



Natural Defences for Flooding

DO WE NEED TO ENGINEER OUR WAY OUT OF EVERYTHING?

UK – Winter 2020

- Rhondda Cynon Taf one of the worst hit regions of the UK
- >600 households affected
- >600 Business affected
- 7 bridges damaged
- Council – bill for >£30mill
- Storms Dennis, Ciara and Jorge in quick succession
- On 16th Feb - The Environment Agency issued 347 flood alerts, 282 flood warnings, the highest on record – followed by 7 severe flood warnings in England.



Wettest February on record and 5th wettest Winter

February 2020 has been the wettest February on record for UK, England, Wales and Northern Ireland, and the second wettest (behind February 1990) for Scotland. It has also been the fifth wettest of any calendar month in a series from 1862 behind only October 1903 (227mm), December 2015 (217mm), November 2009 (215mm), and December 1929 (213mm) (Met Office, 2020)



And what of future predictions?

“Extremely wet days during UK winters are currently up by around 15% compared with previous decades,” said Dann Mitchell of Bristol University’s Cabot Institute for the Environment. “Wetter future winters is a consistent projection with some predicting a 30% to 35% increase in rain by 2070. Our government and town planners need to invest significantly in UK flood defences.”



Are we prepared for that?

“We are simply not prepared for the flooding coming our way in future,” said Prof Hannah Cloke, of Reading University. “We need to carry out a complete overhaul of our defences and be prepared to spend a lot more on them over a longer period of time.”

