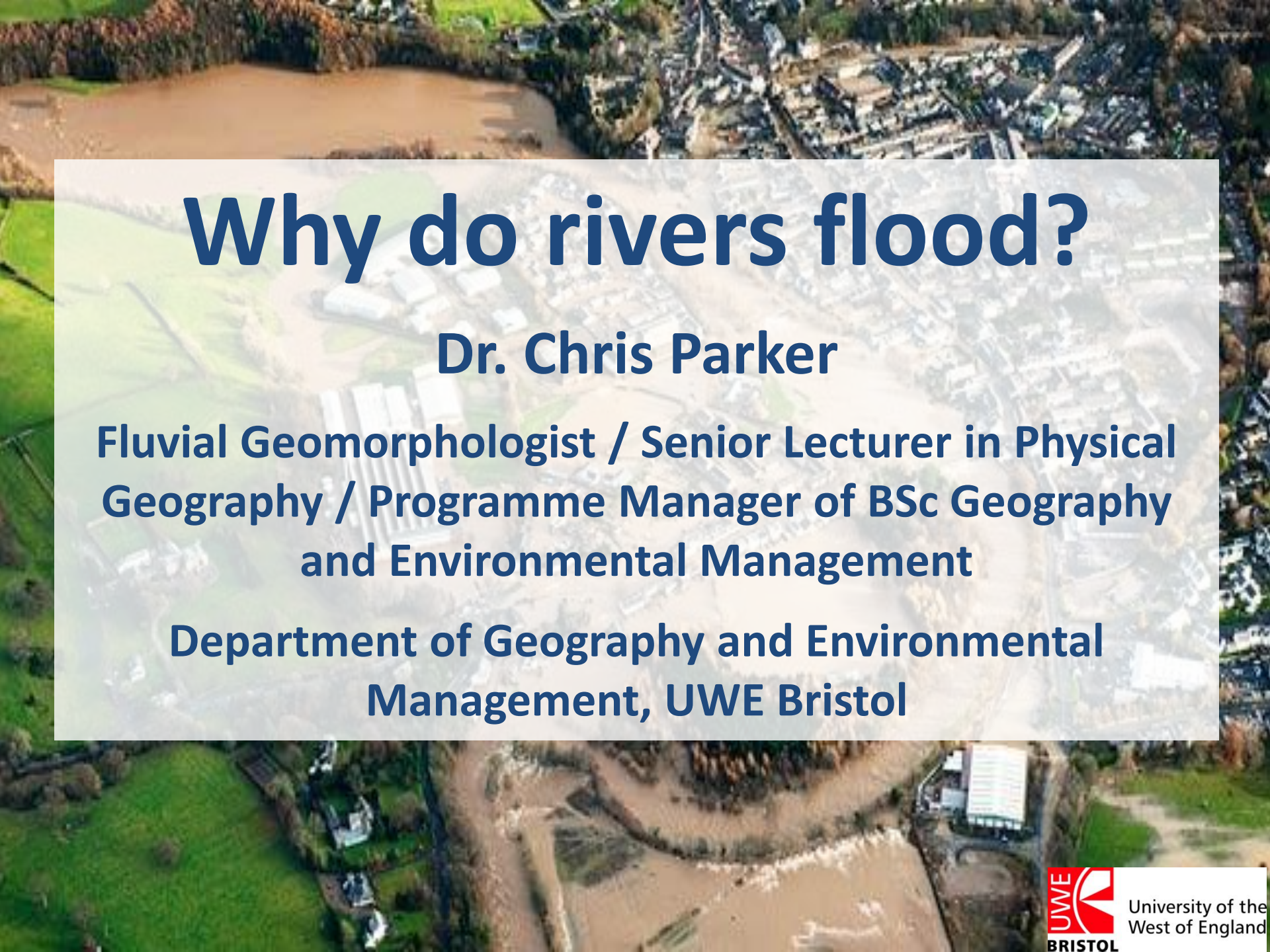


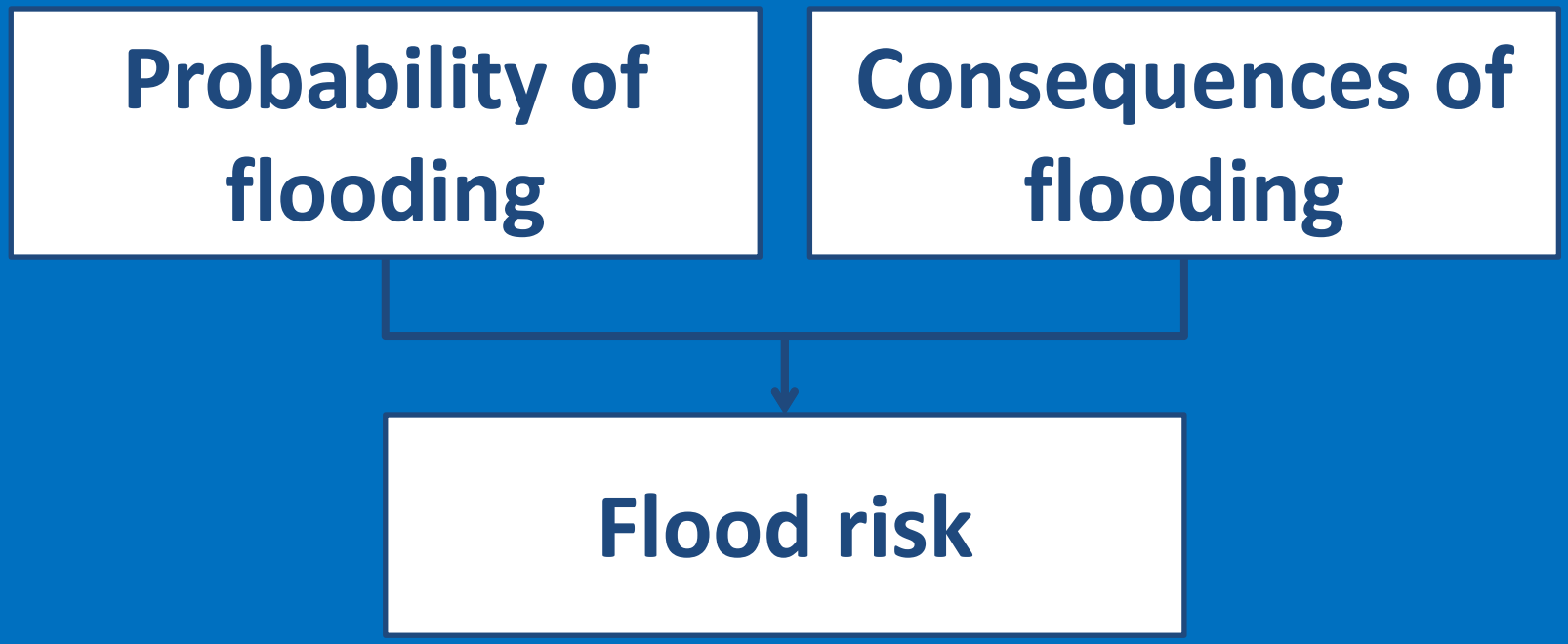
Why do rivers flood?

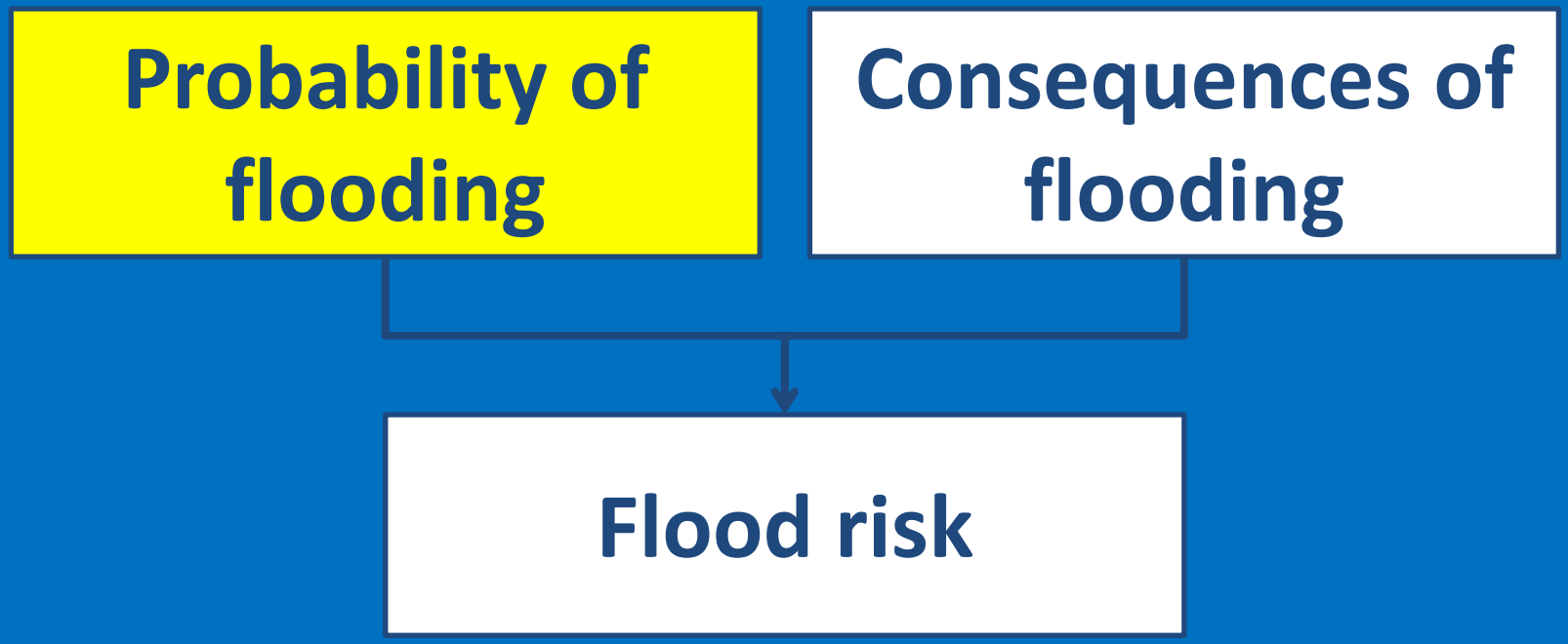
Dr. Chris Parker

Fluvial Geomorphologist / Senior Lecturer in Physical Geography / Programme Manager of BSc Geography and Environmental Management

Department of Geography and Environmental Management, UWE Bristol

University of the West of England

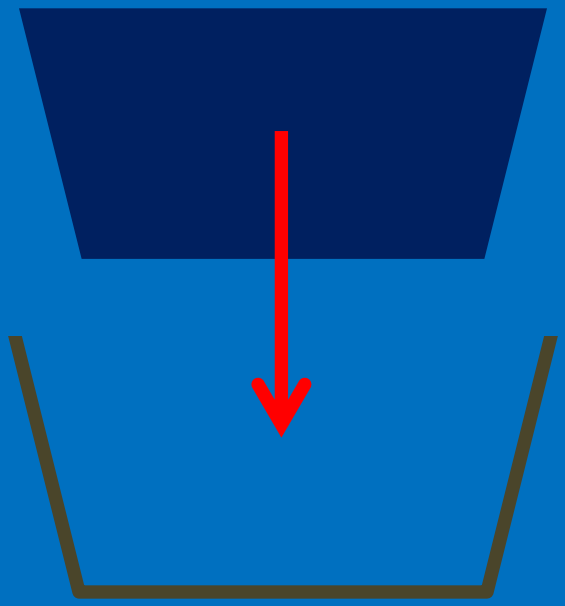

Probability of flooding
Consequences of flooding
Flood risk


Probability of flooding
Consequences of flooding
Flood risk

Why do rivers flood?

Why do rivers flood?

