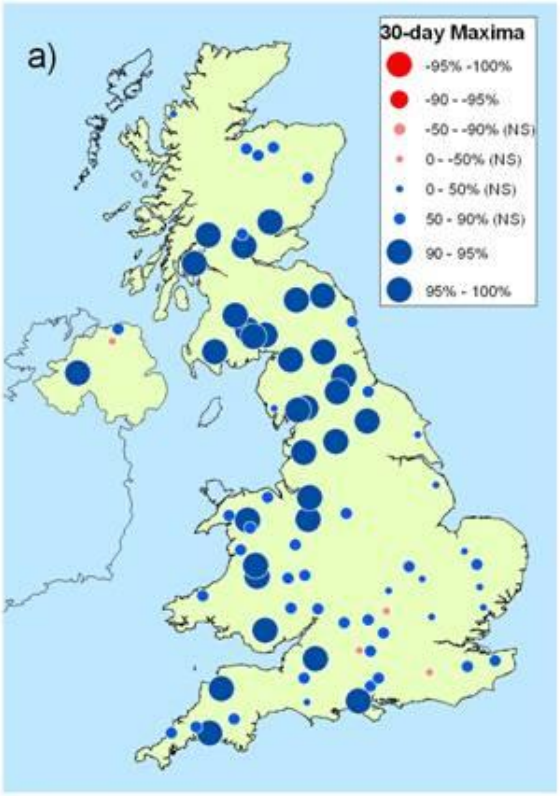
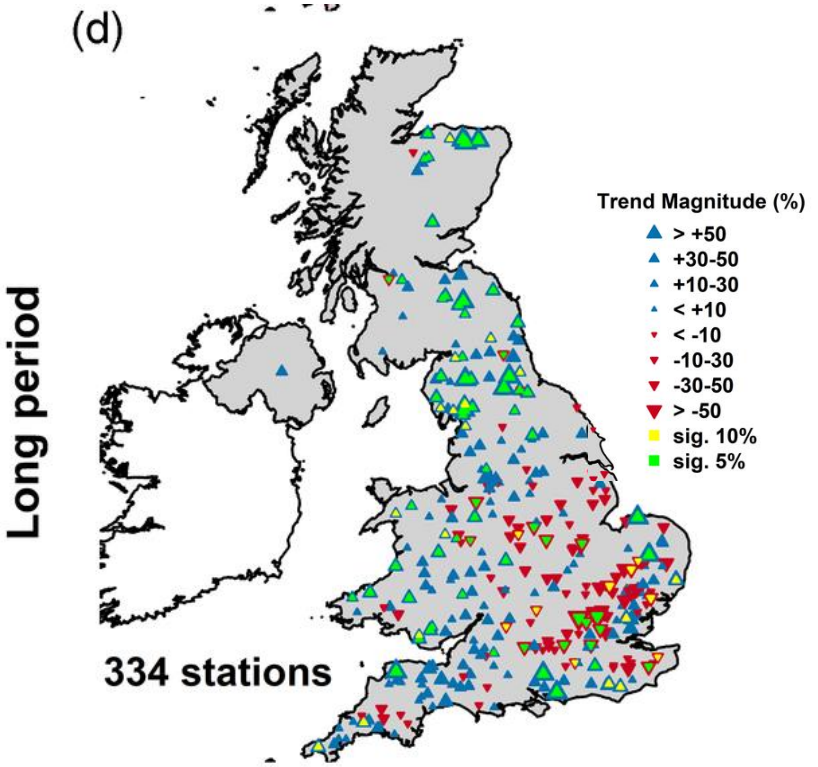
Historical trends in high flows





- Regional differences: No consistent national picture
- More periods of prolonged high flow in N & W
- More extreme floods in N & W (but trends are weaker)

