Landscape in a changing climate: Cumbria and the North-West Conference

This event is brought to you by:

Cumbria Innovative Flood Resilience (CiFR)
and
Cumbria Flood Partnership

with support from the following organisations:

Cumberland Council

Westmorland & Furness Council

CiFR Cumbria innovative Flood Resilience

North West Regional Flood & Coastal Committee

Department for Environment Food & Rural Affairs

Environment Agency

Welcome:

Adrian Lythgo

Chair of North West Regional Flood & Coastal Committee

Cumberland Council

Westmorland & Furness Council

CiFR Cumbria innovative Flood Resilience

North West Regional Flood & Coastal Committee

Department for Environment Food & Rural Affairs

Environment Agency

Aims

1. Building collective understanding
2. Sharing learning, offering inspiration
3. Connecting with others, collaborating

Cumberland Council | Westmorland & Furness Council | CiFR Cumbria innovative Flood Resilience | North West Regional Flood & Coastal Committee | Department for Environment Food & Rural Affairs | Environment Agency

Agenda

Presentations x 5 + Q&A

LUNCH

Presentations x 5 + Q&A

Improving resilience place by place (workshops)

Long term planning for the impacts of Climate Change on water systems

Adam Lechmere

Head of Sustainability

United Utilities

Dovestone Reservoir

United Utilities

Water for the North West

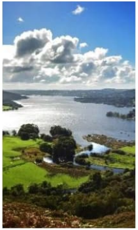
Introducing United Utilities

Providing our services

- **7 million** customers and over **200,000** businesses
- **86** water treatment works
- **43,000** km of water pipes
- **79,000** km of wastewater pipes
- **584** wastewater treatment works
- **200,000** tDS of sludge treatment capacity
- Supporting **over 22,500** skilled jobs across the region

Focus on the North West's five counties

Building our plan for Cheshire, Cumbria, Greater Manchester, Lancashire and Liverpool City Region, delivering outcomes for people in the places where they live.


But we also manage...

- 56,000 hectares of catchment land (**34%** of land in the region has environmental protection)
- 2,200 storm overflows
- 170 reservoirs (one of which is older than the USA)
- 2 mines and 3 quarries
- Access for 65 recreational clubs at our reservoirs
- 1 pigeon tower
- Historic Romanesque Terraced Gardens
- Permits for filming and photography on our landholdings (including for Mission Impossible, Game of Thrones and Star Wars)

Climate change is happening today

Homes flooded in Greater Manchester as storms hit New Year's Day

Safety warnings as snow impacts North West roads

4bn litres of water will be wasted this weekend as quarter of British people fill paddling pools

'It's astonishing how much water it takes to fill a super-sized pool just to use for a day'

Josh Gabbatiss Science Correspondent • Friday 06 July 2018 00:24 BST • 0 Comments

Paddling pools will put additional strain on the UK's water supply over the weekend, according to environment charity Hubbub (Getty)

Drought declared across north-w
England

Water levels have fallen at Haweswater reservoir in Cumbria, which supplies north-west England

the north-west of
nd ready for flooding?

Climate Change in the North West - to date

The climate has already changed, and further change is inevitable. How much change the UK experiences after 2050 is uncertain and will be dependent on global emissions reductions.

To date in the North West we are already seeing;

+1°C warmer than pre-industrial period

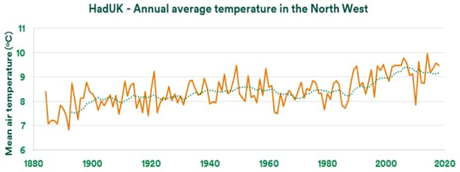
- The average annual UK temp. is around 1.2°C

Twice the likelihood of a hot summer

- The chances of experiencing a hot summer like in 2018 have doubled in recent decades and are now about 10% - 25% per year.

Accelerating temperature rise

Temperature increases over the past 30 years being higher on average than for those over the past 50 years and continue to rise.

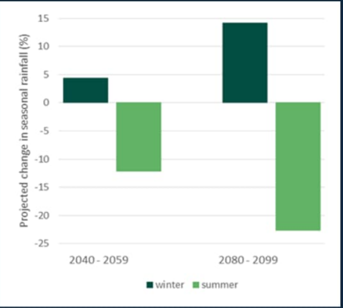


We have identified over **70 climate related risks** that could impact on our services. These have been grouped into **six thematic areas**.

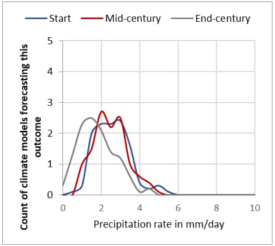
- **Hotter, drier summers**
- **Changes in seasonality**
- **Extreme events**
- **Rising sea levels**
- **Transitional risks**
- **Cold waves and frost**

Changes in seasonality – not enough rain during the summer

We are already seeing changes to seasonality, with seasonal rainfall patterns changing in both summer and winter. This will become more pronounced under future climate projections.



But context is important – there is a regional difference in rainfall patterns and changes across the North West

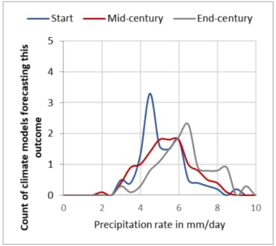


Cumbria in the summer – likely to be drier from mid-century onwards (RCP8.5)

Rainfall average to drop from 2–3 mm/day to 1-2 mm/day

Cumbria in the winter – likely to be wetter in the future (RCP8.5)

Rainfall average to increase from 4.5 mm/day to 6 mm/day by mid-century

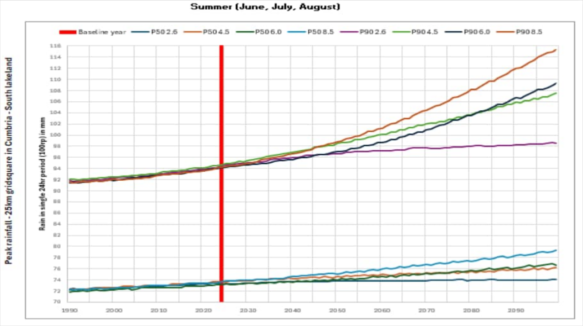


Greater extremes in weather – too much rain

Murphys law dictates that - Anything that can go wrong will go wrong

We have already seen increases in the total amount of rain falling during peak rainfall events and is set to get worse under all future climate change projections.

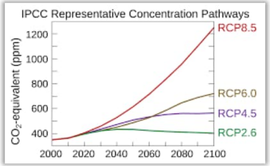
- For every +1^{0}C in air temperature the air can hold 7% more moisture.
- Following the drier summer the ground becomes more compact and soil moisture deficits increase.



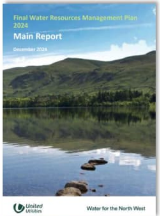
Flooding in Culcheth, Warrington

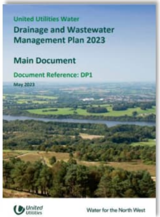
Long term planning for the effects of climate change

Through our strategic plans we analyse the risks from climate change over at least a 25yr planning horizon, developing multiple scenarios across our area of operation.