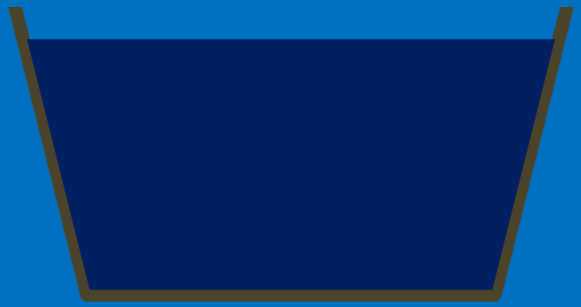
Hydrological regime



Conveyance capacity

Why do rivers flood?

Hydrological regime



Conveyance capacity

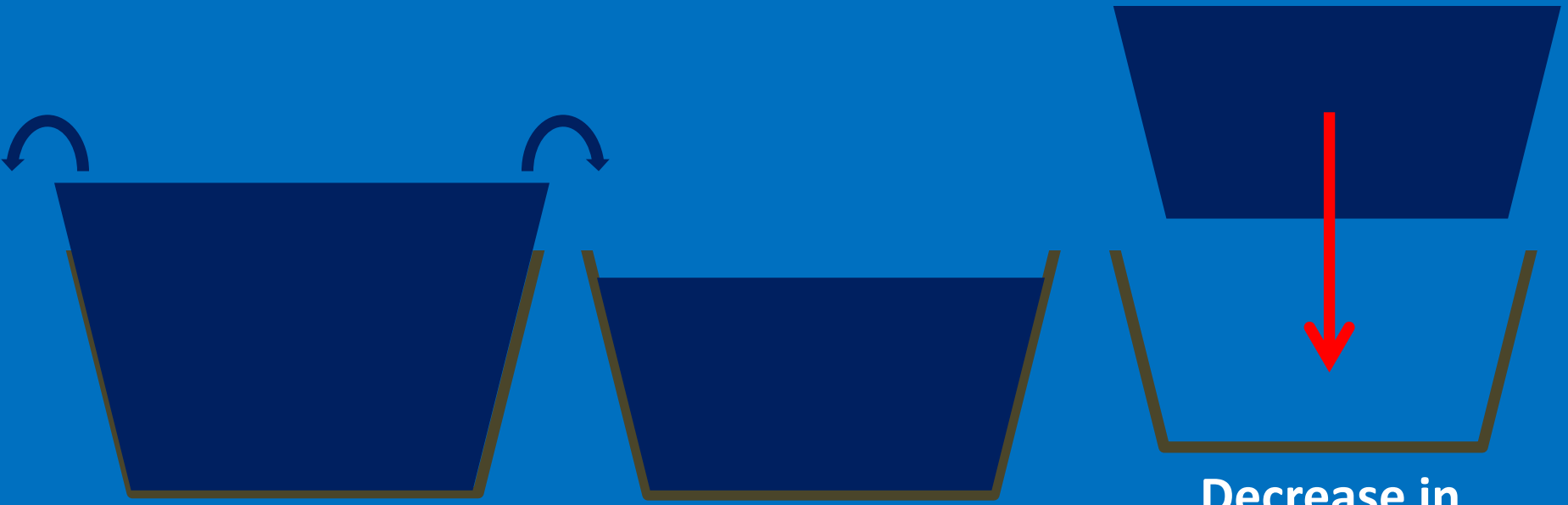
Why do rivers flood?

Increase in hydrological regime

Why do rivers flood?

Increase in hydrological regime

Why do rivers flood?



Increase in hydrological regime

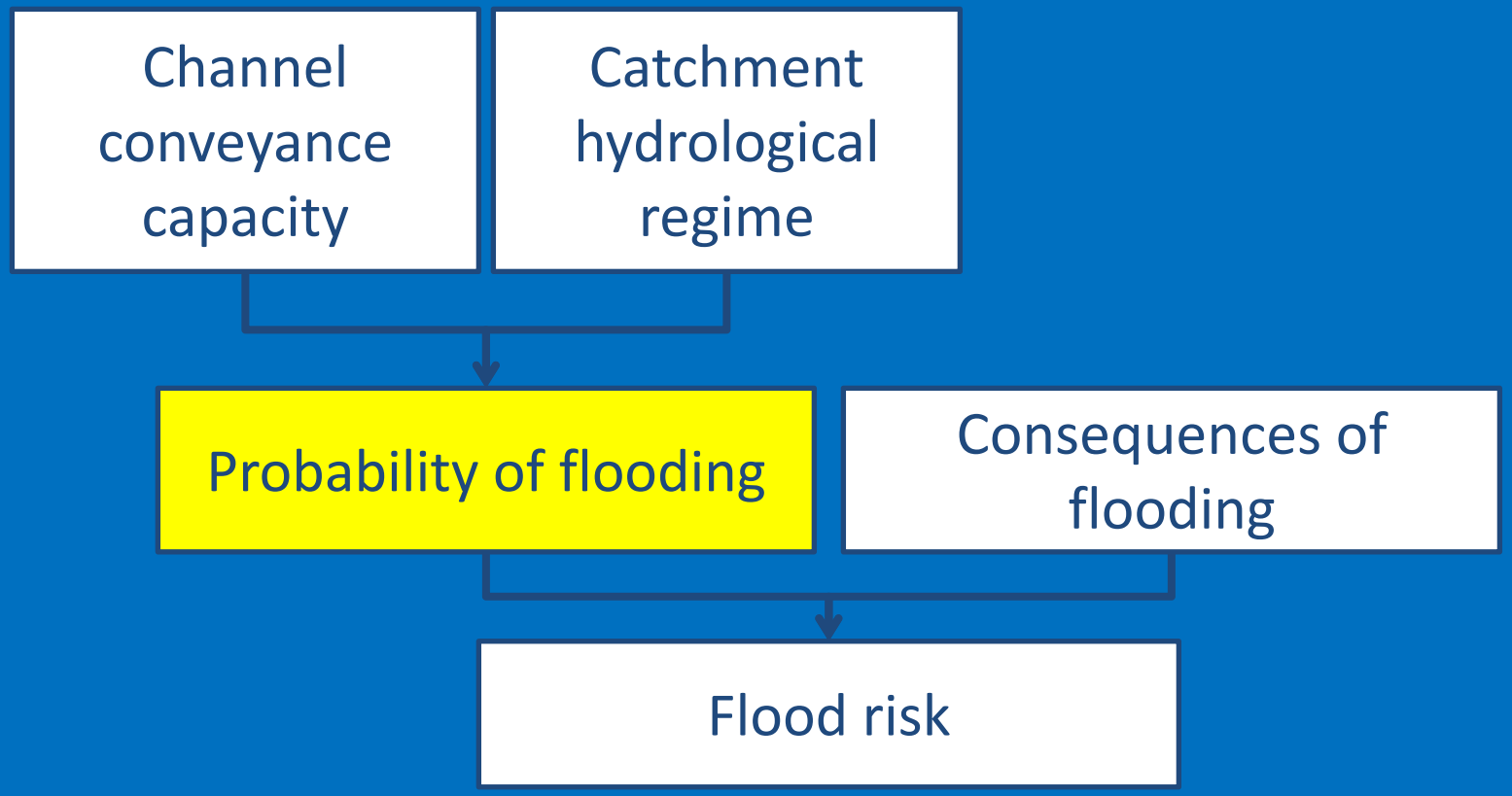
Decrease in channel conveyance capacity

Why do rivers flood?

Increase in hydrological regime

Decrease in channel conveyance capacity

Why do rivers flood?

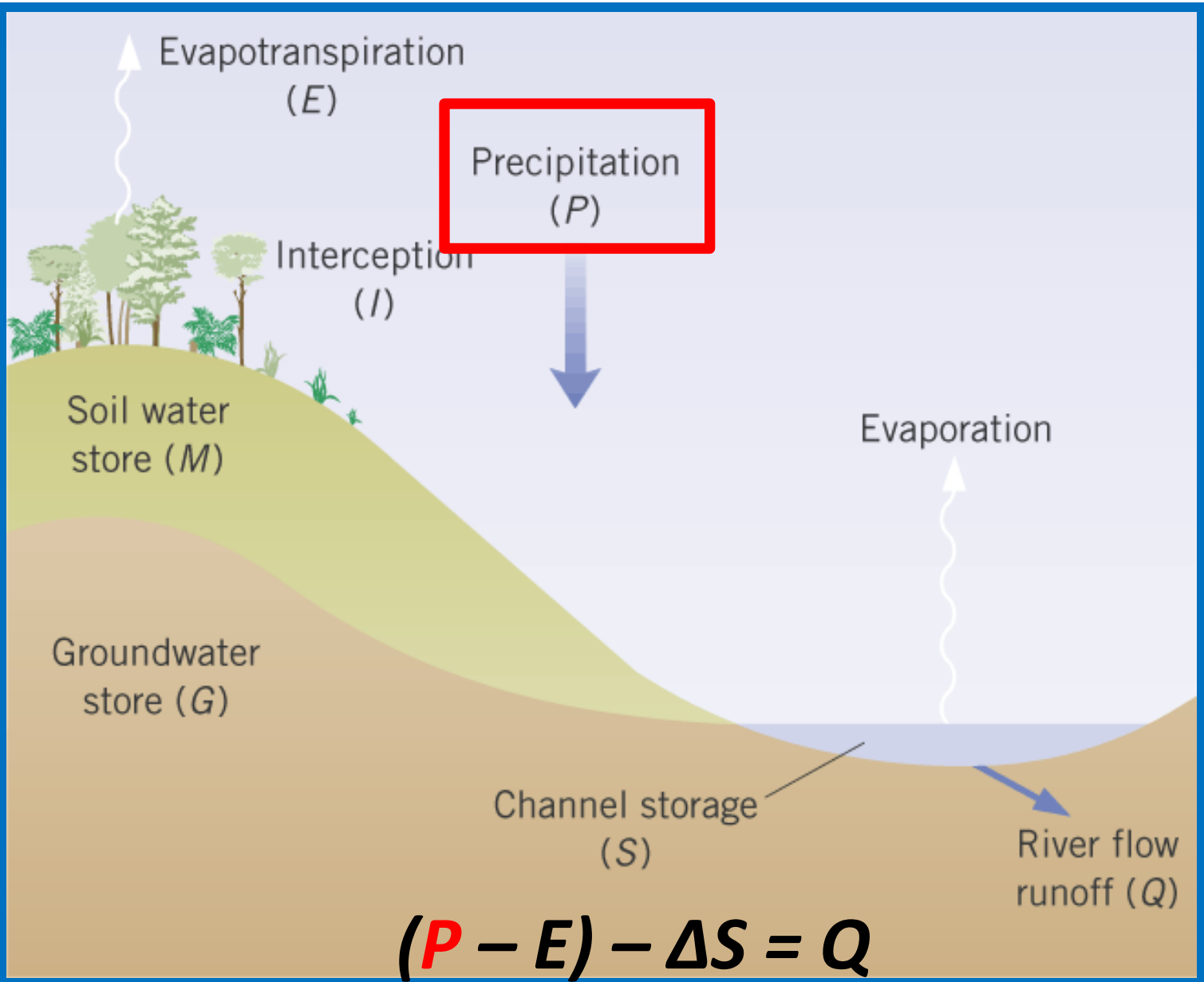


What controls a river channel's hydrological regime?

What controls a river channel's hydrological regime?