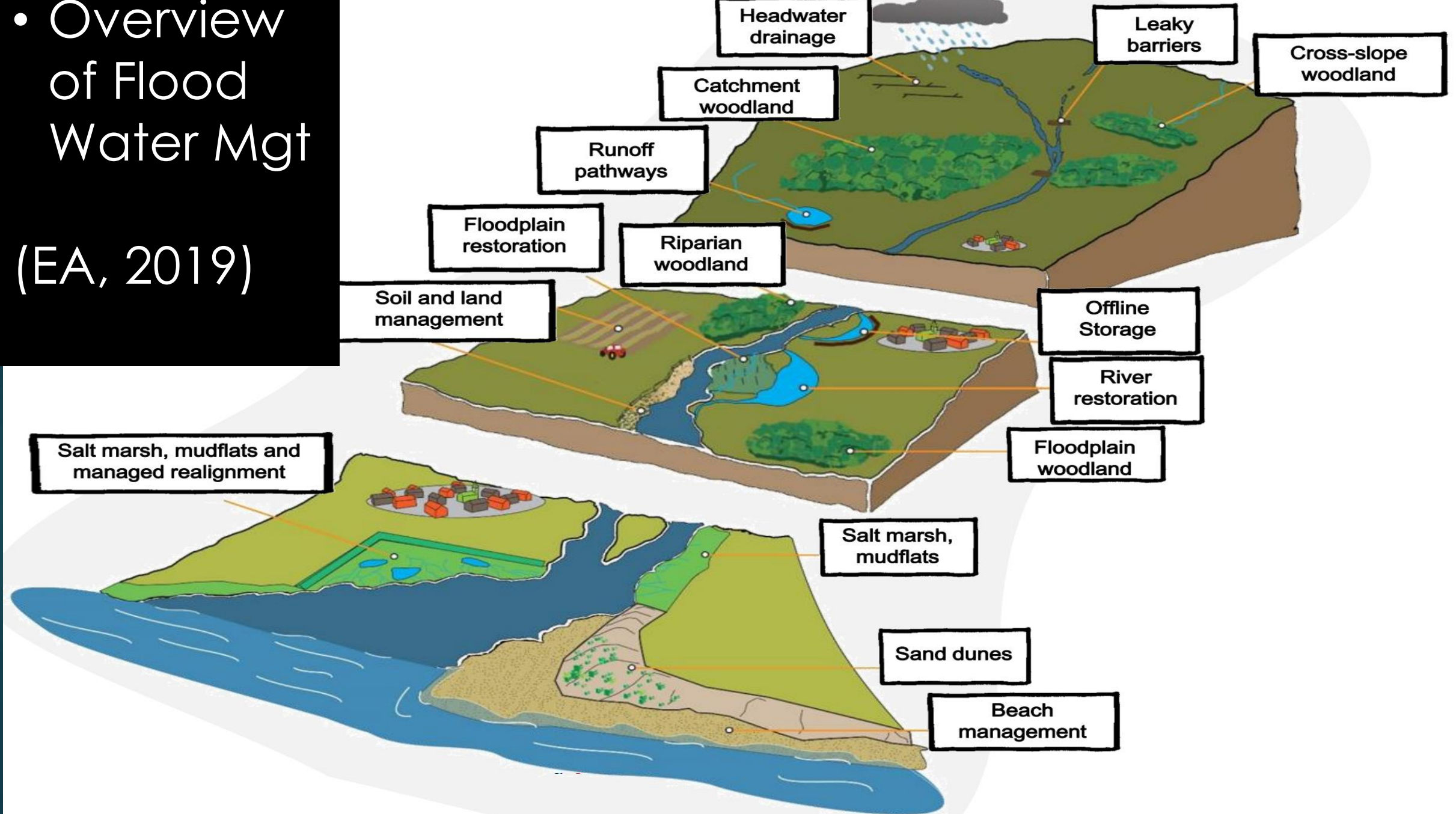


Current Strategy Against Flooding

- Better early warning systems
- Modify homes to withstand floods
- Construct building above flood levels
- Install more flood barriers
- Tackle Climate Change
- Increase spending on flood defences
- Protect wetlands and plant trees strategically
- Restore rivers to their natural courses
- Introduce water storage areas
- Improve soil conditions



- Overview of Flood Water Mgt
(EA, 2019)



River Restoration

- Excavation of additional channels to allow a river to naturally meander rather than flowing through a single channel (Exmoor)
- In a 25 km² catchment in the New Forest the results of a monitoring study found river restoration led to a 21% reduction in flood peak and a 33% increase in peak travel for 2-year recurrence event (Sear et al, 2006).
- Allow for meandering routes:
 - Reduces peak flow
 - Slows velocity of water
 - Allows water storage



Beavers – natural engineers

- £13m project with focus on five key areas: the River Conwy in North Wales, the Derwent in Cumbria, the Upper Bure in Norfolk, the Bollin in Cheshire and Porlock Vale streams in Somerset.
- “Their presence in our river catchments is a sustainable way to help make our landscape more resilient to climate change and the extremes of weather it will bring.” (Ben Eardley, National Trust, 2018, p.2)



Natural engineers

- 5 year study in Devon on the River Otter
 - Alleviated flooding (one family have built 6 dams upstream of the flood prone East Budleigh)
 - Other benefits – ecotourism, reduced pollution,
 - new wetlands benefited water voles, riverine birds such as dippers and wildfowl including teal.
 - 37% more fish in pools created by beaver dams than in comparable stretches of river.
-
- Downside – can create farmland flooding
 - Management is needed for stakeholder harmony



Leaky Barriers/dams

- Natural woody material laid in streams and ditches.
- Temporary hold the water back
- Encourage it to overspill to surrounding area and slow peak flow
- Store it in the landscape
- Intercept rainfall preventing it reaching the rivers in many cases
- Set above the normal stream/beck level, so normal flow and fish movement is not impeded.
- suited to smaller watercourses less than 2m wide
- Low cost and maintenance

(Eden River Trust, 2020)



Water Storage Areas

- ▶ Following the severe flooding of 2009 a £5.6 million flood alleviation scheme was established in Thacka Beck, on the outskirts of Penrith, Cumbria. More than 675 metres of culverts underneath the streets of Penrith were replaced and a 76,000m³ flood storage reservoir – the equivalent of 30 Olympic sized swimming pools – was constructed upstream to hold back flood water. The risk of flooding from the beck was reduced from a 20 per cent chance in any given year to a one per cent chance, according to Cumbria Wildlife Trust. (Grant, 2015)