This informs our strategic plans





This then informs our 5-year business plan activity

Improving drought risk resilience to **1 in 500 years** by 2039, accounting for climate change

Halving our leakage performance by 2050 (from our 2017/18 baseline)

Increasing water resources by **25 megalitres per day** by 2033

Reducing the demand for water to **110 litres per person per day** by 2050

Reducing sustainable water abstraction by **131 megalitres per day** by 2050

Halving the risk of a hosepipe ban by 2031

Investing **£426m** in rainwater management, including **£50m** partnership funding to remove surface water

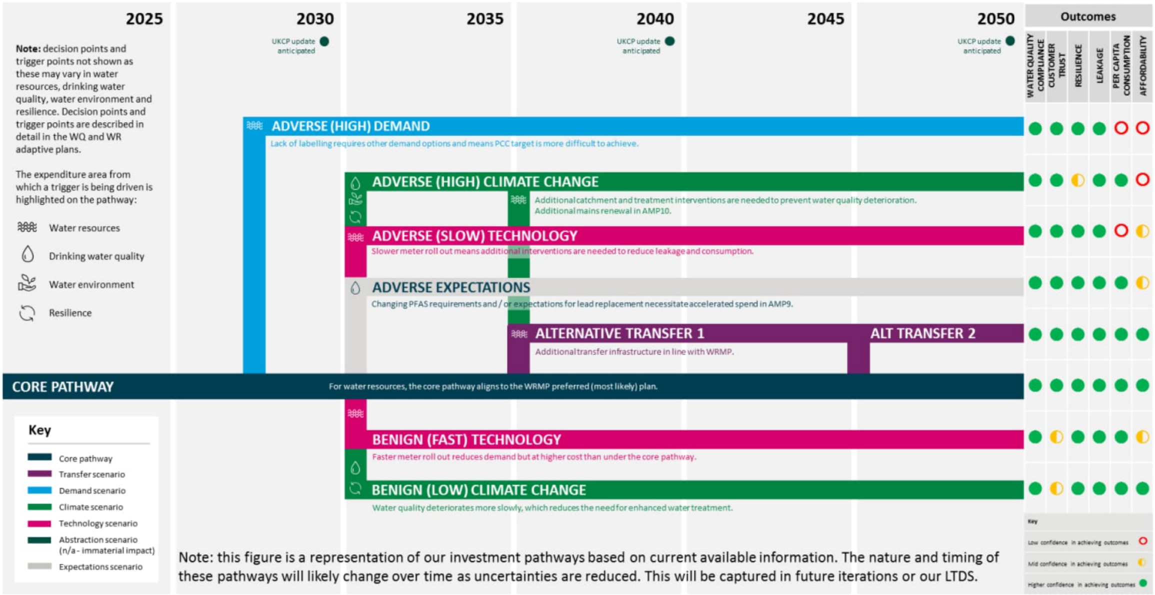
Delivering **increased treatment capacity** to meet supply-demand needs

Delivering **<10 spills** from storm overflows per year (on average) by 2050

Assessing assets **at risk from flooding** and preparing future investment strategies to protect services

Ensuring our services can meet the demands of an additional **860,000 people** in the North West by 2045

Long term planning for the effects of climate change



Thank you for listening.

Adam Lechmere, United Utilities

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Climate change and flood risk in Cumbria

Richard Knight
Environment Agency

How and why do we project future flood risk?

Projections of future climate

UKCP18 – Met Office Hadley Centre

Projects climatic conditions for range of possible futures at different points in the future

Provides data at a local level

Met Office

Environment Agency

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Met Office

Produce climate allowances

Published by EA for rainfall intensity, peak river flow and sea level rise for three future epochs (time periods).

Published for 93 river catchments in England.

Climate projections from UKCP18 are used to produce climate change allowances which inform assessments of future flood risk.

Environment Agency

UK Centre for Ecology & Hydrology

Environment Agency

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Environment Agency

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Uses of climate change allowances

Inform design and funding of future flood risk management schemes

To account for future flood risk in the planning process and design of all new development.

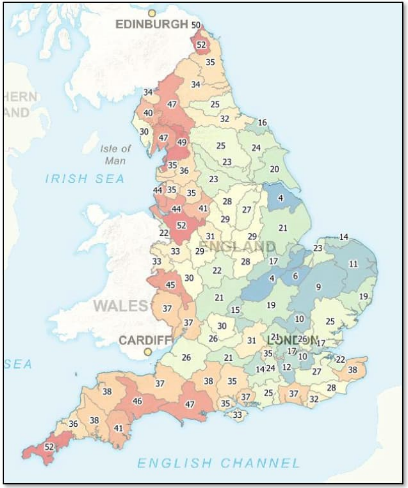
To quantify long term changes to flood risk and to inform strategic planning.

Environment Agency

Climate change impacts across England

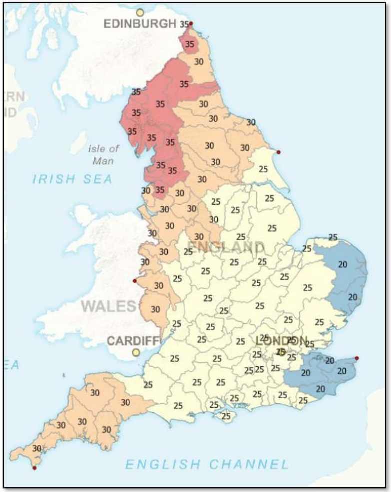
Percentage increase in peak river flow

(Central allowance, 2080's)



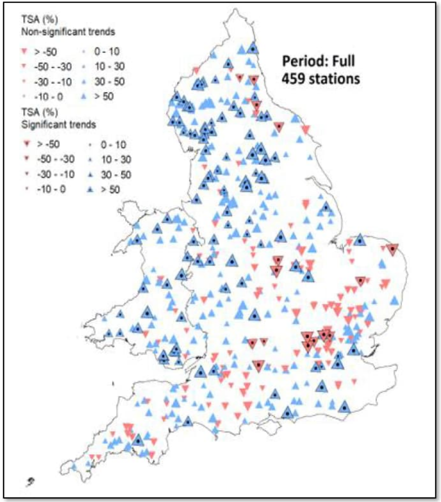
Percentage increase in peak rainfall

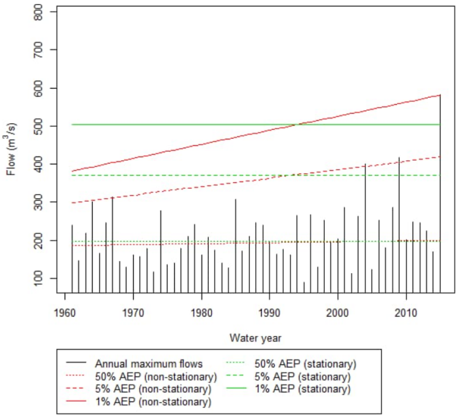
(Central allowance, 1% AEP, 2070's)



Environment Agency

Are large floods already getting more common?





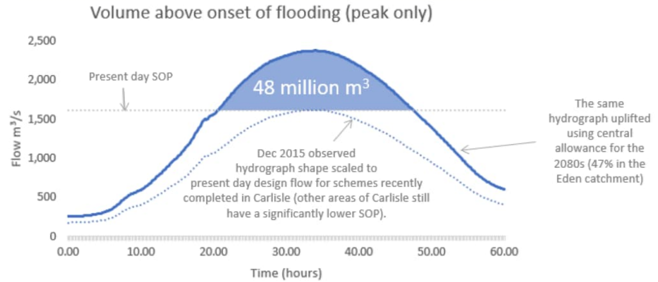
Environment Agency

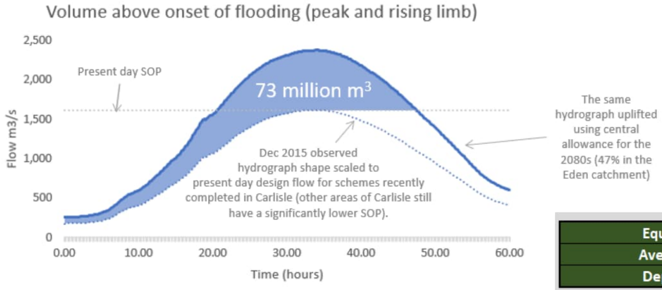
What does this mean in terms of recent major floods?