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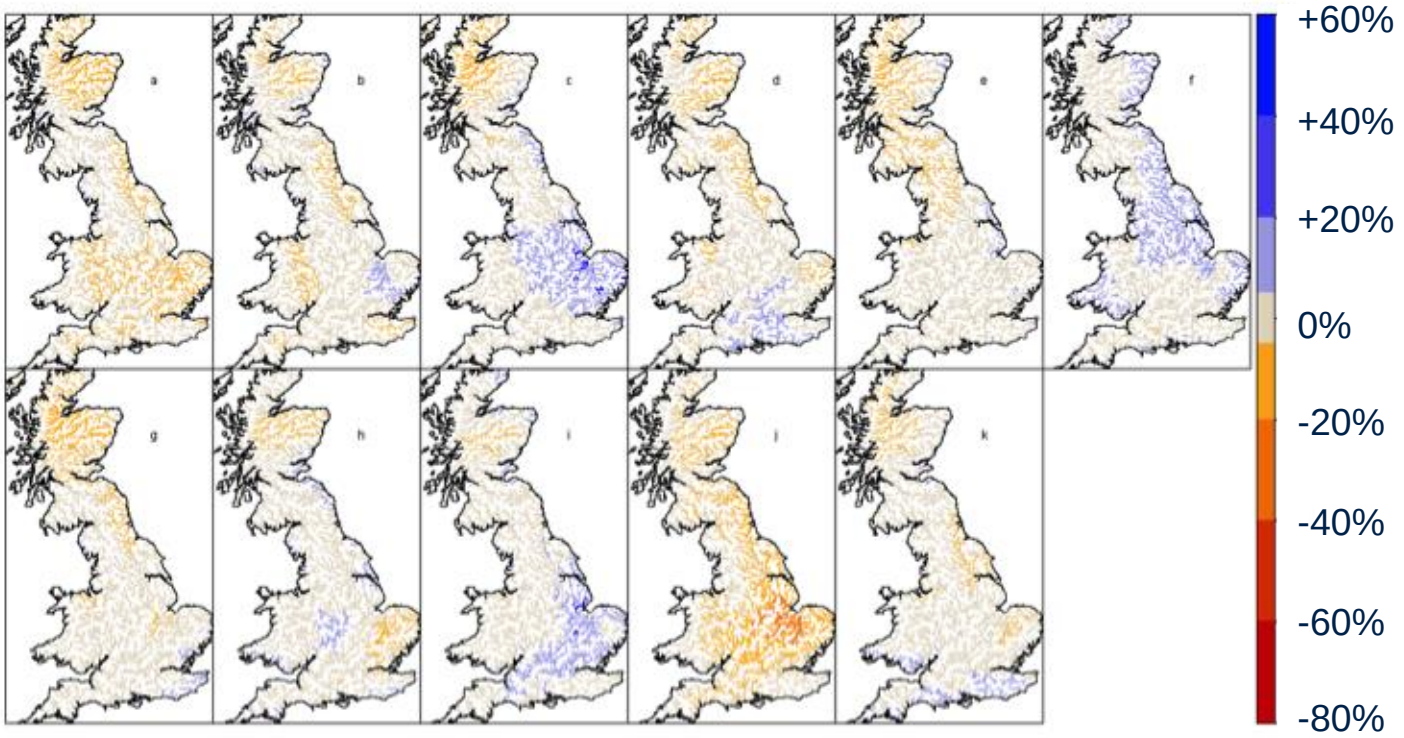
Hannaford and Marsh, 2007; Hannaford et al., 2021 Hydrol. Res. doi:10.2166/nh.2021.156

Future flows in the UK by 2050



- Wide range of possible decreases in summer flow; substantial spatial variability in winter response (shown);
- Adaptation measures must be designed to cope with a wide range of future changes.