Offline Storage

- ▶ Areas of land adapted for water storage containment for slow release at a later stage
- ▶ Use a bund; underground tanks
- ▶ Often Floodplains within the upper catchment area
- ▶ Wetlands and ponds can create space for wildlife also



Floodplain Restoration

- ▶ Restores the hydrological connectivity between the river and floodplain
- ▶ Encourages regular flood inundation and water storage
- ▶ Creating an extra 50ha of floodplain (Norfolk Broads) provides £1m of carbon sequestration benefits and £27m of recreational value over 100 years (Tinch et al., 2012).
- ▶ Ecosystem services



Saltmarsh restoration

reduce and dissipate wave and tidal energy in front of flood defences and can extend their design life.

Valued a habitat, climate regulation

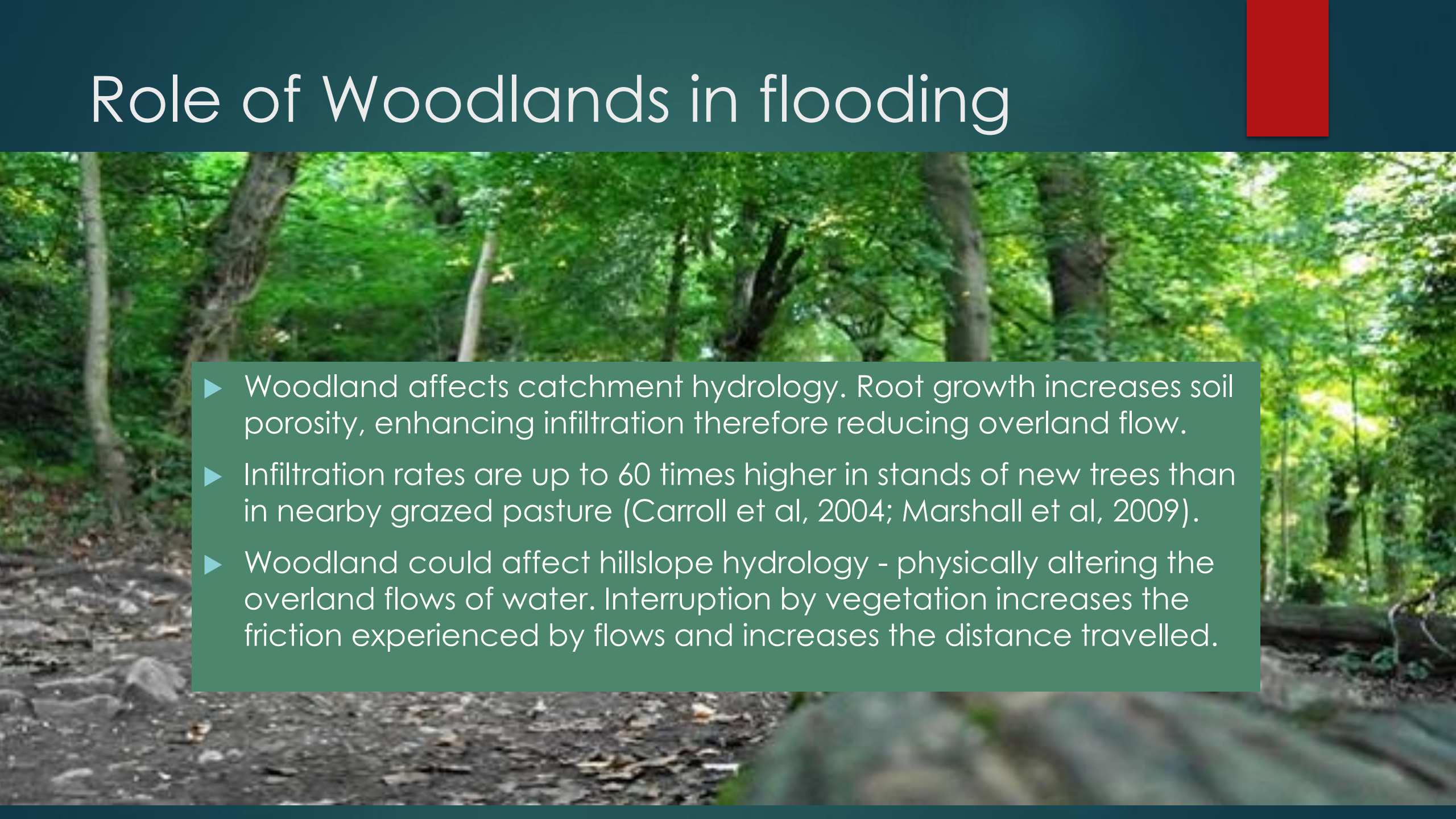
Cwm Ivy in Gower

Not planned but due to a seawall breach

Alleviated flood risk in other parts of Carmarthen Bay



Role of Woodlands in flooding

- 
- ▶ Woodland affects catchment hydrology. Root growth increases soil porosity, enhancing infiltration therefore reducing overland flow.
 - ▶ Infiltration rates are up to 60 times higher in stands of new trees than in nearby grazed pasture (Carroll et al, 2004; Marshall et al, 2009).
 - ▶ Woodland could affect hillslope hydrology - physically altering the overland flows of water. Interruption by vegetation increases the friction experienced by flows and increases the distance travelled.