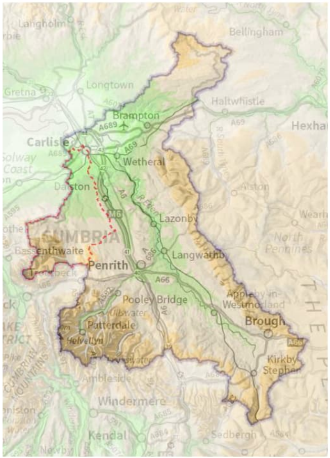
Flood event	Chance of flood of equivalent size flood happening in any given year in Carlisle (1 in X chance)		
	Present day	**2050s**	**2080s**
December 2015 (Storm Desmond)	1 in 205	1 in 33	1 in 22
January 2005	1 in 115	1 in 25	1 in 14

Environment Agency

Impact on flood risk – River Eden in Carlisle







Equivelent depth in Ullswater (m)	5.38	8.09
Average depth over catchment (m)	0.02	0.04
Depth across 100yr floodplain (m)	0.33	0.50

Key points

- The impact the climate change is projected to have on flood risk varies significantly across the country.
- The areas of England with the greatest projected impacts are generally in the west, especially the northwest and southwest.
- Climate change will result and larger and more frequent floods, an effect we are already seeing in Cumbria.
- The volume of water that needs to be stored to mitigate these impacts can be very large.

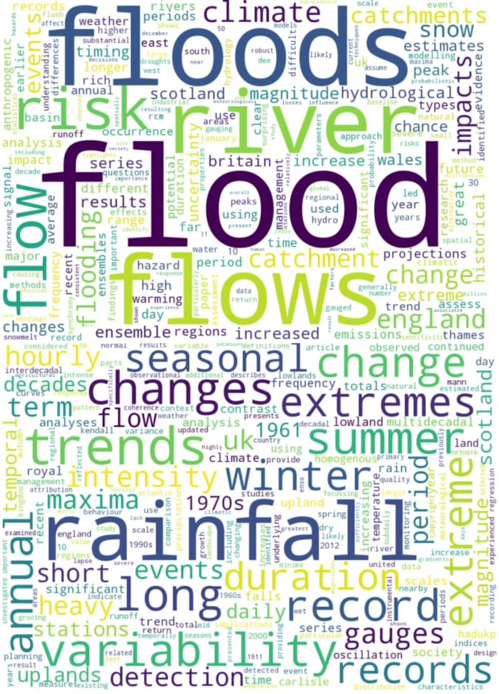
Links

[Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)]()

[Climate change allowances for peak river flow]()

[Flood and coastal risk projects, schemes and strategies: climate change allowances - GOV.UK (www.gov.uk)]()

[The Met Office climate data portal]()



Thanks for listening.

Richard Knight, Environment Agency

richard.knight1@environment-agency.gov.uk

Environment Agency

Response of Cumbria headwater catchments to climate change: geomorphology, extreme events and impacts

Durham University

Jeff Warburton, Department of Geography, Durham University

[Rich Johnson, Mark Kincey & collaborators]

UKRI Natural Environment Research Council

Response of Cumbria headwater catchments to climate change: geomorphology, extreme events and impacts

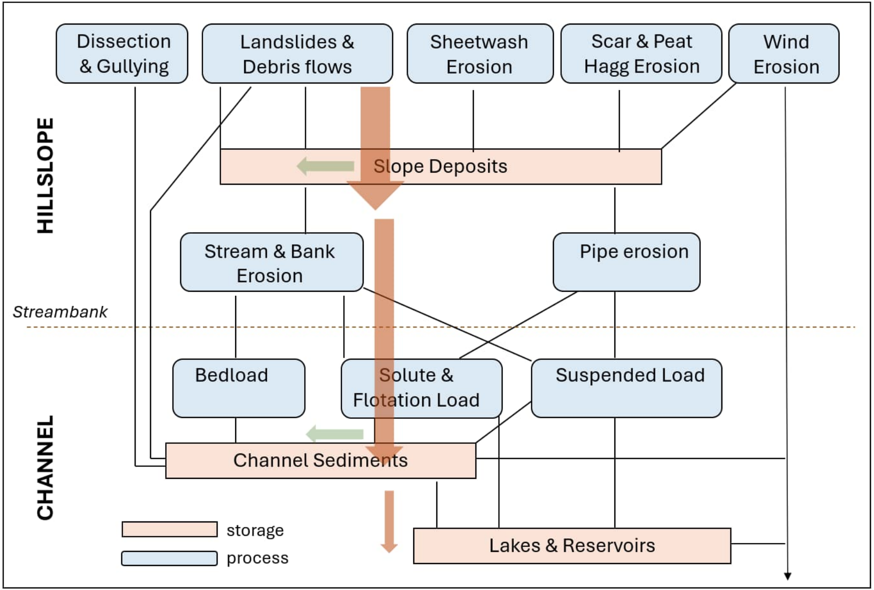
1. The *Headwater Sediment cascade* – geomorphic framework
2. Extreme flood events
3. Shallow landslides (mineral and peat)
4. Contaminated catchments (metal mining)
5. *Upland wildfires*
6. *Revegetation*
7. *Conclusions and Implications*

Durham University

Jeff Warburton, Department of Geography, Durham University
[Rich Johnson, Mark Kincey & collaborators]

UKRI Natural Environment Research Council

(1) Headwater Sediment Cascade (*Northern England*)



KEY CONCEPTS

Sediment cascade:
Pathways of sediment movement

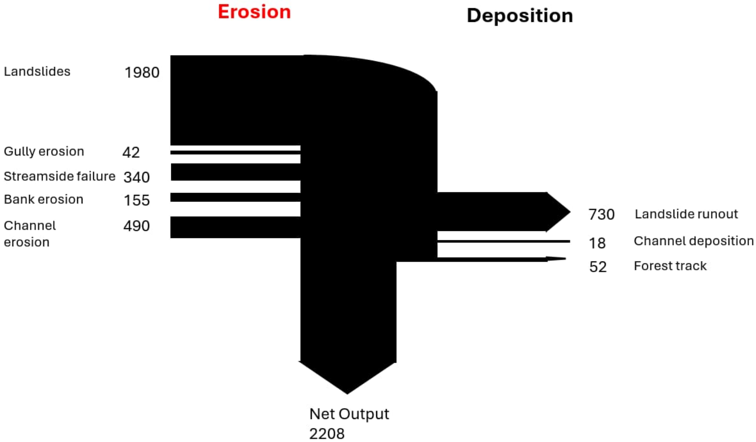
Sediment budget:
Quantifies the transfer and storage of sediment in the landscape

Main driver: *
Rainfall & Runoff

Main erosion control: *
Vegetation

* Both impacted by climate - sediment system in state of flux (quantity & quality)

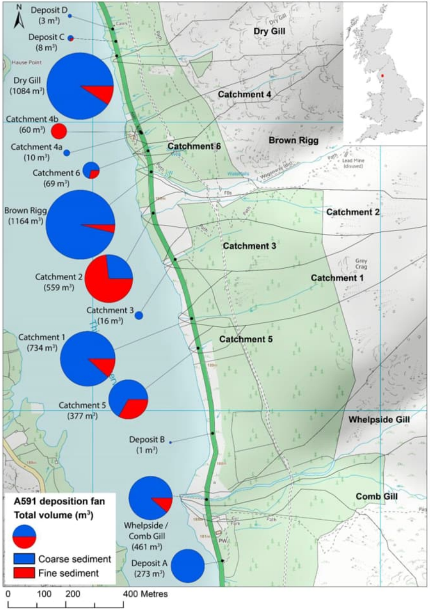
(2) Extreme floods -Storm Desmond, 4-6 December 2015 – Sediment Budgets



WHELPSIDE – TOTAL MASS (Values in tonnes)