Prudhomme, Dadson, *et al*., 2011, *Hydrological Processes*

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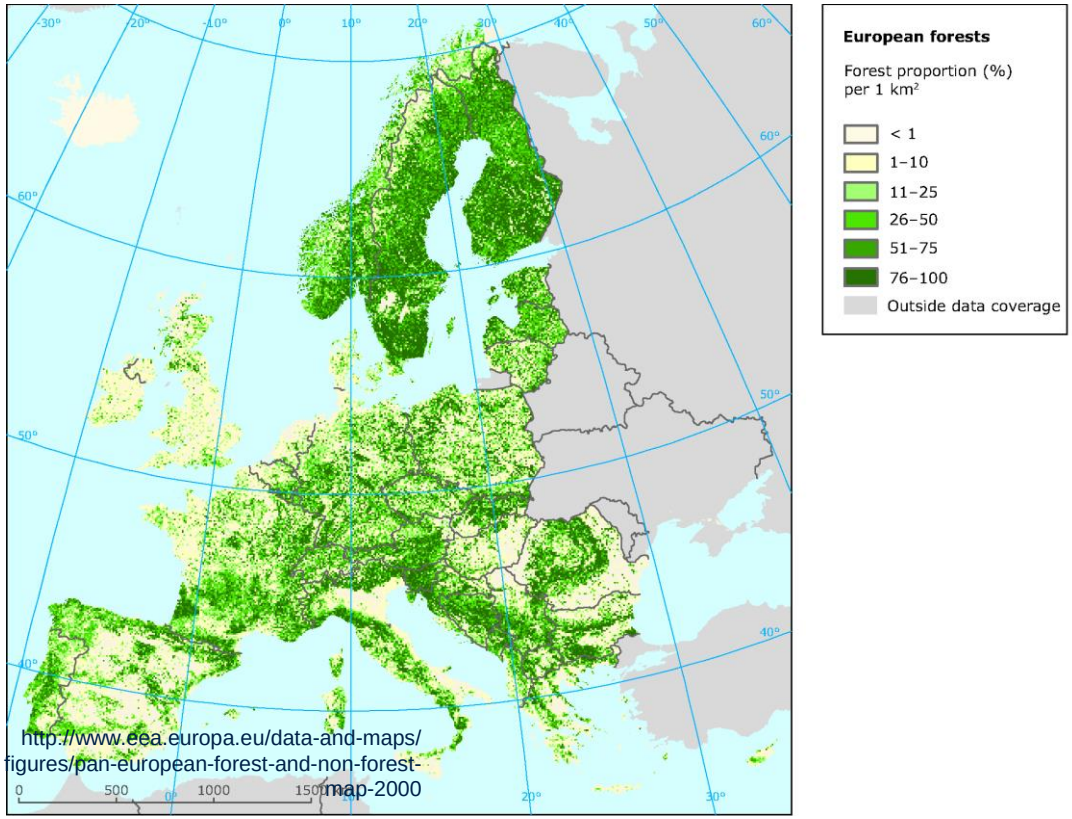
Land cover and land management



- Prehistoric forest cover of most of the UK
- Reduced to 6% in 1930s; currently 13% (2019)
- Post WWII intensification of farming practices

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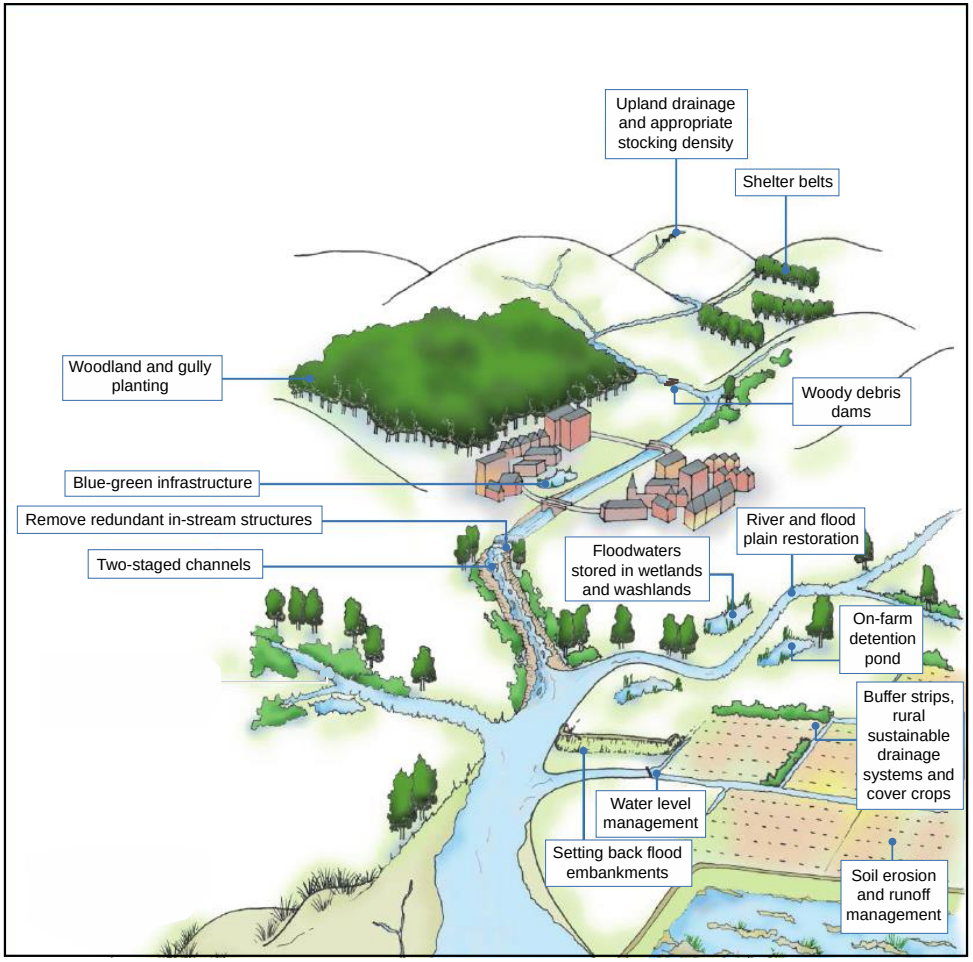
Catchment-Based Flood Management