Catchment Woodlands

- Intercepts, slows, stores and filters waters
- A study in New Zealand demonstrated that 67% catchment afforestation reduced mean flood peaks 55-65% across three different flood peaks (Fahey & Jackson, 1997).
- Carbon sink – climate change
- Biodiversity benefits



Riparian Woodland

- Woodlands found alongside rivers, lakes and streams
- Root stabilise river bank reducing erosion and siltation
- Trap sediment and slow water flow
- High evaporation losses and can store water – below ground storage
- Multiple ecological benefits through shading and nitrate removal
- One study found that riparian vegetation removed more than 20% of nitrates than the channelised river section (Peter *et al.*, 2012)



Soil and land management

- ▶ Encouraging better infiltration
- ▶ Slowing and storing surface water run-off
 - ▶ Agriculture – soil aeration, conservation tillage, crop rotation, stock density; hedgerow management and buffer strips
 - ▶ Conversion of arable land to grassland – carbon capture
 - ▶ Peatland management



UK's Current Peatland Health

- At least 80 per cent of UK peatlands are damaged by drainage, heavy grazing, regular burning, cultivation, forestry or other management.
- It can take over 1000yrs to generate 1m of peat
- 28 mil tonnes C stored in Lake District alone
- 5% loss of UK peat soils = annual man-made C emissions