70% eroded sediment from the 1.31 km^2 catchment is delivered to the lower toe slopes (debris fan)

(2) Extreme floods - Debris fan deposits and the A591 and reservoir 'sediment traps'

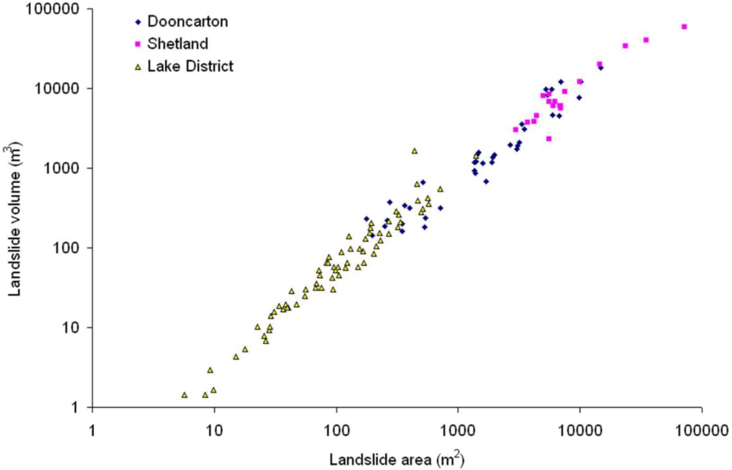


The proportion of coarse / fine (< 2 mm) is indicated in the charts. [Surveyed 8/12/15]

(3) Shallow Landslides (mineral and peat)

Cumbria January 2005 (mineral)

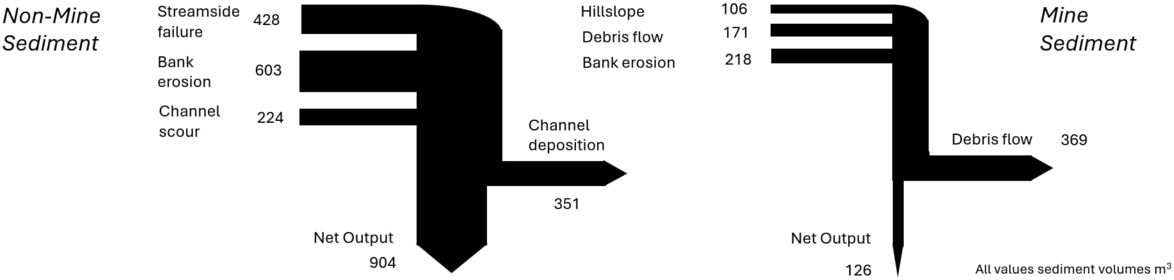
Burnhope Burn August 2006 (peat)



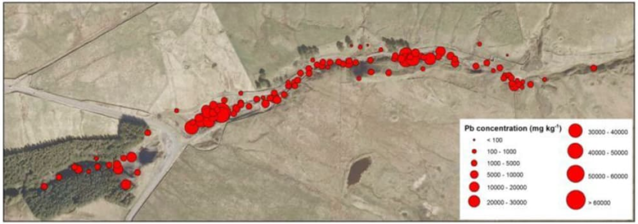
Lake District 2005 landslides only 46% of sediment was delivered to the stream channel. At-a-site and offsite impacts

(4) Contaminated catchments (metal mining) - 'sediment quality'

