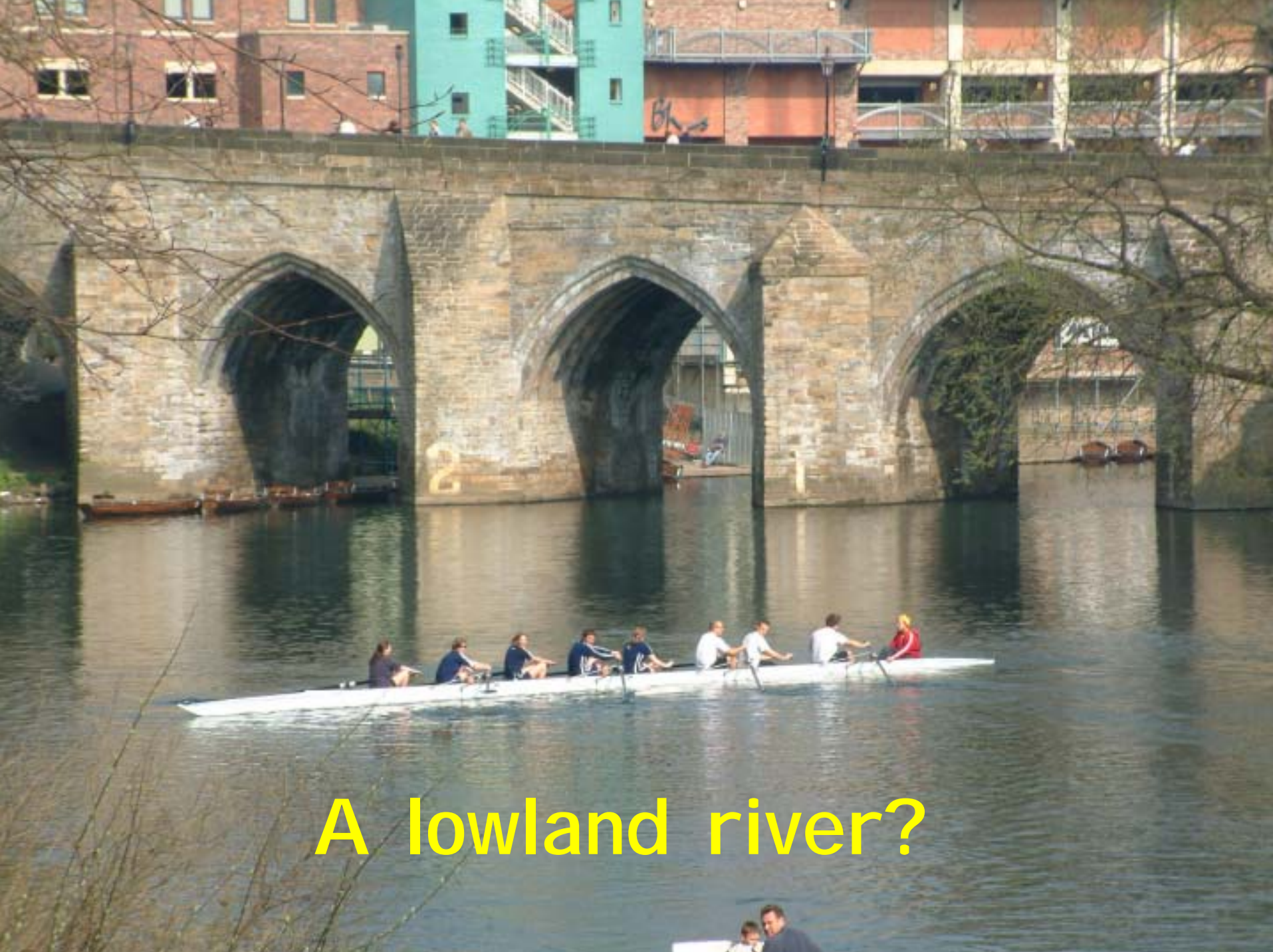


Upland hydrology

**Professor Tim Burt