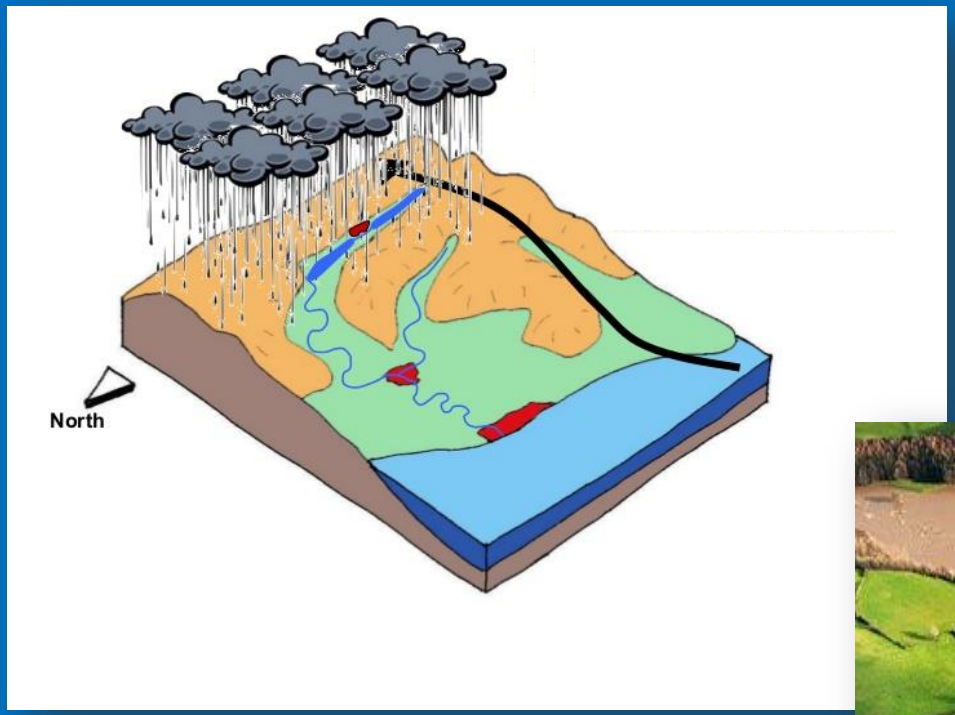
$$(P - E) - \Delta S = Q$$

What controls a river channel's hydrological regime?



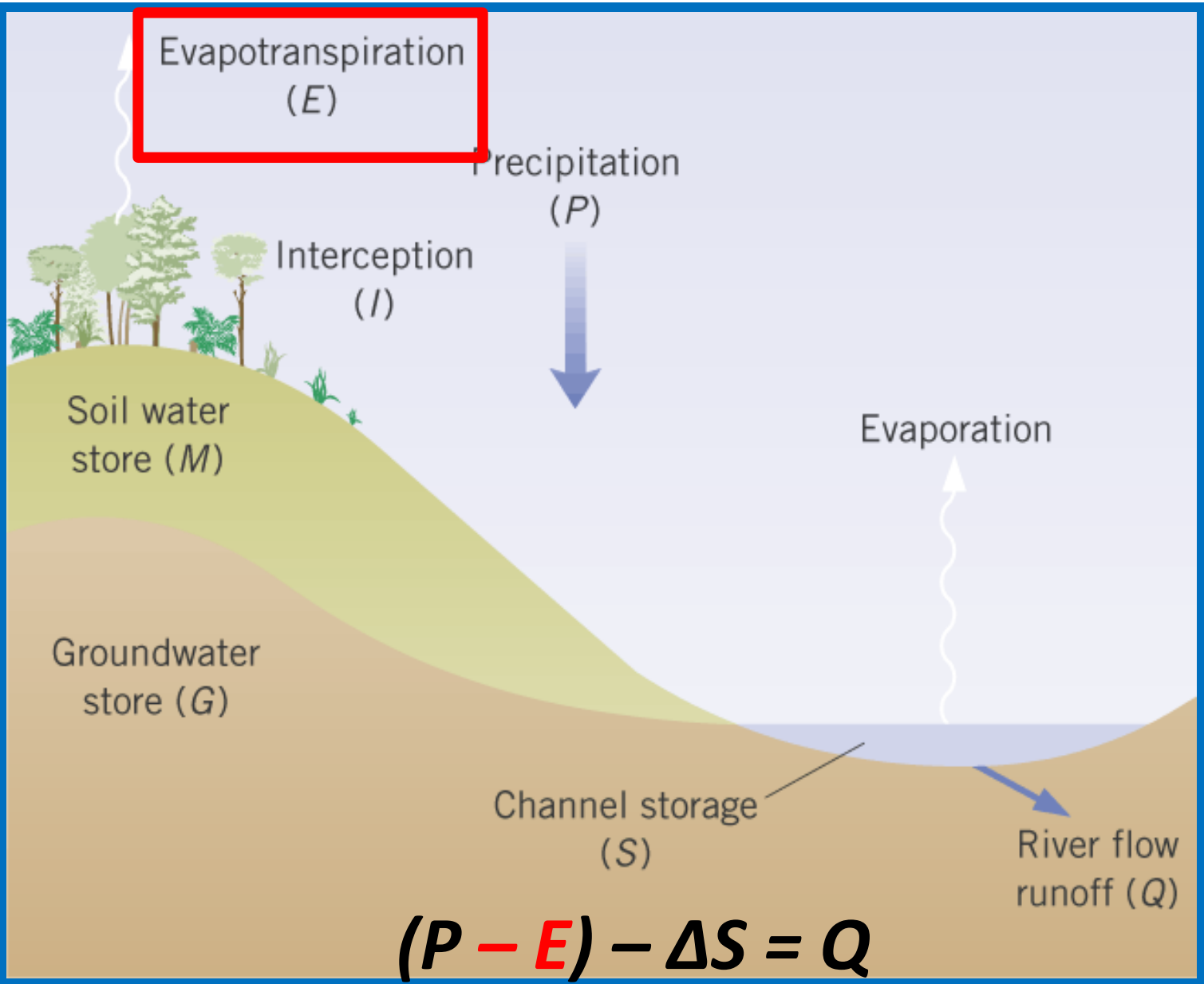
$$(P - E) - \Delta S = Q$$

What controls a river channel's hydrological regime?



Cockermouth, 2009 – 400mm rainfall in 24 hours

What controls a river channel's hydrological regime?



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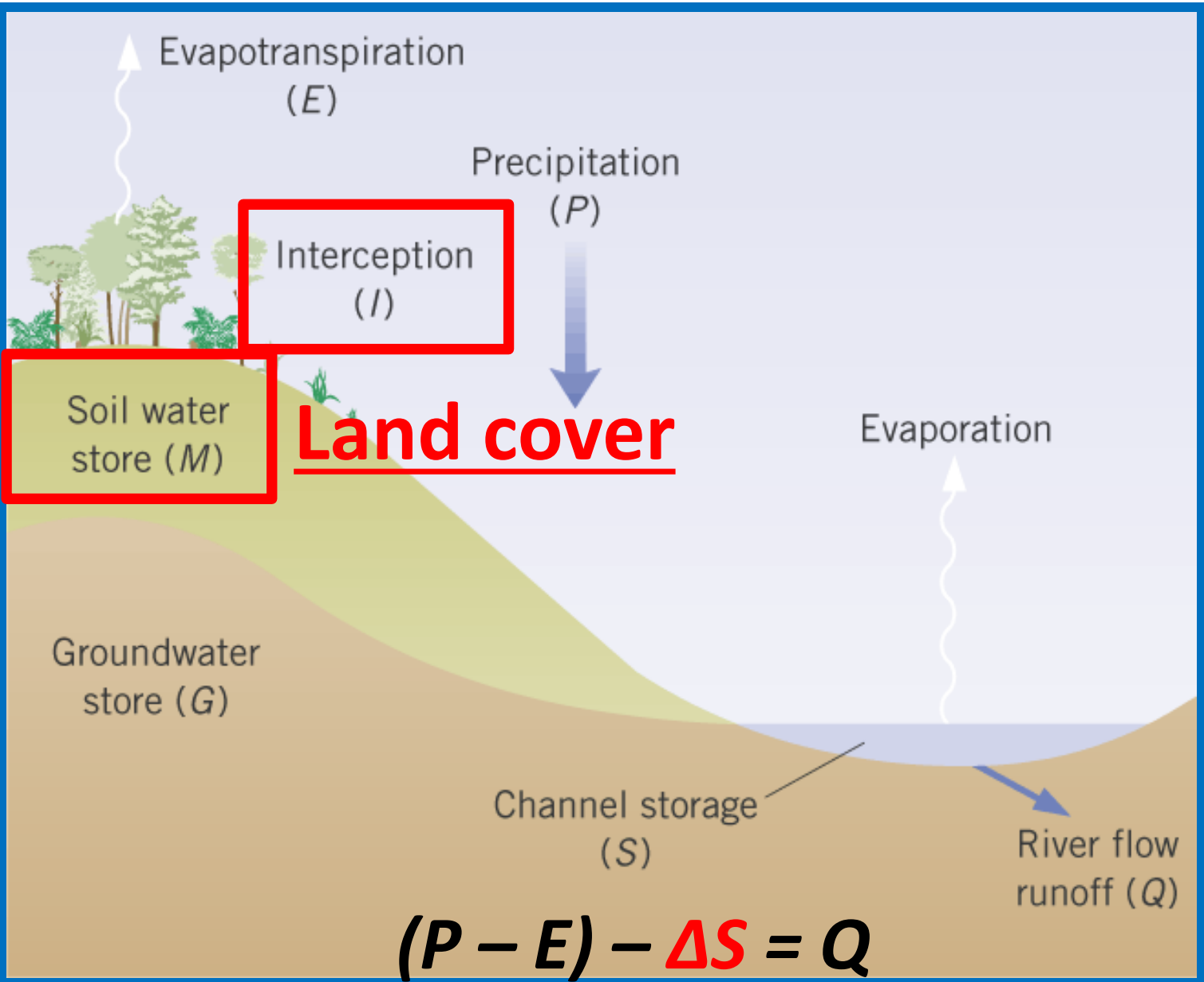
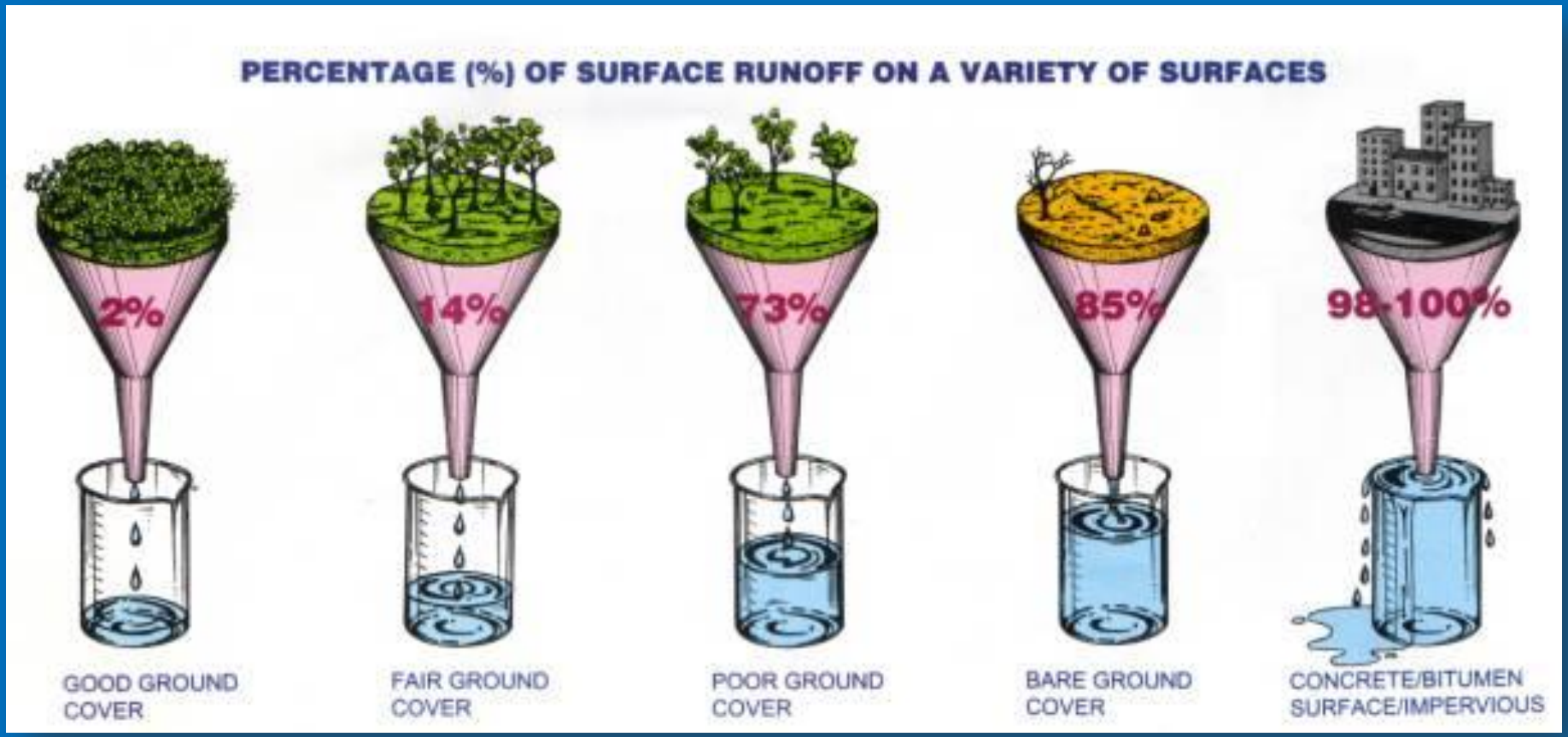
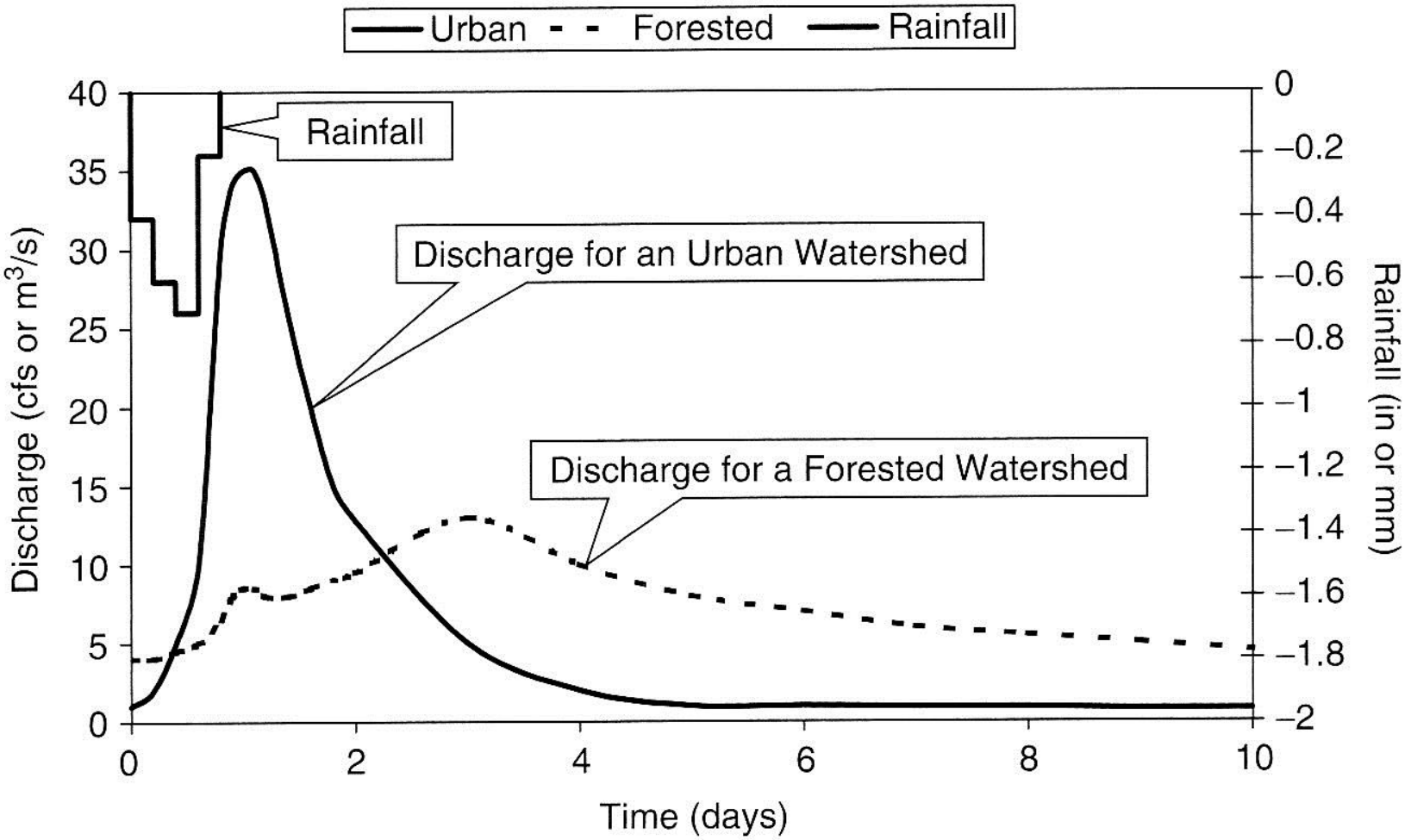