Brown Rigg, Helvellyn 2015

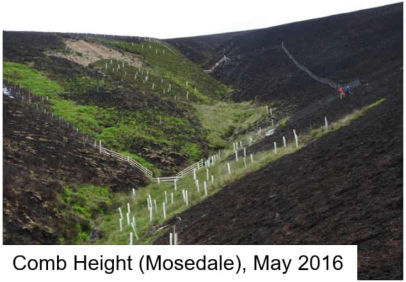


Whitesike, South Tyne , North Pennines



(5) Upland Wildfires - Revegetation and Recovery

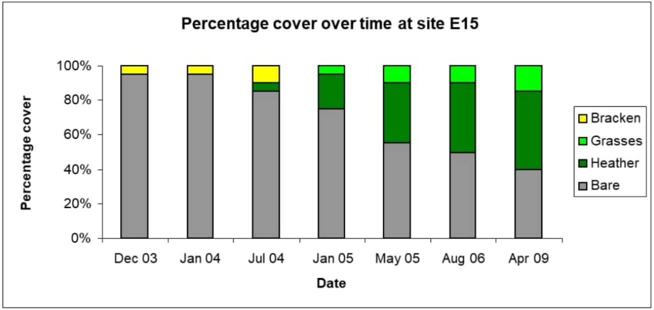

Barrow Fell, April 2003


Comb Height (Mosedale), May 2016

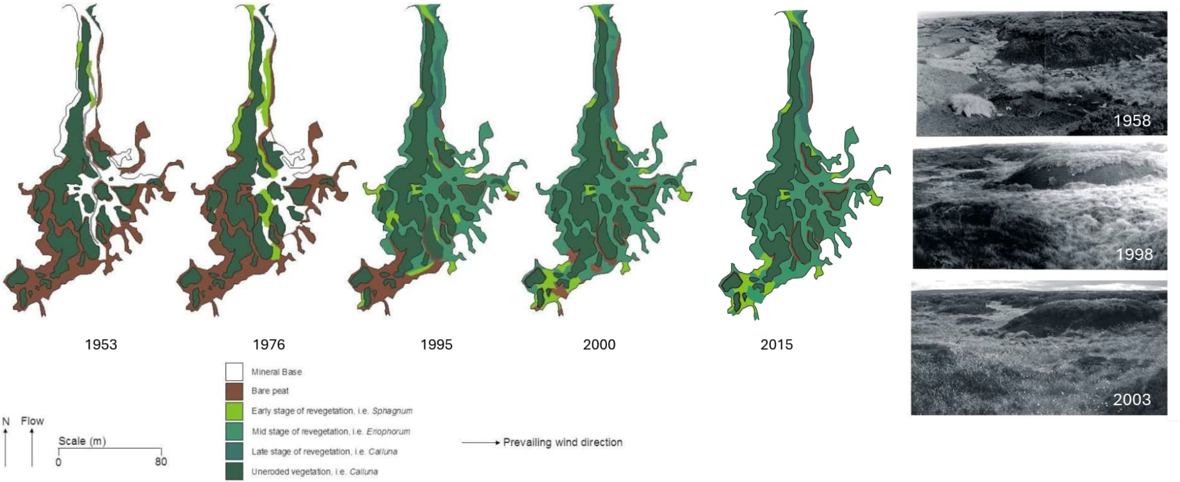
November 03

January 05

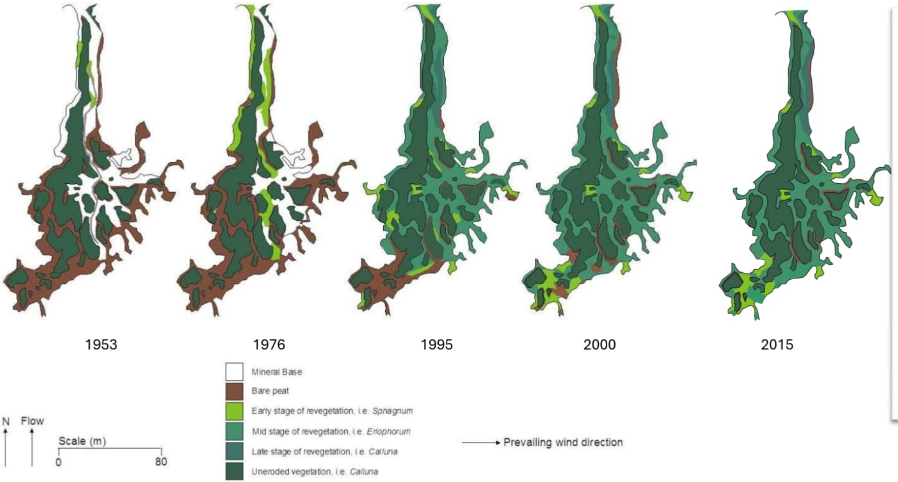
March 09

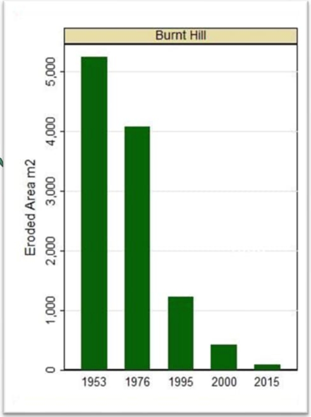


(6) Peatland Re-vegetation - Burnt Hill gully system (Moor House) from 1953-2015



(6) Peatland Re-vegetation - Burnt Hill gully system (Moor House) from 1953-2015





(7) Conclusions	Implications
Storm sediment delivery is extremely high (50-70% of the eroded sediment delivered to the catchment outlet). Flood sediment yields up to two orders of magnitude greater than average annual sediment loads.	**Large floods will impact infrastructure** (not 'if' but 'when'). Large size needs 'big' engineering or costly clean-up. Sediment management strategies - low yields (most of time) and infrequent (?) high yields.
Sediment sources close to the main stream dominate the sediment load	Debris dams effective in delaying sediment Repairing eroded slopes – small effect?
Coarse sediment is trapped by the roads / tracks on lower slopes (debris fans) - major hazard, road closure, costs to the regional economy.	**Improved highway engineering** – culvert design/capacity Increasing event frequency? – Road realignment?
Sediment quality is an important consideration (mineral, peat and contaminated)	Important for sediment dynamics (physical impacts) Important for chemical / biological impacts.
An understanding of 'headwater geomorphology and sediment budgets (magnitude and frequency)' provides an **important tool for decision-making**	**Timescales of recovery and revegetation** (*natural resilience*) Understanding magnitude frequency informs cost : benefit analysis

Thanks for listening.

Jeff Warburton, Durham University

jeff.warburton@durham.ac.uk

[Rich Johnson, Mark Kincey & collaborators]

Durham University

UKRI Natural Environment Research Council

Impacts of climate change on rail infrastructure: working with the landscape to mitigate impact

Mike Norbury and Olivia Devan, Network Rail

North West and Central region in numbers

- 246.5 million annual rail passenger journeys
- 1.3 million passengers travel through this region each weekday
- 571 stations
- 4 managed stations: Birmingham New Street, Manchester Piccadilly, Liverpool Lime Street, London Euston
- We are 24% of Britain's railway
- 6,724 passenger and freight services per day
- 700,000 tonnes of freight is moved each week
- 712 level crossings
- 7,100 bridges
- 150 signal boxes

Climate change adaptation - Network Rail

NetworkRail

Climate and the railway ...


Waves can damage coastal infrastructure


Heavy rain can cause embankment failure and landslides


Rivers and heavy rain can flood the track


Flooding can cause erosion, destabilising bridges


Heatwaves can cause track to buckle


Snow can block tracks and affect electrical connectivity


Wind can blow objects onto the track

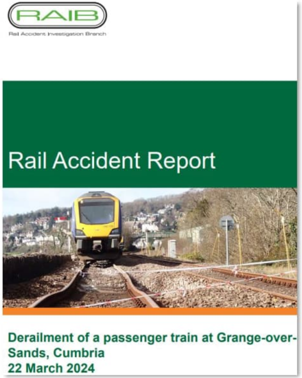

Wind can blow trees onto overhead lines and the track


Leaves on the line make tracks slippery and affect connectivity


Lightning can damage signalling and electrical equipment

WCM1 near Caldew Viaduct in Carlisle – May 2024


Impact of flooding in Carlisle


RAIB

Rail Accident Investigation Branch

Rail Accident Report

Derailment of a passenger train at Grange-over-Sands, Cumbria
22 March 2024

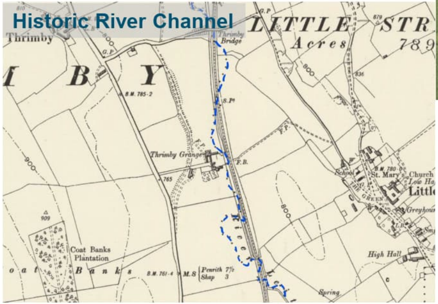
Cumbrian Lines and Some Climate Pinch-Points

NetworkRail

Scour resilience through river restoration

Thrimby Grange River Leith Restoration

- The geotechnical asset was being scoured due to the velocity and proximity of the watercourse to the toe of the embankment. There was also flood risk downstream.
- The channel has been removed from the embankment toe in most areas, reducing scour risk. This was done with Eden Rivers Trust.
- There has been additional flood risk and biodiversity benefits



Eden Rivers Trust

Environment Agency

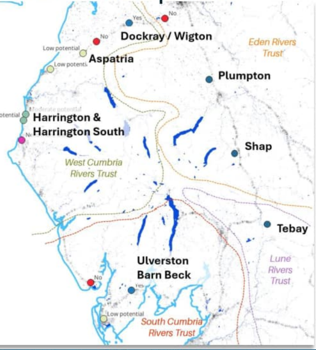
So what of the future?
Proposal and business case development

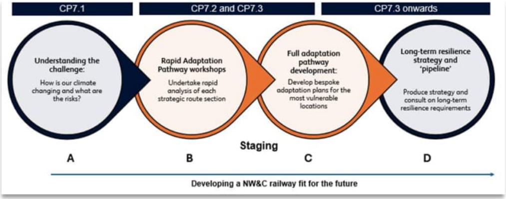
OFFICIAL

NetworkRail

8 shortlisted sites for review and prioritisation today

Flood site		NbS potential	Delay costs
1	Shap	Yes	£2m
2	Plumpton	Yes	£1.5m
3	Tebay	Yes	£1.5m
4	Ulverston, Barn Beck	Yes	£229k
5	Dockray / Wigton	Yes	£5k
6	Harrington	Moderate	£15k
7	Harrington South	Moderate	-
8	Aspatria	Low	£207k





Control Period 8 – What sort of railway do we want?

	Track km	Revenues	Train Delay Costs	Train Accident Risk	SRSs
VoS 1&2 - Primary and Economic	47%	81%	90%	70%	26
VoS 3&4 - Secondary and Social	53%	19%	10%	30%	45

Two types of railway: primary (economic) and secondary (social)

The economic and social railways behave differently

Train accident risk and train performance are not split equally

Requires different strategies to manage each

Input from government on expected outcomes and budgets

Sustainable Growth Must. A cleaner, greener railway fit for the future.

Thanks for listening.