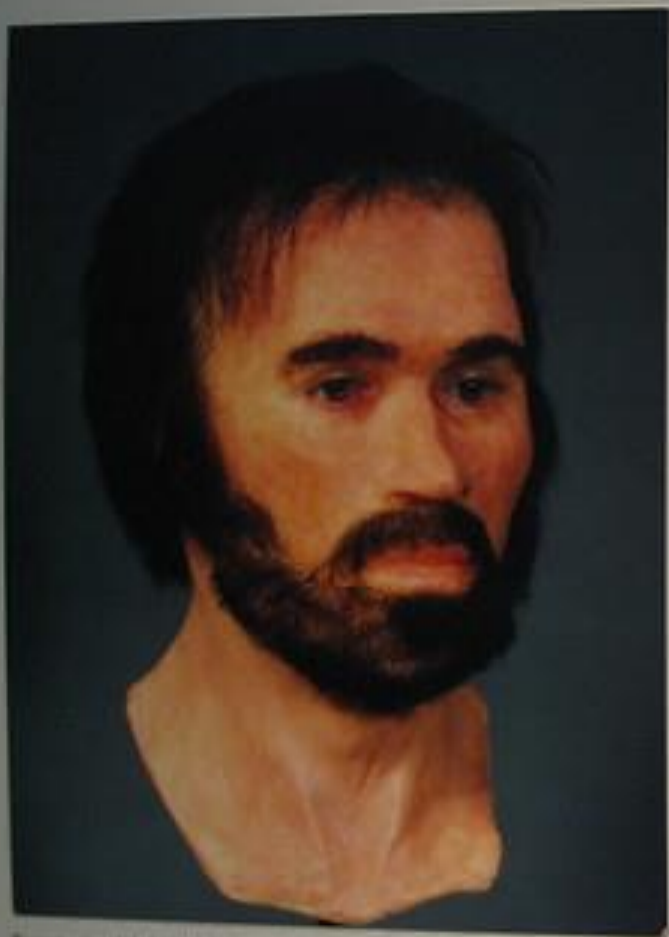


The lost Archives



- ▶ Peat restoration is important for environmental reasons but what of anthropology and history?
- ▶ Plant, insect and microbial remnants in peat – historical record of landscape changes
- ▶ How past natural systems responded to climate changes

Lindow Man



Reconstruction of the head, the face, beard and mustache had been bleached by the action of acid peat-water
Reconstructed by William Starna, Manchester University

Lindow Man is the name given to a human body found in a peat-bog at Lindow Moss, near Manchester, in 1985. After a leg was discovered by workmen sorting peat, archaeologists were called in and the upper part of the body was found, still in the ground. It was boxed and transported to the British Museum, where it was carefully excavated and thoroughly examined by a large team of scientists.

When he met an horrific death, sometime in the middle of the first century AD, Lindow Man was about 25 years old. Stunned by a couple of blows to the head, he was then garotted, his throat was cut and he was bled, before being placed in a pool in the bog. This elaborate sequence of events strongly suggests that Lindow Man was a ritual sacrifice, and it may be no coincidence that shortly before his death he had had a drink including mistletoe - the pollen was still in his stomach. Mistletoe was sacred to the Druids, and it is recorded that Druids carried out human sacrifices. At least one other contemporary body was found in the same bog.

FLOOD PREVENTION

- ▶ Water running over Sphagnum on blanket peatlands moves much more slowly (iCASP, 2008; IUCN, 2019)
- ▶ Water movement dominated by flow close to the surface
- ▶ Sediment released from bare peat strongly influences peatland stream ecosystems affecting both their biodiversity and functioning.