What controls a river channel's hydrological regime?



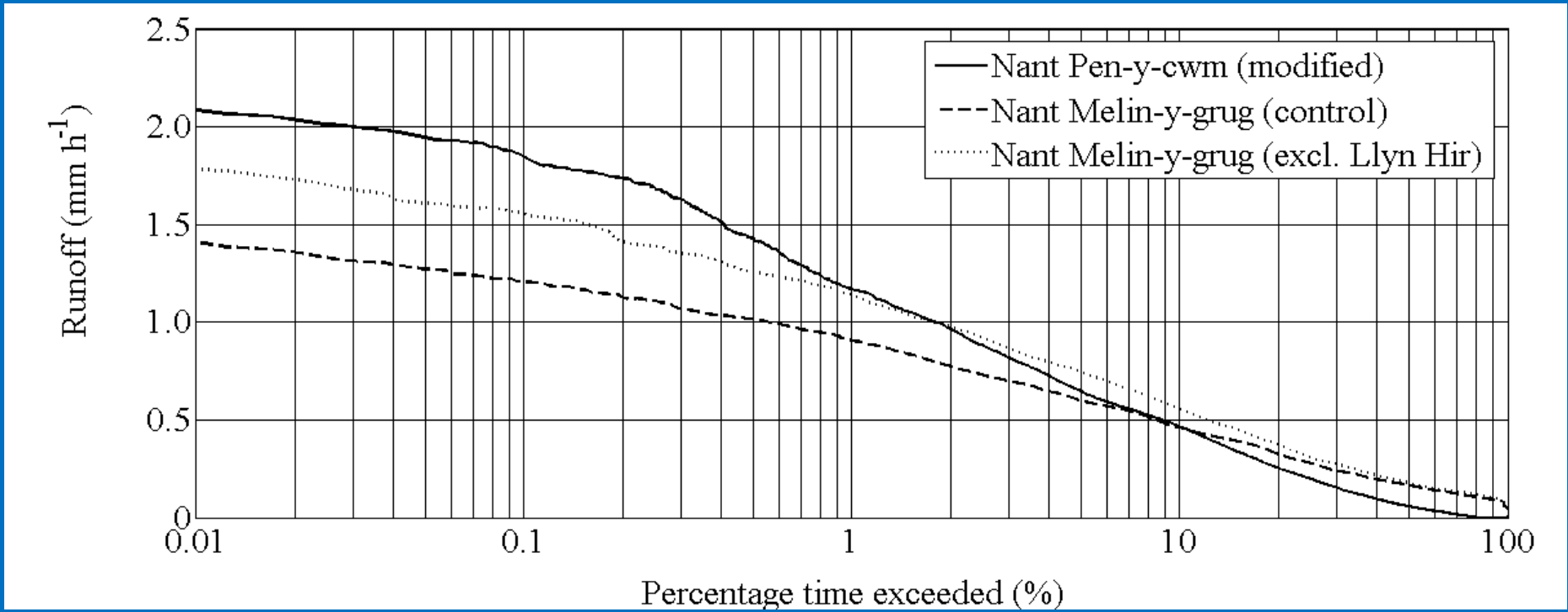
What controls a river channel's storm hydrograph?



What controls a river channel's hydrological regime?

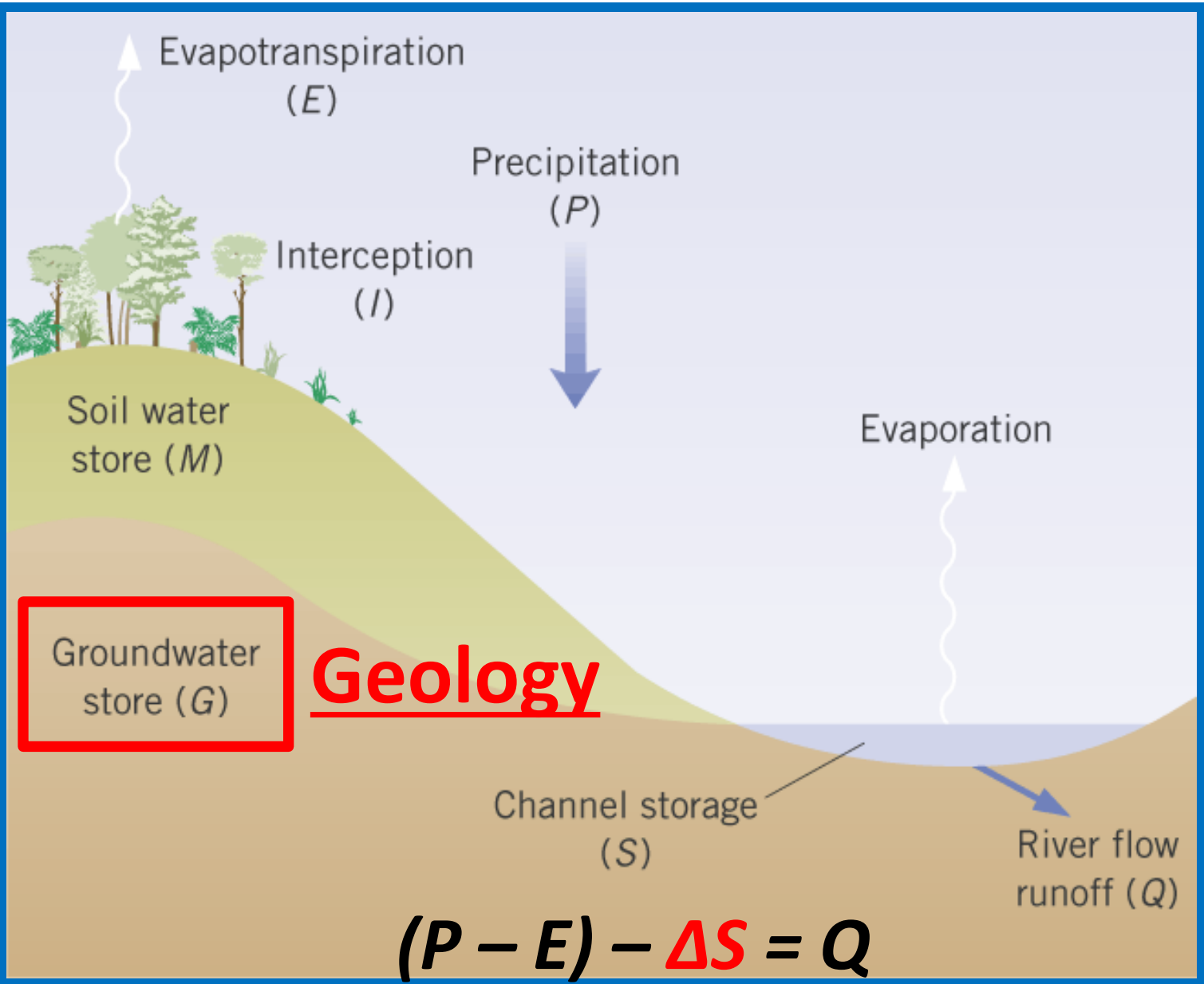
Pont Bren, mid-Wales

What controls a river channel's hydrological regime?