Mike Norbury and Olivia Devan, Network Rail

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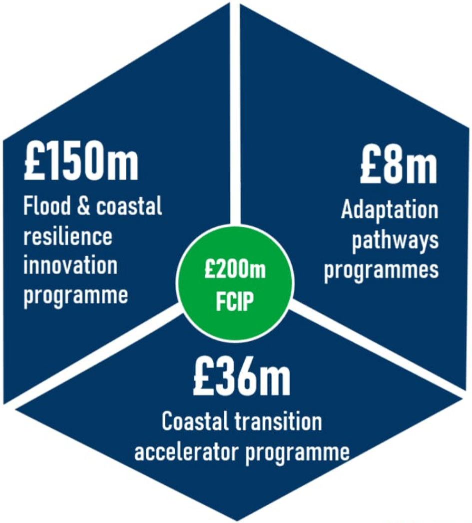
How the Environment Agency is innovating to combat the threat of climate change

Christine Dulake
Senior Advisor, Strategic Overview, FCERM
9 October 2025

Environment Agency

The Flood and Coastal Innovation Programmes

- Test and pilot new ways of delivering adaptation and resilience
- Generate evidence on costs and benefits of resilience and adaptative action
- Enhance local resilience and adaptive capacity
- Use evidence to inform future policy and investment



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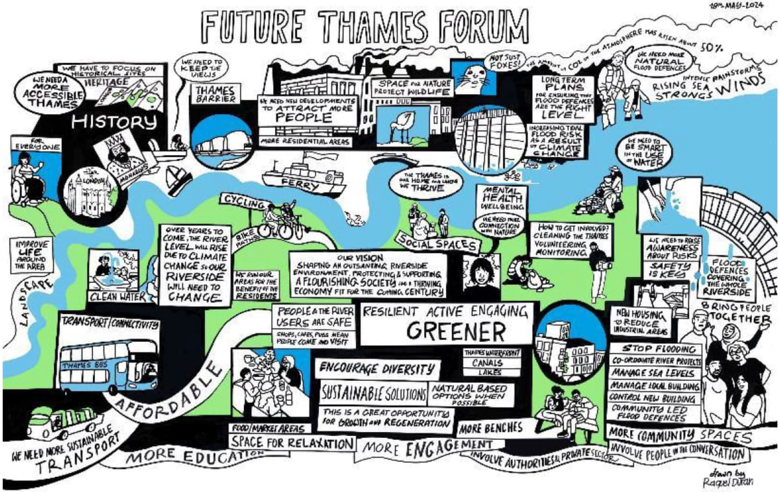
Adaptation Pathways Programme

https://engageenvironmentagency.uk.engagementhq.com/adaptation-pathway-programme

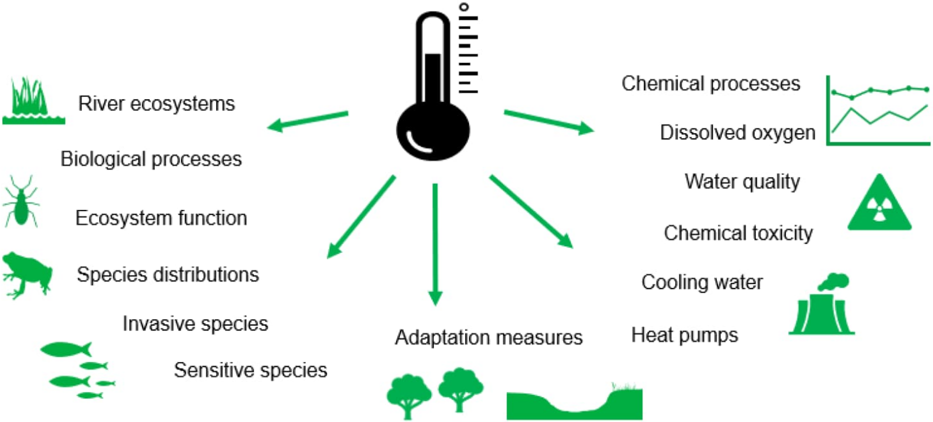
Environment Agency

Working together



Citizen panels give a local voice to communities, finding out what matters to them and testing different local choices and policies for adapting to climate change

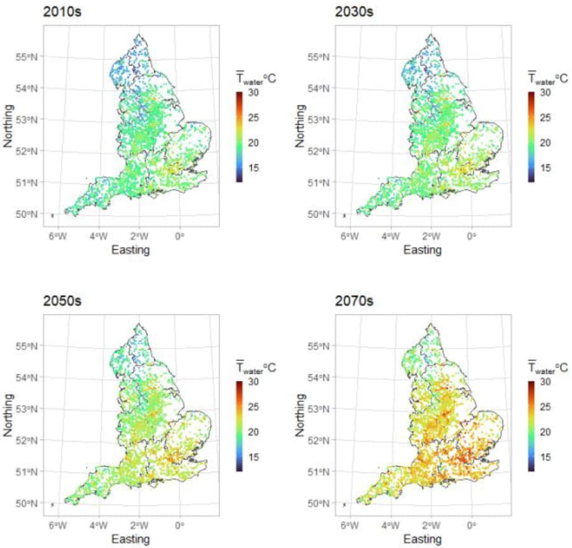
England's rivers temperatures into the future



Projections

Projected warmest monthly water temperatures by 2080

- Grass upland sites >28°C
- Chalk streams <26°C.



https://www.gov.uk/government/publications/water-temperature-projections-for-englands-rivers

How we can use these projections

- Modelling future water quality changes
- Water industry planning
- Water transfers
- Keeping rivers cool
- Effects on biodiversity
- Algal bloom risks

Together, we are innovating, developing, and embedding approaches that help enhance local resilience and adaptative capacity

Environment Agency

Additional note from Chief Scientists Group:

Our work building on the river temperature predictions continues with more research to be published in the future. We're looking at the results from an environmental perspective to help us better understand effects on water quality and ecological change. With that greater understanding, we can help direct management actions and adaptations such as NFM and river restoration.

You can also find out more generally about our work with water at

https://engageenvironmentagency.uk.engagementhq.com/welcome-to-the-water-hub

Environment Agency

Thanks for listening.

Christine Dulake,
Environment Agency

christine.dulake@
environment-agency.gov.uk

Environment
Agency

Forestry England

Forests and climate change mitigation
Some Cumbrian examples

Gareth Browning MBE

Beat Forester and Wild Ennerdale Partner


Avoiding steep
south facing slopes,
clear fells and
changing ground prep


More thinning and CCF


Increasing
species
diversity

Forestry England



Natural process focused and restoring species


Natural regeneration
and woodland creation


Restoring
Wetlands

Thanks for listening

Forestry England | Growing the future

Gareth Browning

gareth.browning@forestryengland.uk

Useful link: https://www.forestresearch.gov.uk/climate-change/

Ensuring NFM investment mitigates floods

This project is funded by Defra as part of the £200 million Flood and Coastal Innovation Programmes which is managed by the Environment Agency. The programmes will drive innovation in flood and coastal resilience and adaptation to a changing climate.

Working for Cumberland Council and Westmorland & Furness Council

Nick Chappell

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Lancaster University

Natural Environment Research Council

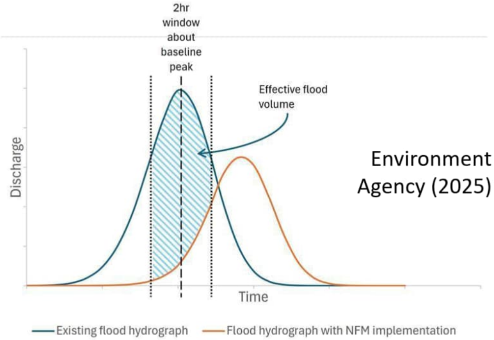
Environment Agency

10 years of visionary investment

objective-based monitoring-analysis

How much temporary storage* needed at flood peaks?

Chappell et al (2023)
Chappell & Beven (2024)



Environment Agency (2025)

* dynamic equivalent storage

guide : 1,000 m³/km²/±2hrs

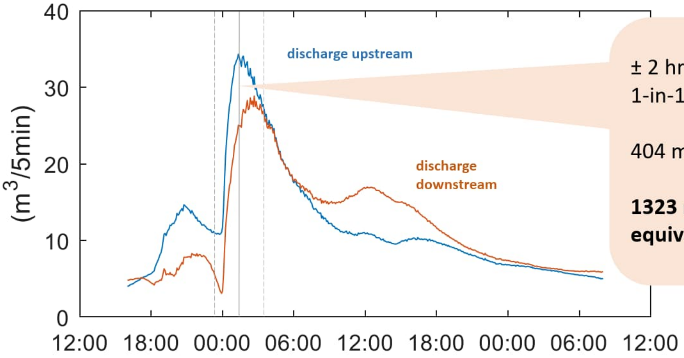
Q1: Is it working at flood peaks?

unchanging channel bed & level control

Find out :

volume change (m^3)
@ peak levels (m) in local watercourse

Q2: Is it delivering sufficient volume (m^3) at flood peaks?