Making Space for Water Project

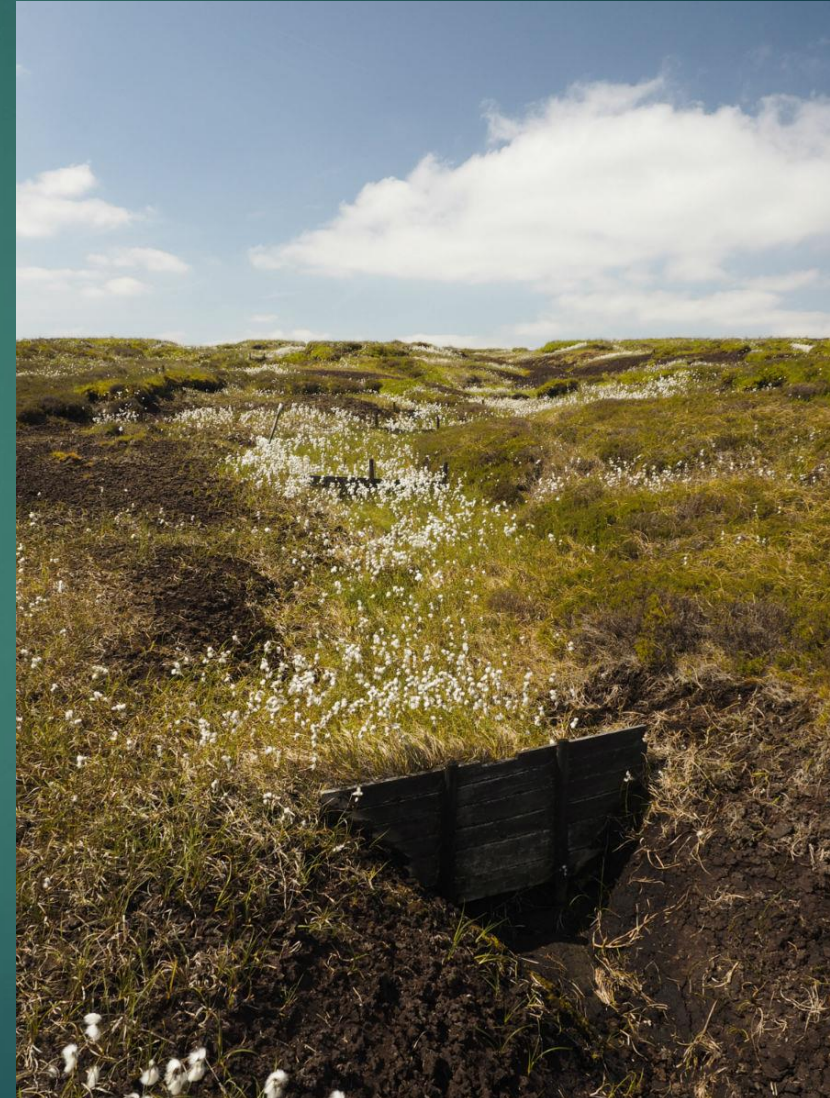
- ▶ Defra funded
- ▶ Project to monitor local flood risk on the Kinder Scout plateau
- ▶ Project 2012-2015
- ▶ Monitored:
 - ▶ Rainfall volumes in mini catchments
 - ▶ Volume flowing out of catchments
 - ▶ Height of water table below surface
 - ▶ Quantity of peat and carbon washed away
 - ▶ Colour of water
 - ▶ Control plot left



Kinder Catchment Monitoring Project, 2015

- ▶ peat accumulation or water pooling associated with 95% of gully blocks
- ▶ upstream vegetation establishment associated with 94% of gully blocks
- ▶ 'nurse' grasses dominating vegetation cover
- ▶ mosses and Lichens cover increased significantly
- ▶ 39 new locations of either single plants or carpets of sphagnum
- ▶ bare peat was reduced by 75% where work was carried out
- ▶ gradual rise in the water table, and reduced water flow after heavy rain

(MoorLIFE Project; 2015; IUCN, 2019)



Research on the effect of Peat Pipes (current PhD)



Peat Pipes.... tbc

- ▶ Underground channel – a conduit for water beneath the peat
- ▶ How?
- ▶ Why?
- ▶ What effect on the peatlands
- ▶ Finding them is a challenge



CARBON SINK

- 
- ▶ Peatlands – largest store of carbon in UK
 - ▶ Bare peat has the potential to lose more than 500 tonnes of carbon per square kilometre, per year. (IUCN, 2019)

Downstream Catchments

- Cities have a role to play too
- Adherence to policy
- Planners and Local Authority responsibility
- Innovation construction methods



Urban areas

- ▶ Sustainable drainage systems
- ▶ The Stroud rural sustainable drainage system (or SuDS for short) project aims to help reduce the risk of flooding to around 112 properties by introducing a large number of small-scale measures in the upper catchment aimed at slowing peak flood flows. Over 250 structures have been built so far, including leaky woody dams, culverts with soak-aways, field bunds and dry ponds.
- ▶ Green infrastructure – green roof, green walls, swales, permeable pavements



Revision Tips

- ▶ Familiarise yourself with up-to-date statistics regarding flooding
 - ▶ Research some case studies which will provide further understanding and knowledge of each of these processes
 - ▶ Take a critical view – not all these will work
 - ▶ There needs to be a case by case investigation
 - ▶ There will be pros and cons to all so be aware of that
-
- ▶ Generally, I will always include a topical themed question in my exams!