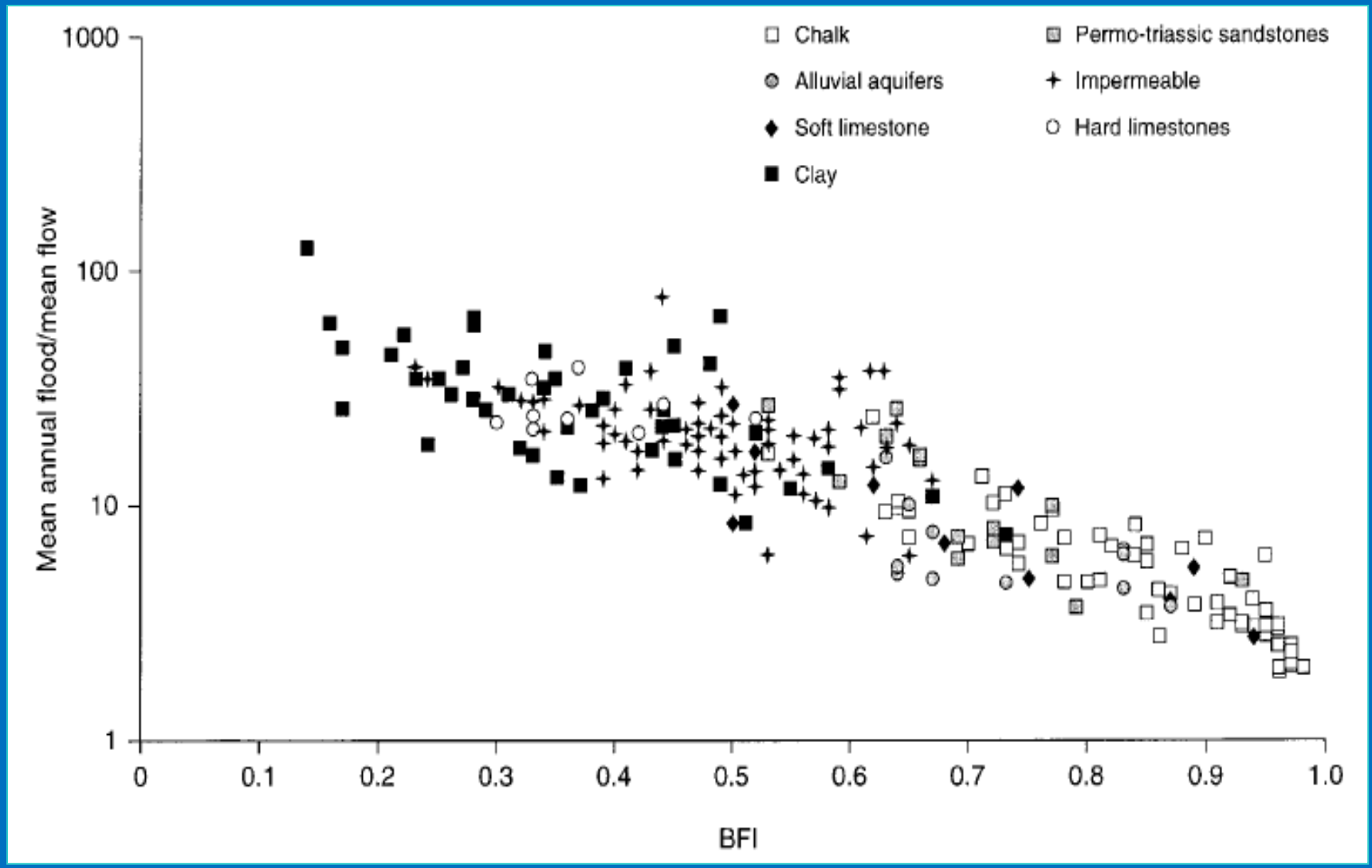


Henshaw (2009)

What controls a river channel's hydrological regime?



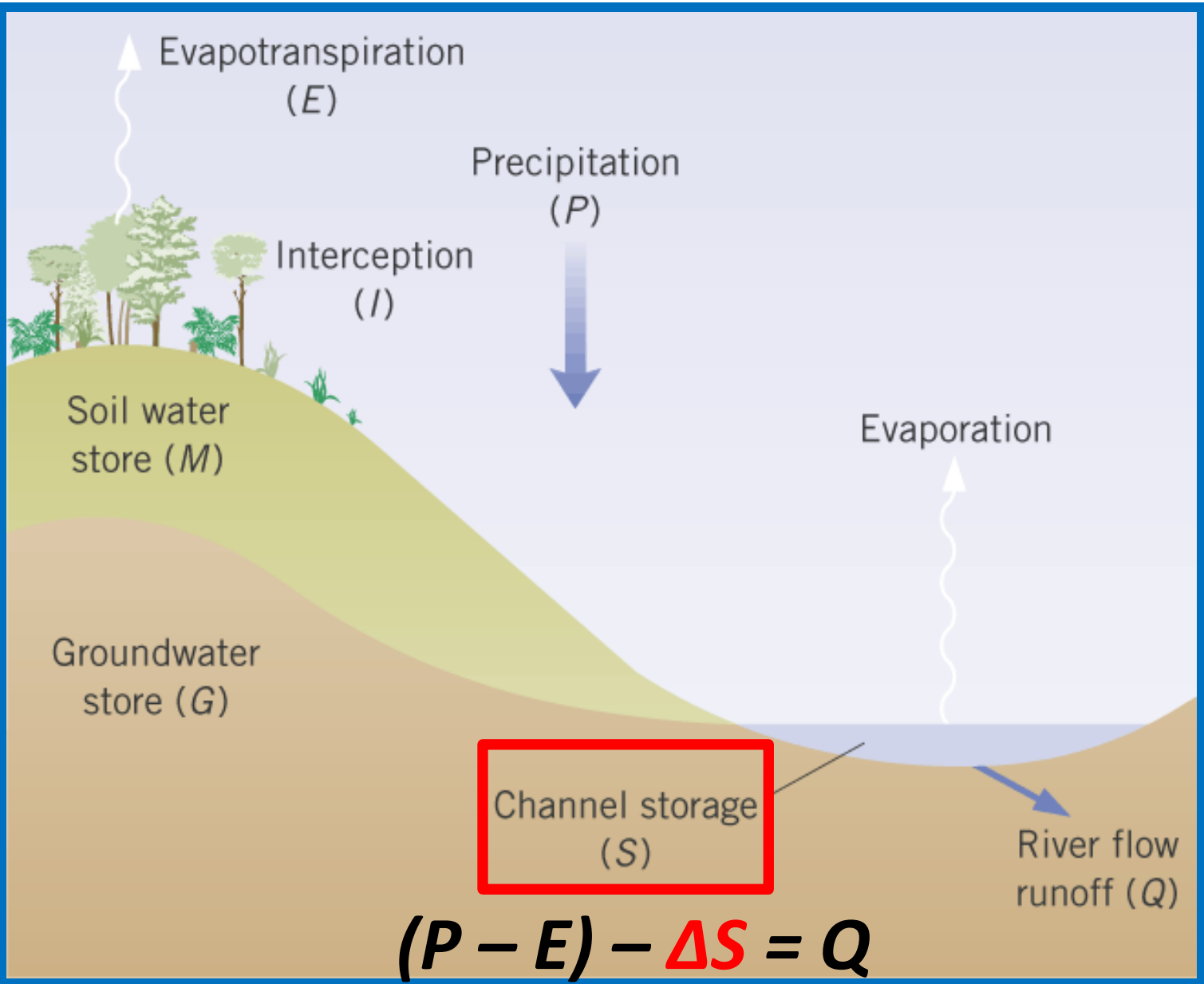
What controls a river channel's hydrological regime?



Difference between flood flow and mean flow

Contribution of baseflow (groundwater)

What controls a river channel's hydrological regime?



$$(P - E) - \Delta S = Q$$

How should we manage a river channel's hydrological regime to reduce flood risk?

How should we manage a river channel's hydrological regime to reduce flood risk?

- Precipitation?
- Evapotranspiration?
- Interception and soil water storage (land cover)?
- Ground water storage (geology)?
- Channel storage?

How should we manage a river channel's hydrological regime to reduce flood risk?

- ~~Precipitation~~
- ~~Evapotranspiration~~
- Interception and soil water storage (land cover)
- ~~Ground water storage (geology)~~
- Channel storage

Managing interception and soil water storage (land cover)

How should we manage a river channel's hydrological regime to reduce flood risk?

Pont Bren, mid-Wales

Tree belts

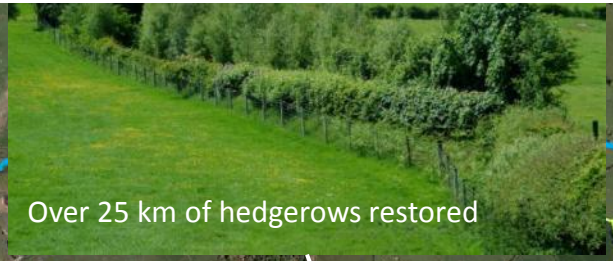
How should we manage a river channel's hydrological regime to reduce flood risk?

PONTBREN

Tree belts

How should we manage a river channel's hydrological regime to reduce flood risk?