± 2 hr window around 1-in-1 yr flood peak

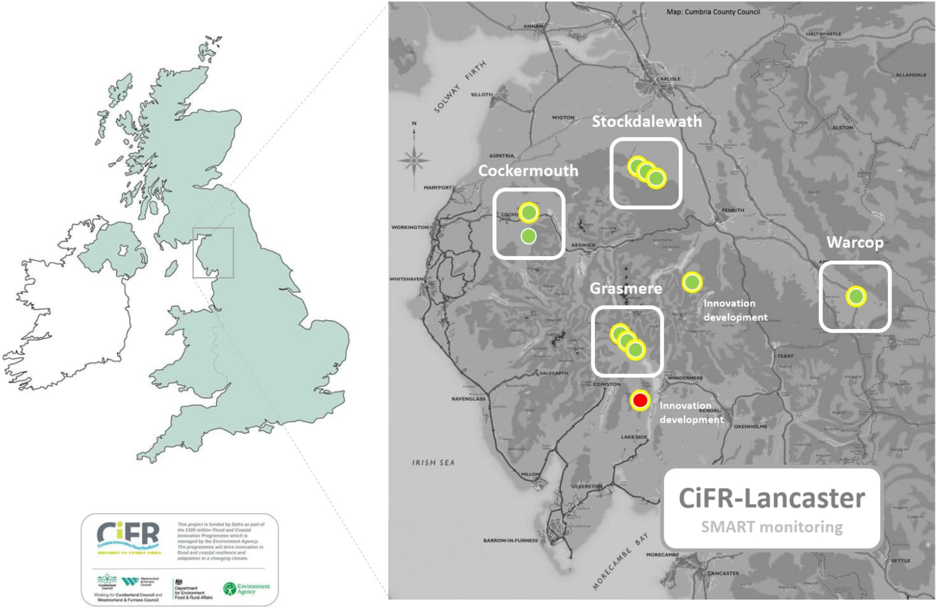
404 m^3

1323 m^3/km^2 equivalent volume

Alt: upstream-downstream high-fidelity discharge

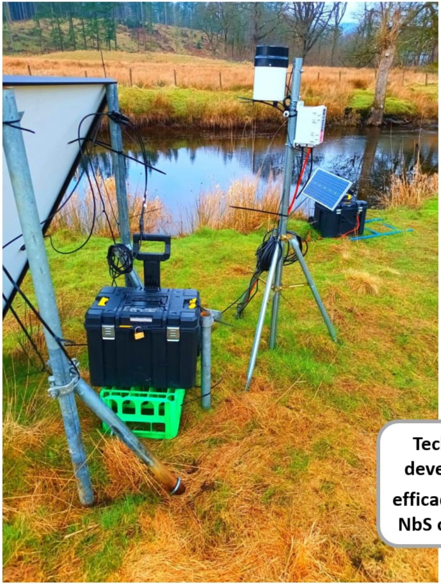
Find out :

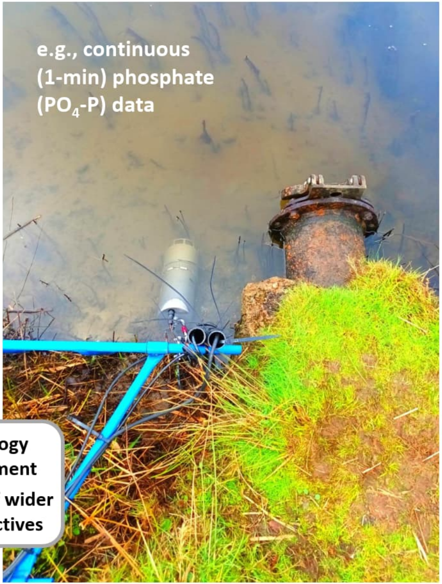
volume change (m^3/s) per high fidelity discharge @ peaks (m^3/s)



This project is funded by Defra as part of the £200 million Flood and Coastal Innovation Programmes which is managed by the Environment Agency. The programmes will drive innovation in flood and coastal resilience and adaptation to a changing climate.
Working for Cumberland Council and Westmorland & Furness Council
Department for Environment Food & Rural Affairs
Environment Agency


Reference stream monitors
Cockermouth
Grasmere
Stockdalewath
Warcop
Technology development systems





Technology
development
efficacy of wider
NbS objectives

Thank you for listening.

CiFR Cumbria innovative Flood Resilience

This project is funded by Defra as part of the £200 million Flood and Coastal Innovation Programmes which is managed by the Environment Agency. The programmes will drive innovation in flood and coastal resilience and adaptation to a changing climate.

Cumberland Council
Westmorland & Furness Council
Working for Cumberland Council and Westmorland & Furness Council
Department for Environment Food & Rural Affairs
Environment Agency

Natural Environment Research Council

Nick Chappell

n.chappell@lancaster.ac.uk

Lancaster University

Environment Agency

10 years of visionary investment

objective-based monitoring-analysis

Use of natural processes in land management to secure water resources

John Gorst

Lead Catchment Partnership Officer

United Utilities

United Utilities

Water for the North West

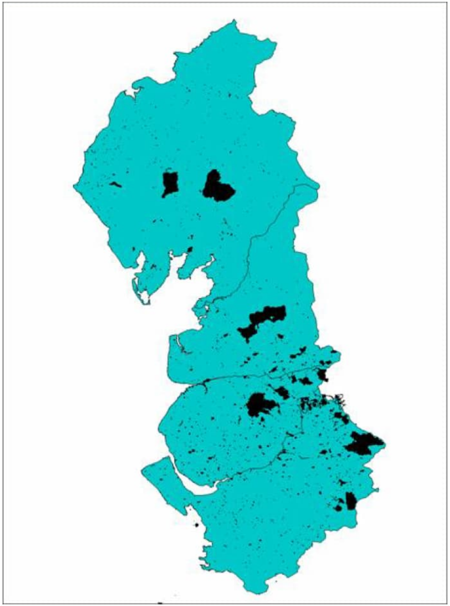
Catchment Land

- UU own 57,000 Ha catchment land
- 1980 ML average daily water supply

  65% upland reservoirs

  25% river and stream

  10% ground water

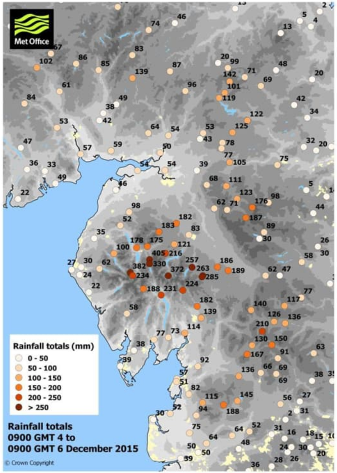


Reservoirs in Cumbria

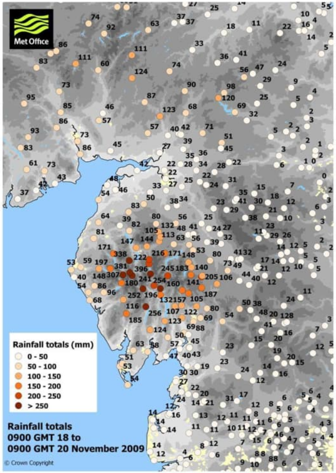
Thirlmere
250 Ml per day

Haweswater
400 Ml per day

Climate change - Increased frequency and severity of storm events



Storm Desmond December 2015,
rainfall at Thirlmere 405mm



November 2009 storm,
rainfall at Thirlmere 341mm

Water Quality impacts

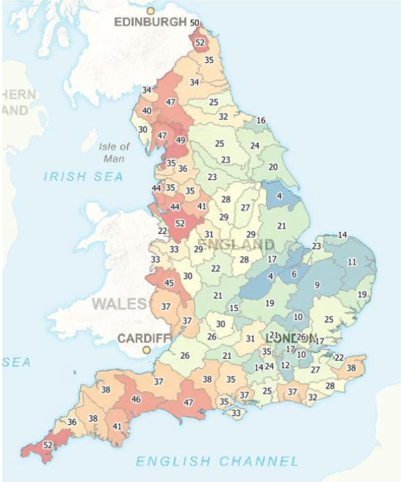
Thirlmere Overflow 8th December 2015

Following storm Desmond the turbidity levels in Thirlmere increased from about 0.4 NTU to close to 40 NTU. This took the reservoir beyond the treatable limit.