(after Barlow/EA et al., 2014)

- Retaining water in the landscape through management of infiltration and overland flow
- Retaining water in the landscape by managing connectivity and conveyance
- Making space for water by managing floodplain conveyance and storage

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Natural Flood Management

- Restore processes adversely affected by development.

- Aim to reduce flood hazard, and sustain or enhance other aquatic, riparian, and terrestrial ecosystem services:
  - improved soil and water quality,
  - biodiversity
  - carbon sequestration,
  - reduced soil erosion,
  - greater agricultural productivity, and
  - improved public health and well-being.

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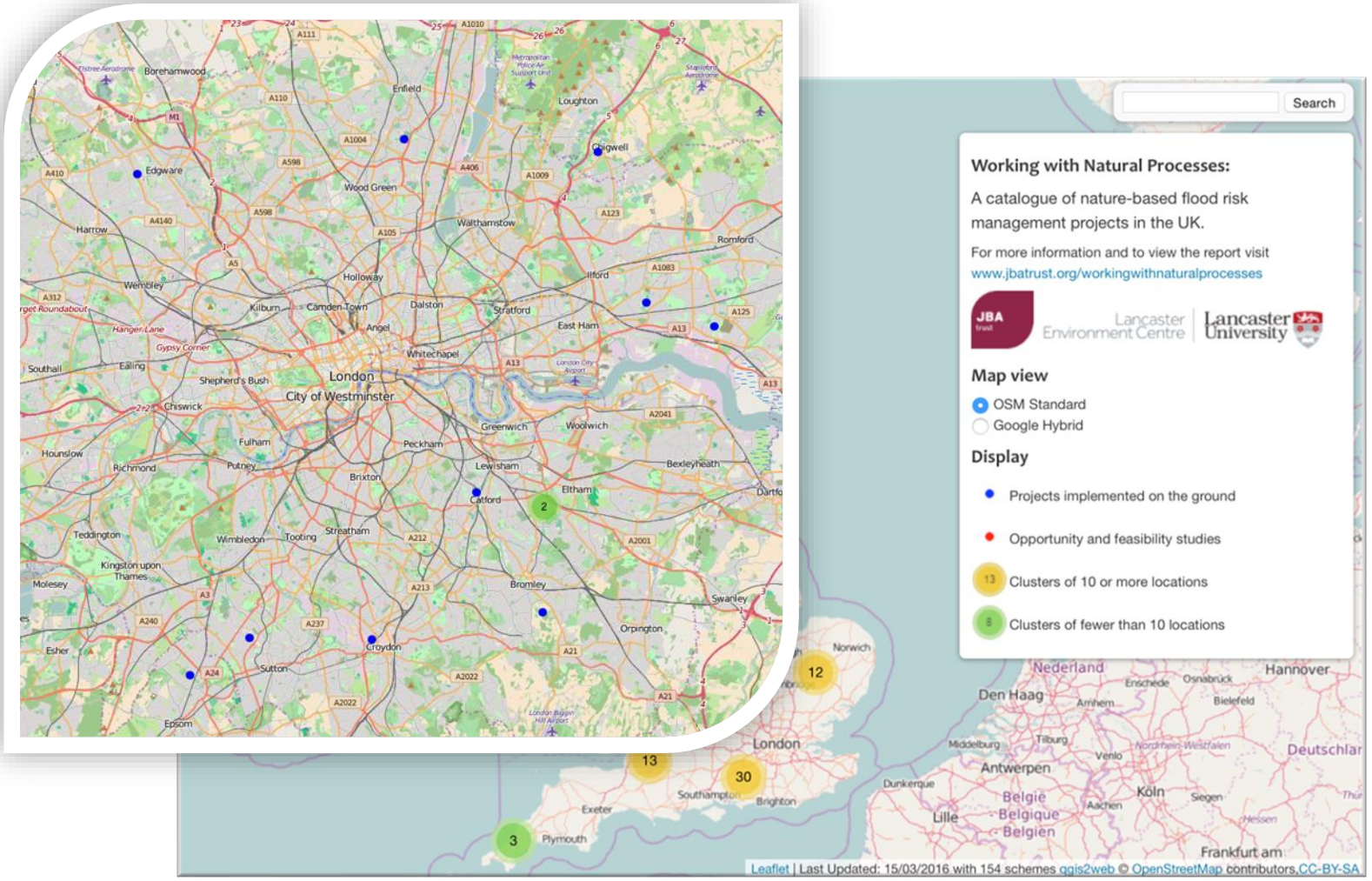
Natural Flood Management Projects