120,000 native trees planted



Over 25 km of hedgerows restored

12 ponds created covering 2.2 ha

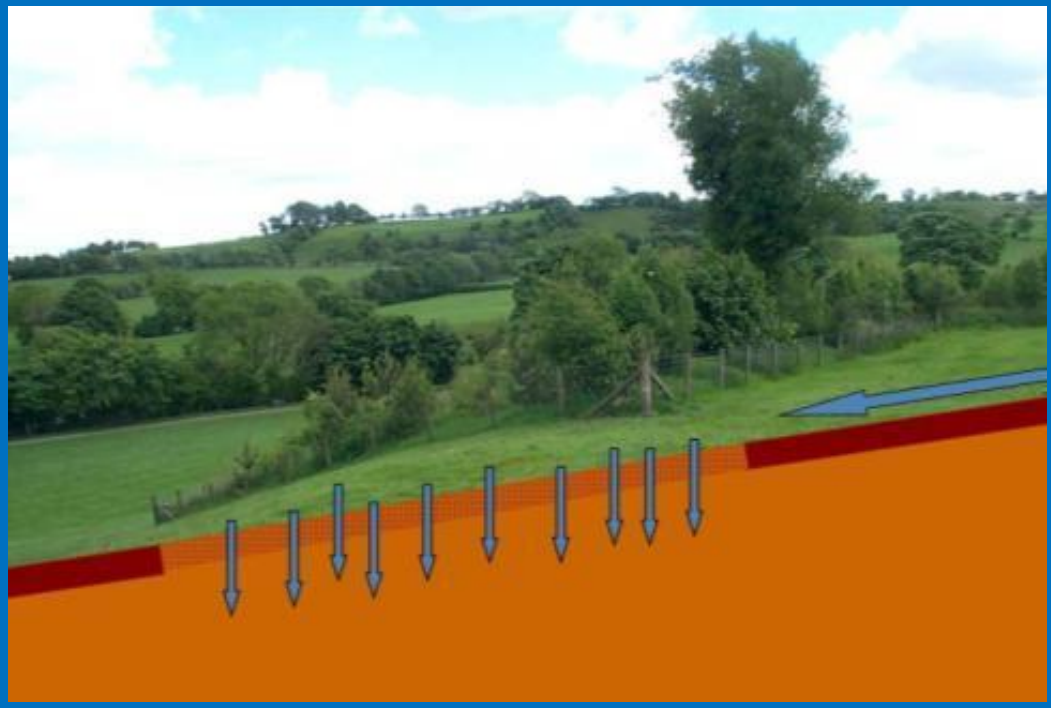
Tree belts

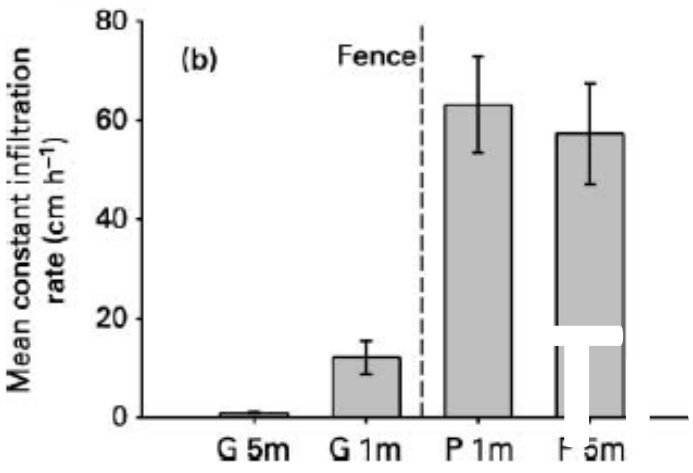
New pond/wetland

Restored hedgerow

New woodland

How should we manage a river channel's hydrological regime to reduce flood risk?

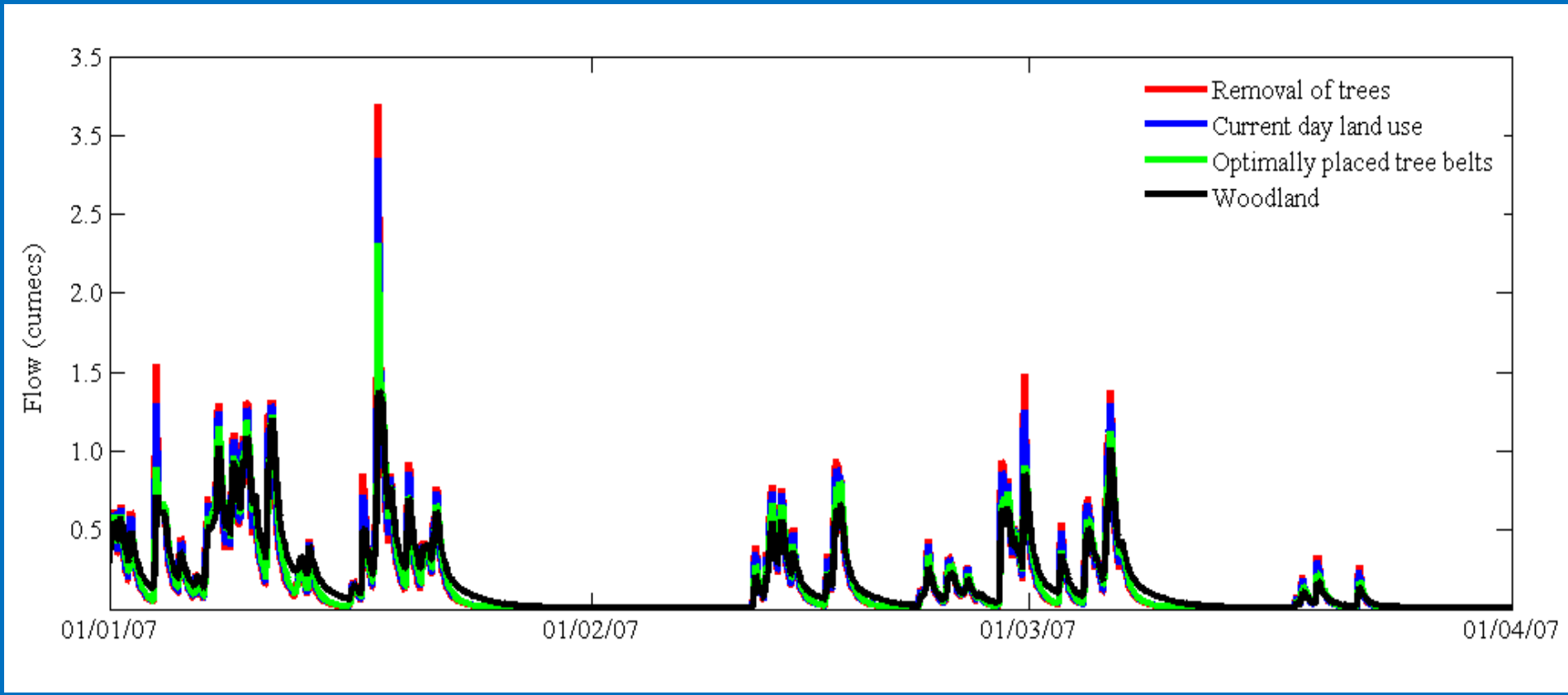




Carroll *et al.* (2004)

T e belts

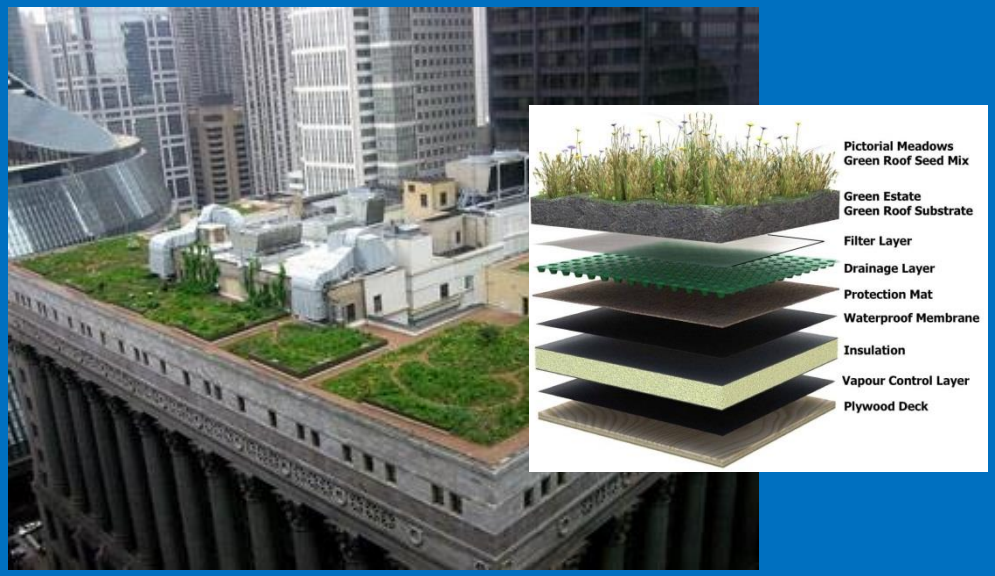
How should we manage a river channel's hydrological regime to reduce flood risk?

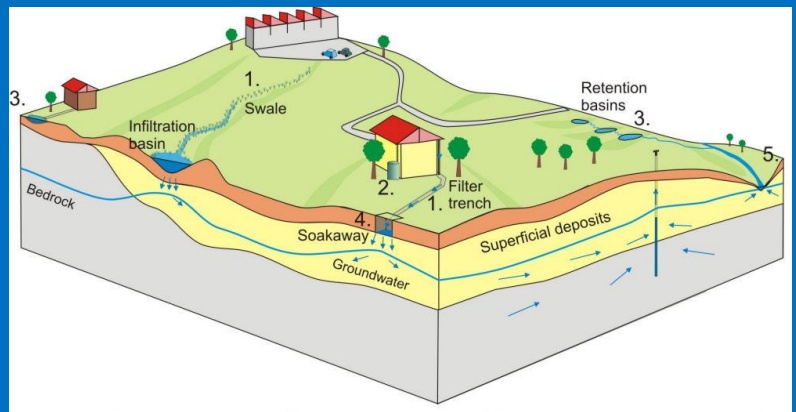


Tree belts

Wheater *et al.* (2008)

How should we manage a river channel's hydrological regime to reduce flood risk?





During a storm event, surface water flows through swales and filter trenches that remove entrained polluants (1). The peak river discharge is delayed and reduced by; storage of water for re-use (2), storage in ponds (3), or infiltration of water to the ground through infiltration basins and soakaways (4). This process improves the quality of water in rivers and decreases peak river discharge (5).