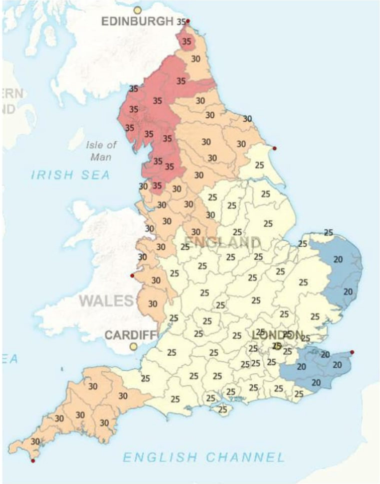
Dry Weather events

Climate change predictions

Percentage increase in peak river flow (2080)



Percentage increase in peak rainfall (2070)



Increases are relative to a 1981 – 2000 baseline.


Carrifran 1999


Carrifran 2015

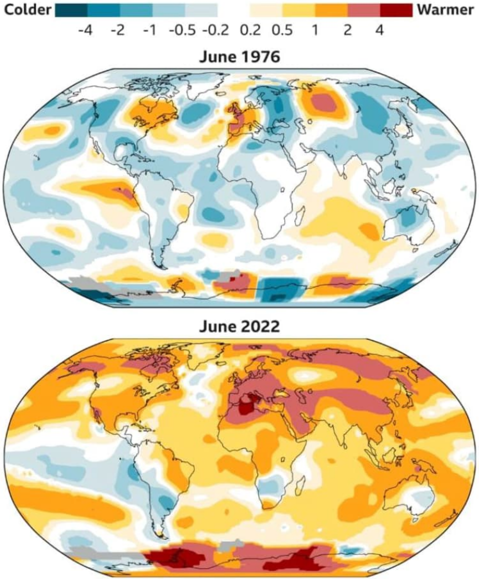

Dinsdale


20 EURO

Future catchment resilience - we need to restore the hydrological integrity of our catchments. This gives us the best chance to mitigate the impacts of climate change and restore biodiversity and bio abundance.

How global temperatures have changed

Temperatures (°C) compared with 1951-80 global averages



Source: NASA

BBC

Thank you for listening.

John Gorst, United Utilities

john.gorst@uuplc.co.uk

Upper Duddon Landscape Recovery
Professor Dominick Spracklen

Farmers & the community working together for nature recovery

National Trust

Forestry England

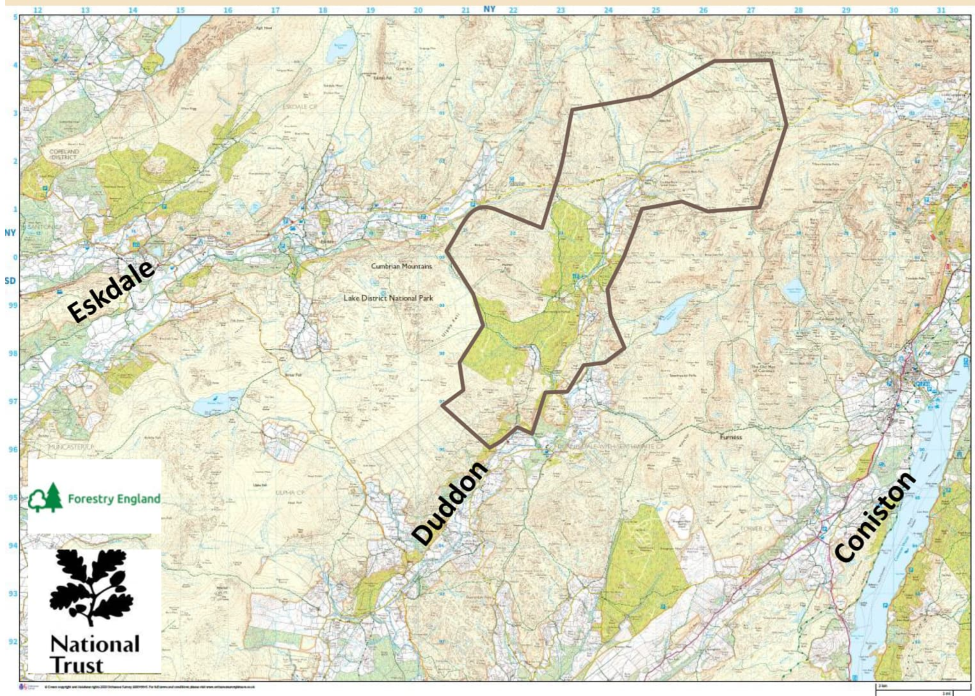
UNIVERSITY OF LEEDS

SCRT South Cumbria Rivers Trust

Restoring Hardknott Forest

University of CUMBRIA

NATURAL ENGLAND



Duddon valley
Lake District
National Park

2818 hectares

100 to 830 m
elevation

10 land
managers

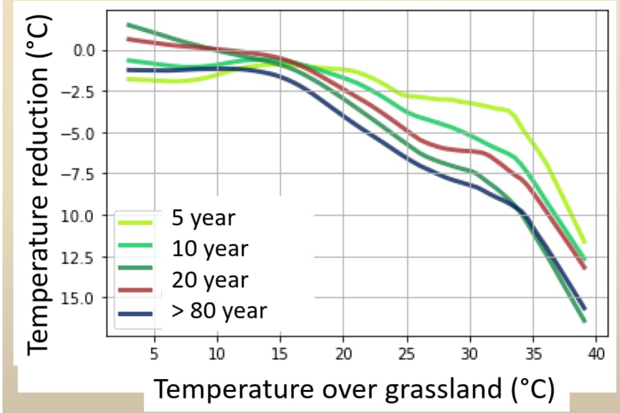

Co-designed with land managers and fell farmers


Ambitious 20-year landscape-scale restoration
1300 ha moorland restoration
400 ha wood pasture
750 ha temperate rainforest
River & Peatland restoration


Baseline, Monitoring & Payments for Outcomes


Partnership Working & Green Finance

Monitoring shows benefits of increased canopy cover



5°C cooler in heatwaves

15% less peak flow in storms

Thanks for listening.

D.V.Spracklen@leeds.ac.uk

Professor Dominick Spracklen, University of Leeds

Workshops - Improving resilience place by place:

Choose one of four communities at risk of flooding in Cumbria to:

1. Share knowledge and experience of what's being done.
2. Explore what interventions in the landscape might be possible.
3. Identify possibilities of how we might collaborate to improve flood risk and delivering wider benefits such as infrastructure, peat, biodiversity, and water quality.

Or (fifth session) ***What role could the RFCC play in enabling and facilitating better collaboration?***

Closing remarks:

Kate Morley

NW RFCC representative for conservation

Cumberland Council
Westmorland & Furness Council
CiFR Cumbria innovative Flood Resilience
North West Regional Flood & Coastal Committee
Department for Environment Food & Rural Affairs
Environment Agency