http://naturalprocesses.jbahosting.com/

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Peer-reviewed Evaluations of CBFM and NFM

Name of Scheme	Type of intervention	Location	Study area	Sponsor / Funder
Belford	Off-channel storage	Northumberland	5.7 km^2	Environment Agency
Pontbren	Tree planting; ditch blocking	Carmarthenshire	12.5 km^2	Coed Cymru, Coed Cadw Woodland Trust
Pickering	Off-channel storage, and other interventions	North Yorkshire	69 km^2	Defra, Forestry Commission
New Forest LIFE3 (Blackwater)	Runoff attenuation features	Hampshire	12 km^2	Forestry Commission, Environment Agency, Natural England
Berwyn Drain Blocking	Drain blocking	Mid Wales	100 km^2	RSPB, EU-LIFE-Nature
SCaMP Hodder	Tree planting, ditch blocking	Lancashire	260 km^2	Environment Agency, United Utilities

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Tree shelterbelts in Pontbren, mid-Wales (~18 km^2)

- Infiltration rates 67x higher in shelterbelts
- 2-11% reduction in extreme flood peaks predicted at small catchment scale (~ 6 km^2)
- Reduced bedload and suspended sediment load

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Upland management in the Hodder, Lancashire (260 km^2)

- Upland drainage management
- Reduced sheep numbers
- Minor impact which diminishes as catchment size increases (260 km^2)

Source: Enda O'Connell; Photo: United Utilities

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Pickering, North Yorkshire (69 km^2)

- Large wood, timber-built bunds, heather bale check dams, farm & riparian woodland & buffer strips
- Off-channel concrete engineered storage bund, capable of holding 120,000 m^3 of floodwater
- Designed to protect Pickering against at least a 0.04 Annual Exceedance Probability flood