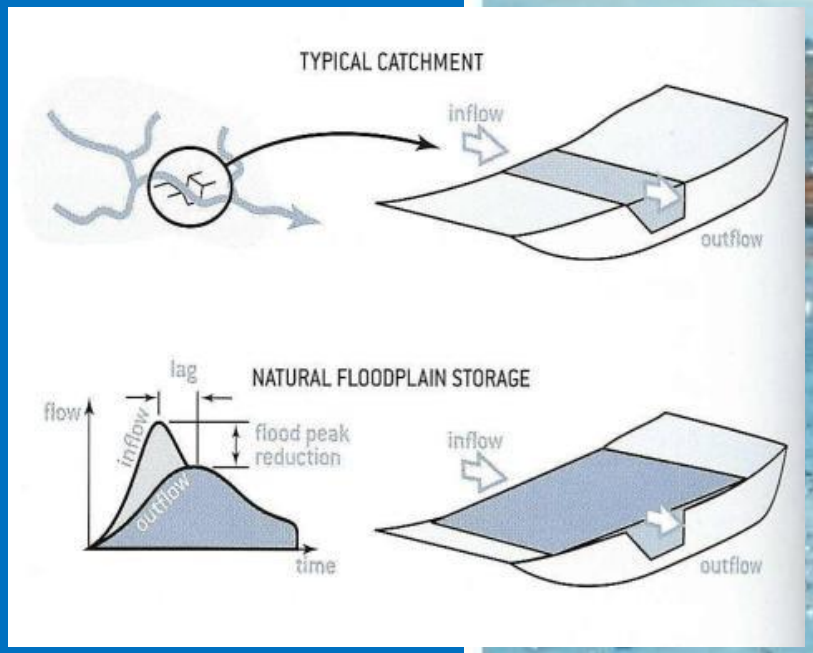
Sustainable Urban Drainage Systems

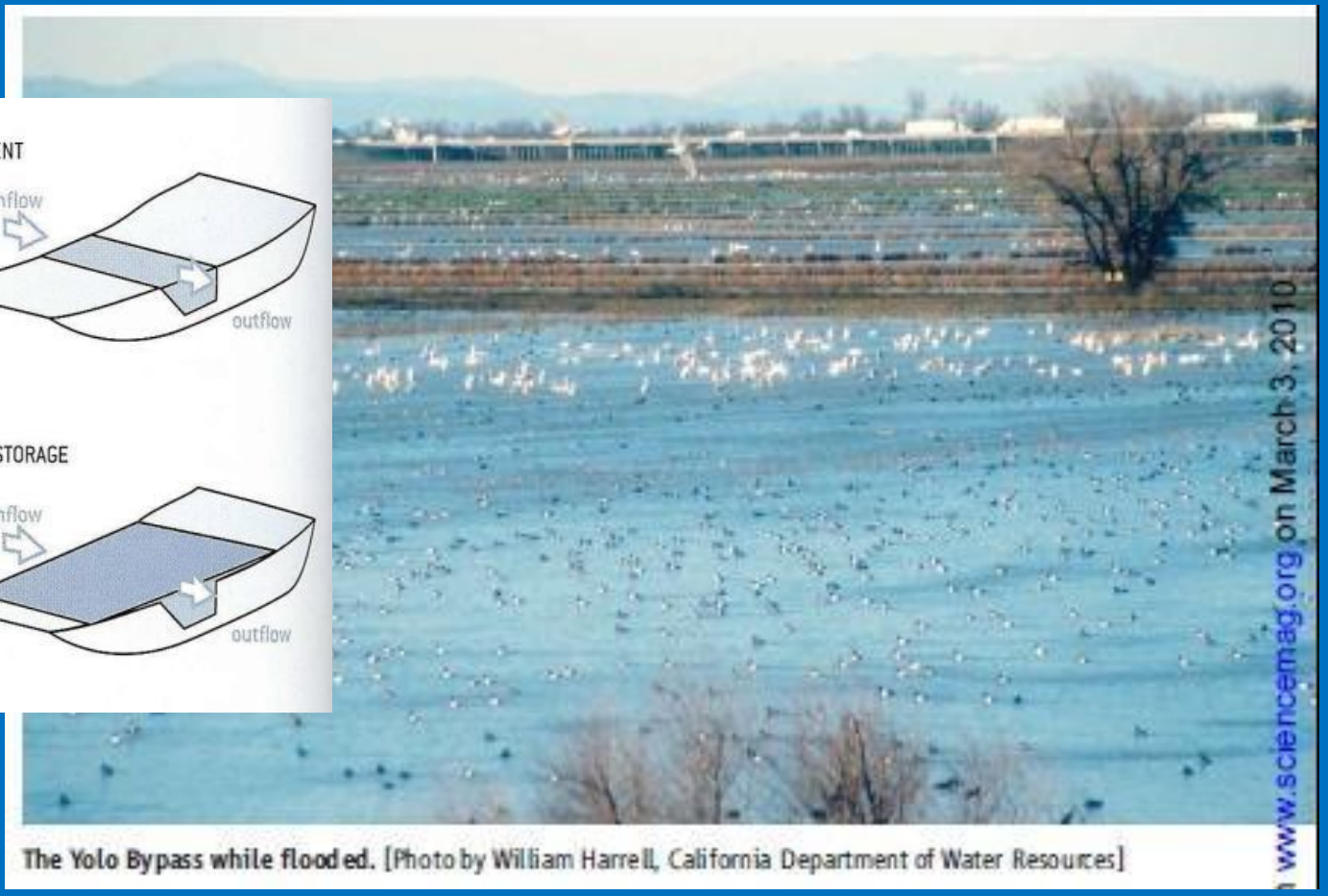
Managing channel storage

How should we manage a river channel's hydrological regime to reduce flood risk?

Impoundment

How should we manage a river channel's hydrological regime to reduce flood risk?



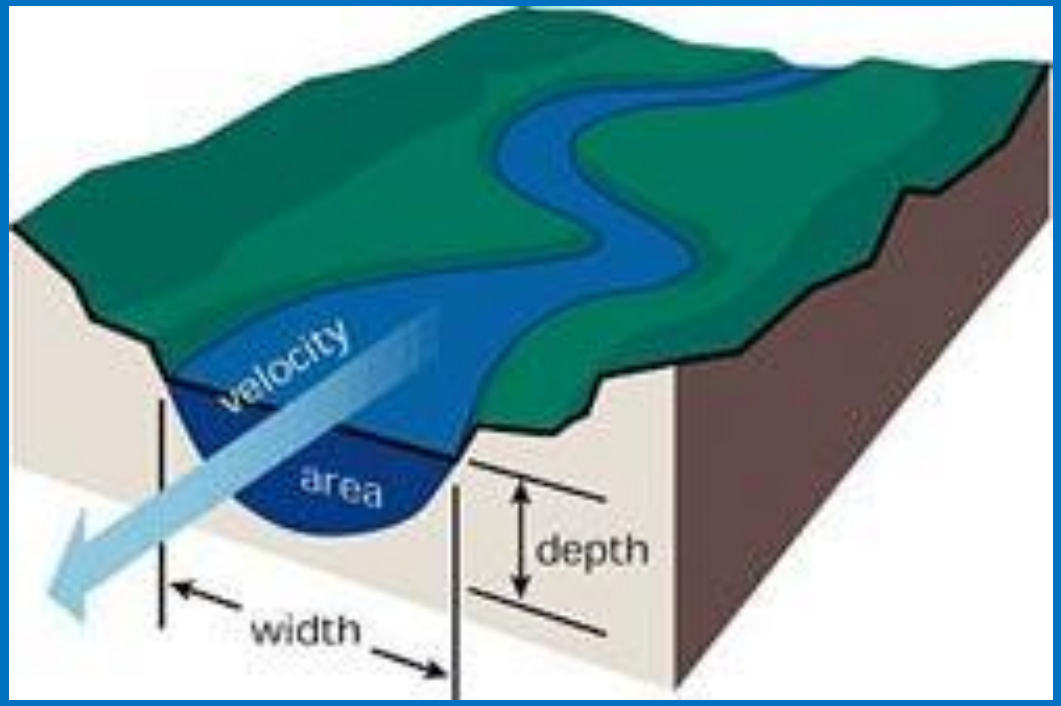


The Yolo Bypass while flooded. [Photo by William Harrell, California Department of Water Resources]

Floodplain storage

What controls a river channel's conveyance capacity?

What controls a river channel's conveyance capacity?



$$Q_{bf} = V_{bf} \times A_{bf}$$

What controls a river channel's conveyance capacity?

$$V_{bf} = \frac{R_{bf}^{2/3} \times S^{1/2}}{n}$$

What controls a river channel's conveyance capacity?

River channel conveyance capacity decreases (and therefore the likelihood of flooding increases) when:

Cross-sectional area decreases

Porlock, 1960

What controls a river channel's conveyance capacity?

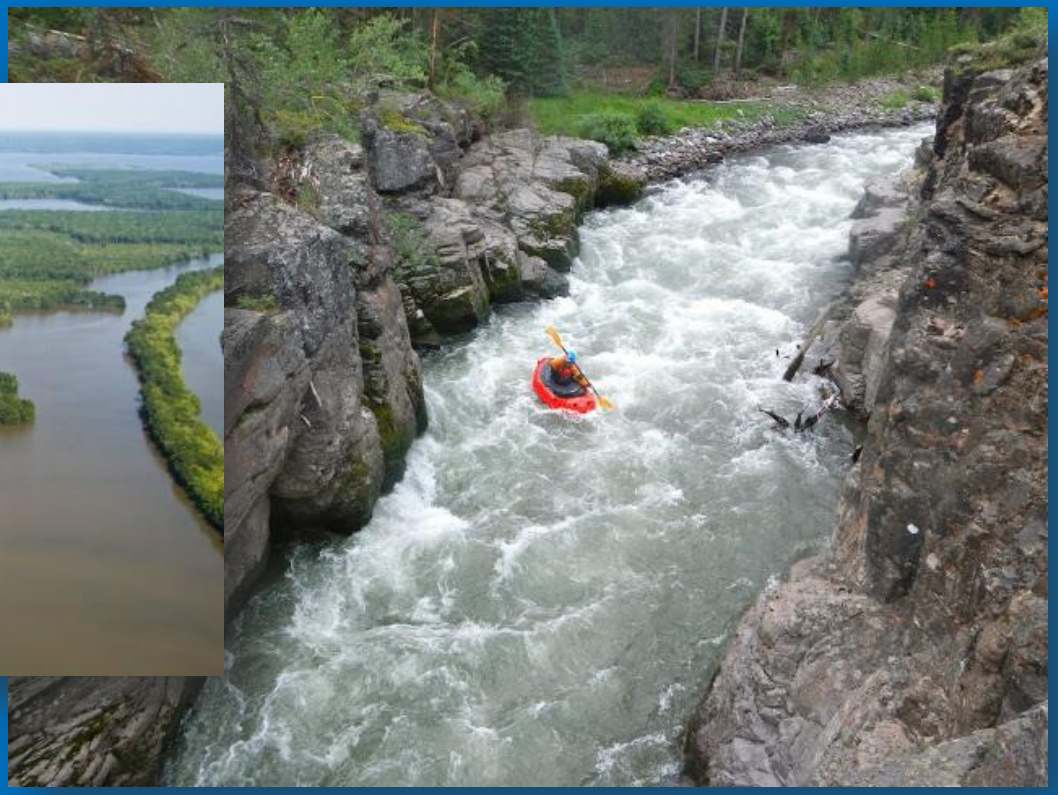
River channel conveyance capacity decreases (and therefore the likelihood of flooding increases) when:

Hydraulic radius decreases

What controls a river channel's conveyance capacity?

River channel conveyance capacity decreases (and therefore the likelihood of flooding increases) when:

Channel slope decreases



What controls a river channel's conveyance capacity?

River channel conveyance capacity decreases (and therefore the likelihood of flooding increases) when:

Channel roughness increases

How should we manage a river channel's conveyance capacity to reduce flood risk?

How should we manage a river channel's conveyance capacity to reduce flood risk?

Increase river channel cross-section area using flood embankments / flood walls

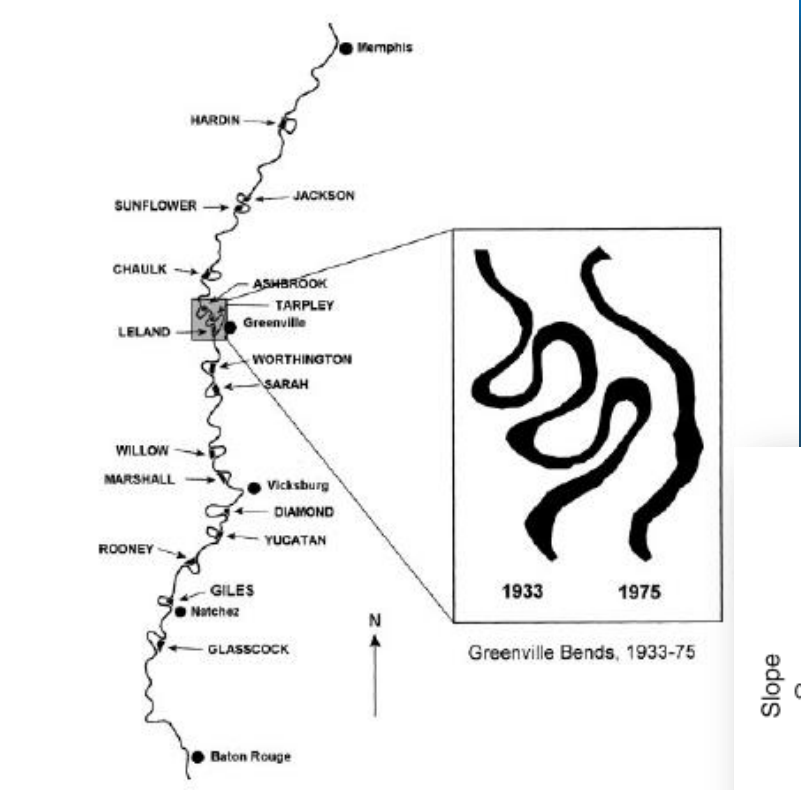
How should we manage a river channel's conveyance capacity to reduce flood risk?

Increase river channel cross-section area by dredging

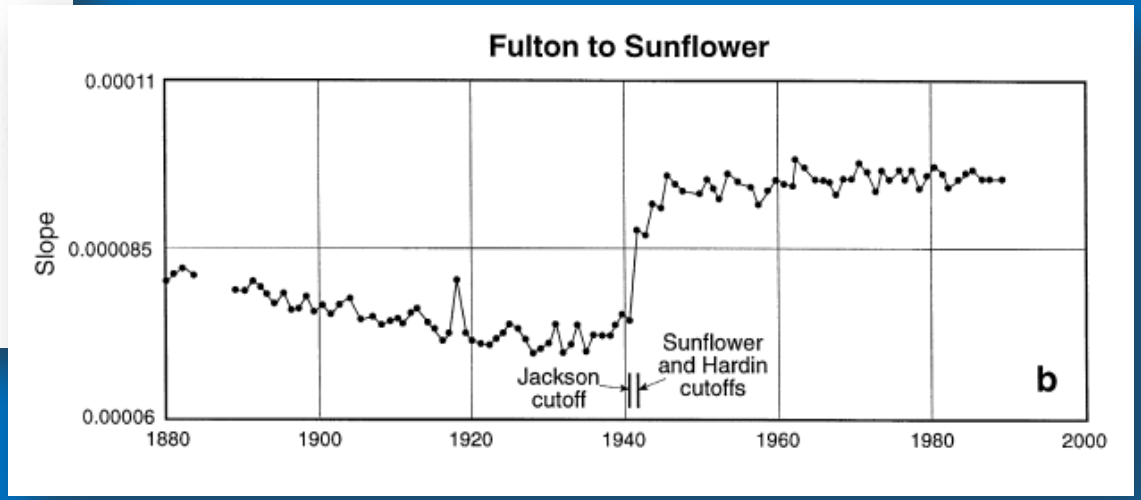
How should we manage a river channel's conveyance capacity to reduce flood risk?

Reduce river channel roughness by clearing vegetation

How should we manage a river channel's conveyance capacity to reduce flood risk?



Lower Mississippi (Harmar et al, 2005)



Increase river channel slope by reducing sinuosity

How should we manage a river channel's conveyance capacity to reduce flood risk?

However, attempts to increase channel conveyance can have negative impacts…

How should we manage a river channel's conveyance capacity to reduce flood risk?

http://serc.carleton.edu/details/files/19164.html

Increasing channel slope can create an unstable river channel

How should we manage a river channel's conveyance capacity to reduce flood risk?

Mimshall Brook (Newson et al, 1997 p332)

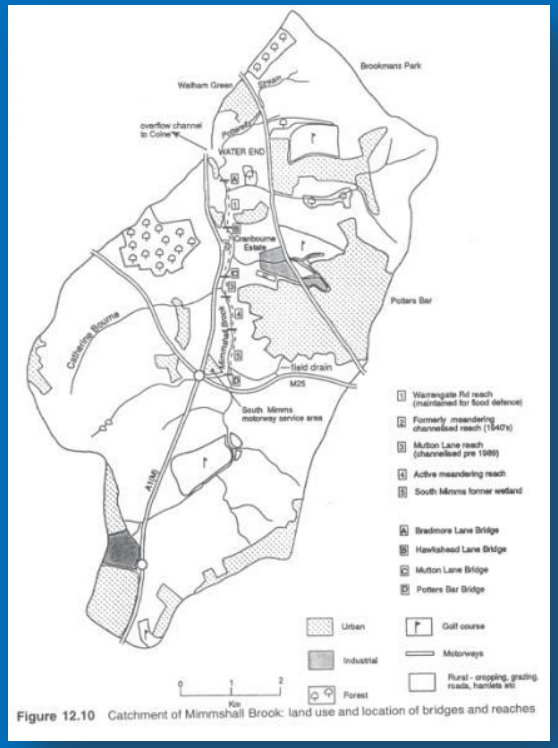


Figure 12.10 Catchment of Mimmshall Brook: land use and location of bridges and reaches

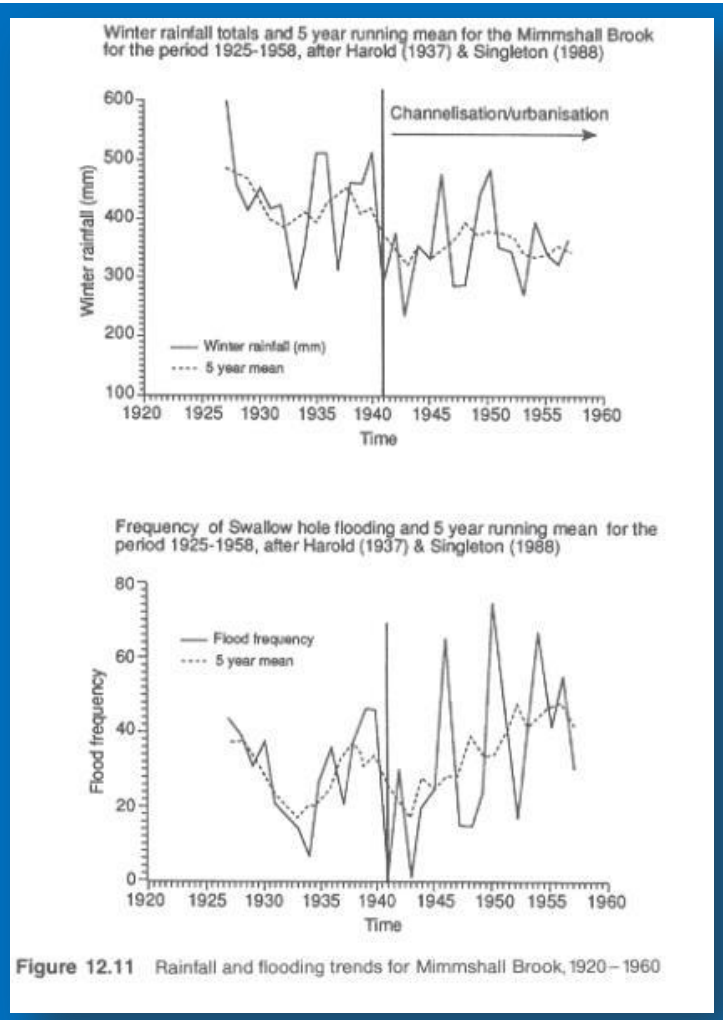
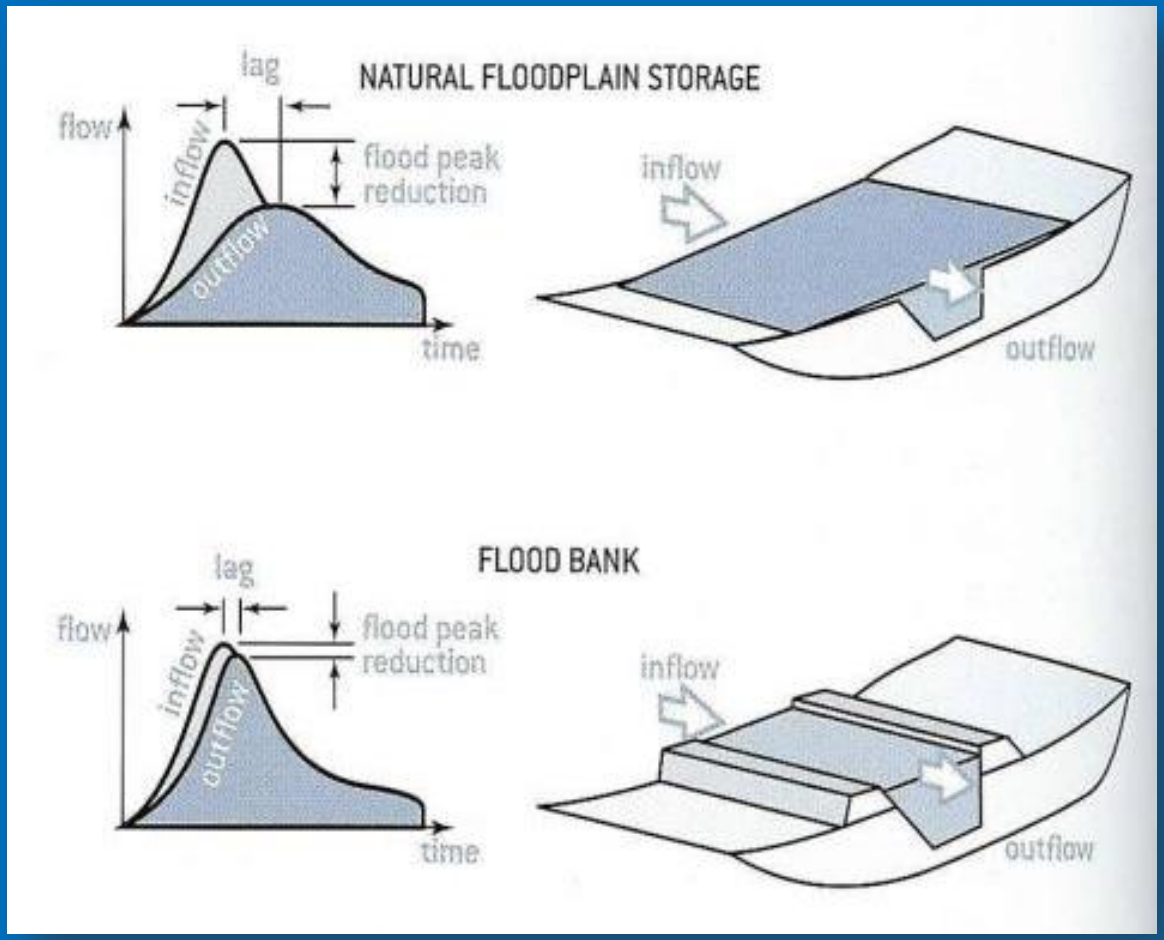


Figure 12.11 Rainfall and flooding trends for Mimmshall Brook, 1920 – 1960

Increasing cross-section size can create an unstable river channel

How should we manage a river channel's conveyance capacity to reduce flood risk?



Preventing natural overbank flooding can increase the likelihood of flooding downstream

What else can we do to reduce flood risk?

What else can we do to reduce flood risk?

Avoid development on floodplains

What else can we do to reduce flood risk?

Figure 2: Wet proofing – measures to make the building more resilient to flooding

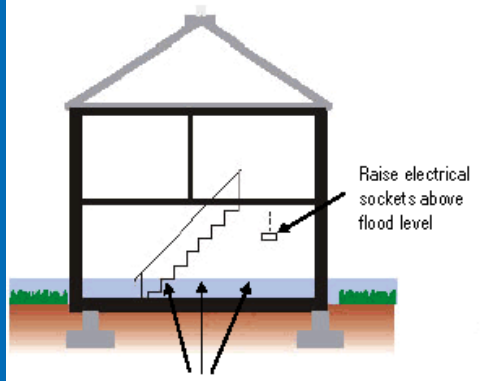
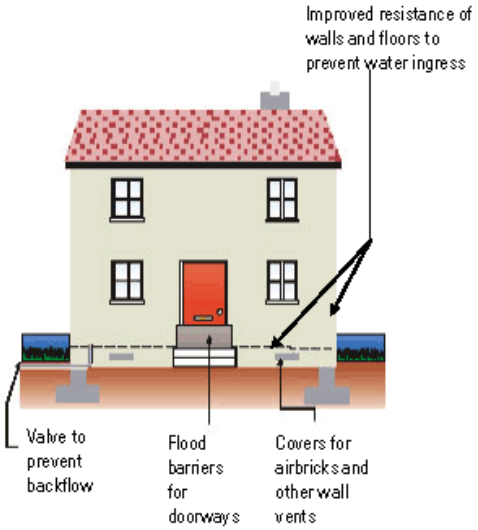


Figure 3: Dry proofing – measures to keep water out of building



Make properties flood resilient

What else can we do to reduce flood risk?

http://youtu.be/DtZ-oMG_sQk

Be prepared for flooding

Sustainable Flood Management

Sustainable flood management is an approach to planning and delivering measures to reduce flood risk.

Increasing resilience to flood risk is an important component of sustainable flood management. Resilience to flooding can be increased through a variety of measures, including flood warning, flood defences, natural flood management (e.g. floodplain storage) and quick and effective responses to flooding.