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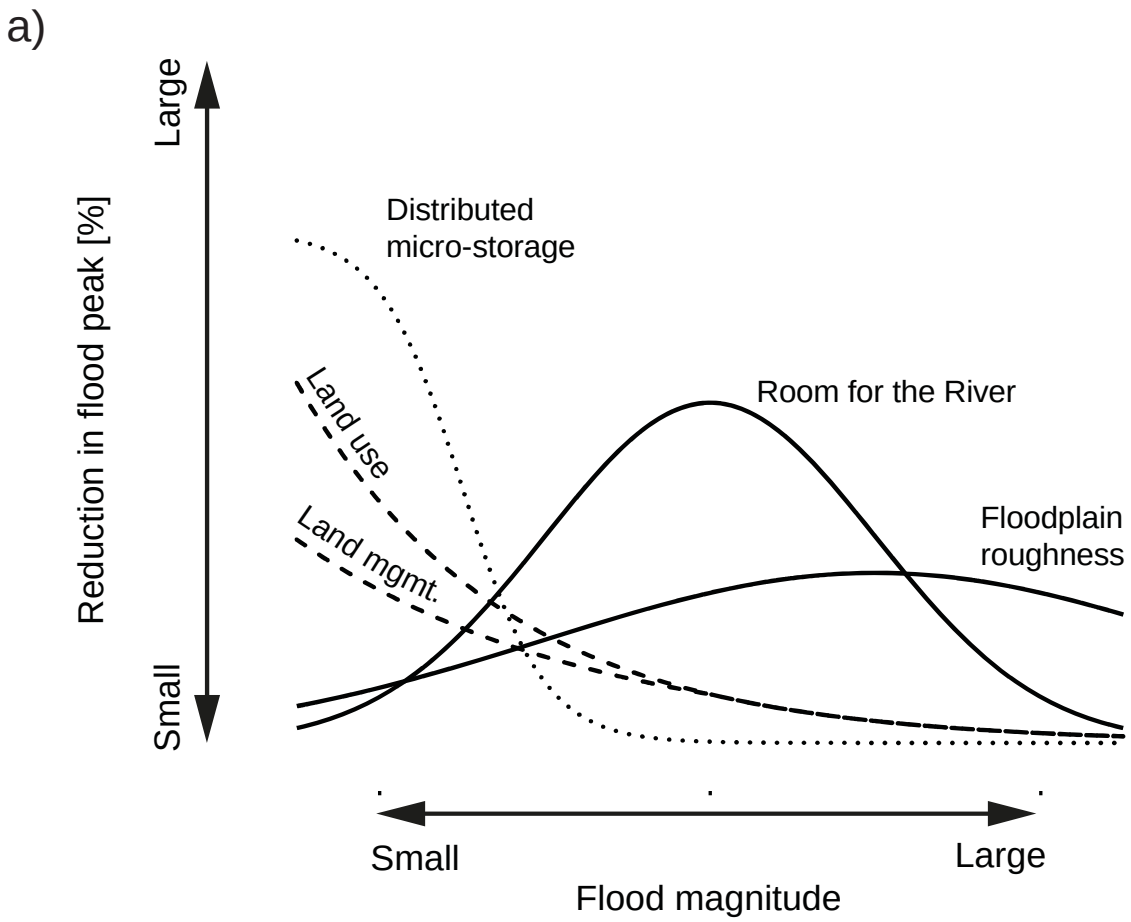
Relative Effects of Catchment-Based Interventions



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Recommendations

- Maintain monitoring networks
- Extend modelling studies to larger catchments
- Evaluate importance of co-benefits
- Practitioner toolkit and evaluation protocol
- Improved stakeholder communication

Dadson, S., Hall, J.W., Murgatroyd, A., Acreman, M., Bates, P., Beven, K., Heathwaite, A.L., Holden, J., Holman, I.P., Lane, S.N., O'Connell, E., Penning-Rowsell, E., Reynard, N., Sear, D., Thorne, C. and Wilby, R. (2017) A restatement of the natural science evidence concerning catchment-based 'natural' flood management in the UK. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 473(2199): 1-19.

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Ongoing work

- Investment in NFM studies via NERC and Defra
- Referred to in policy and legislation
- Where it works; where it provides value for money
- Additions to the evidence base in past five years
- Currently finalizing an update to our 2017 paper

Dadson, S., Hall, J.W., Murgatroyd, A., Acreman, M., Bates, P., Beven, K., Heathwaite, A.L., Holden, J., Holman, I.P., Lane, S.N., O'Connell, E., Penning-Rowsell, E., Reynard, N., Sear, D., Thorne, C. and Wilby, R. (2017) A restatement of the natural science evidence concerning catchment-based 'natural' flood management in the UK. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 473(2199): 1-19.

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Update Highlights

- Interventions continue to be mainly at local scale
- Catchment-specific conclusions hard to generalise
- Modelling studies need to consider uncertainty
- Still a need to quantify co-benefits properly
- Must fund monitoring over wide area & long term

To find out more and contribute to stakeholder review contact Marcus.Buechel@ouce.ox.ac.uk

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