Durham University**

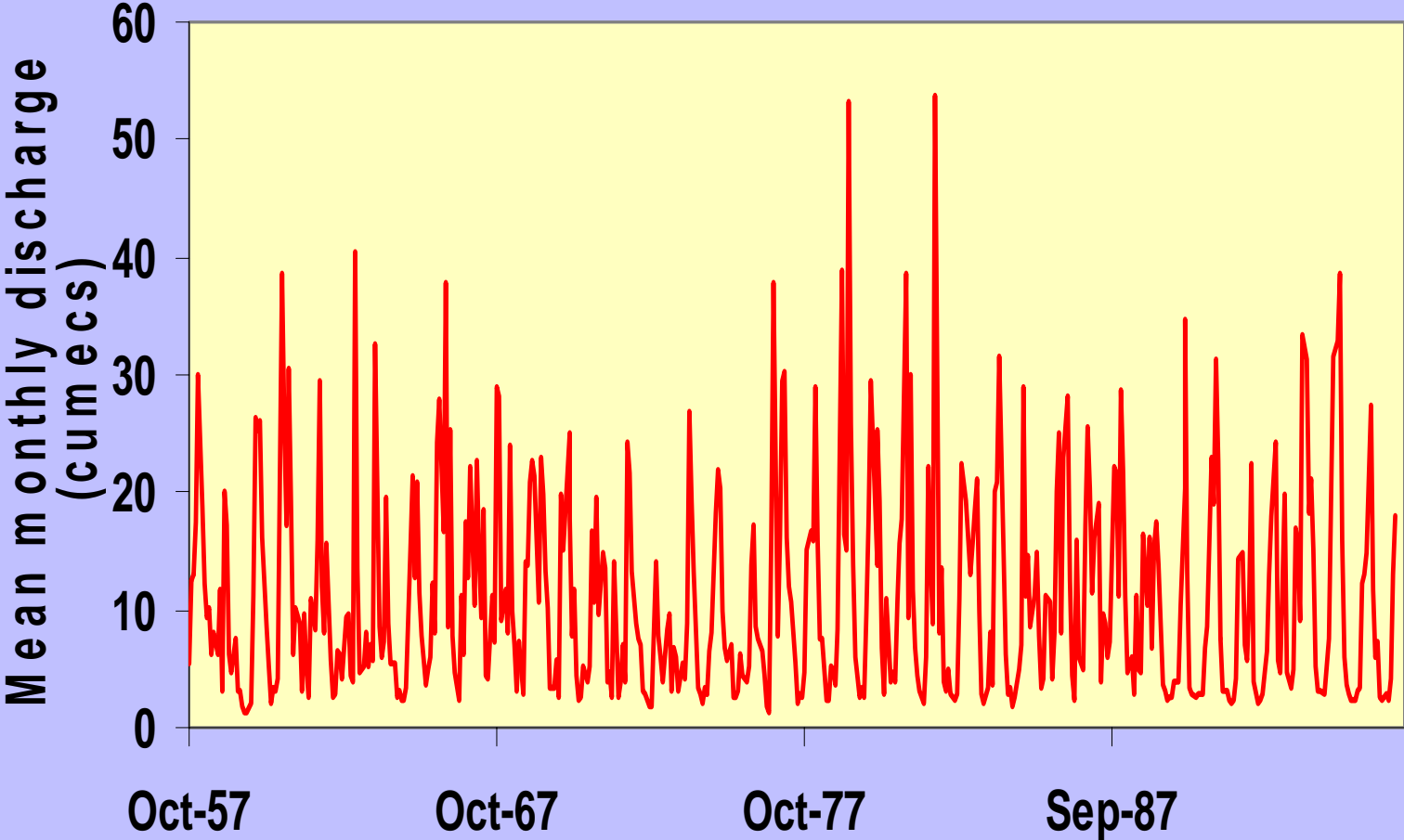


A lowland river?

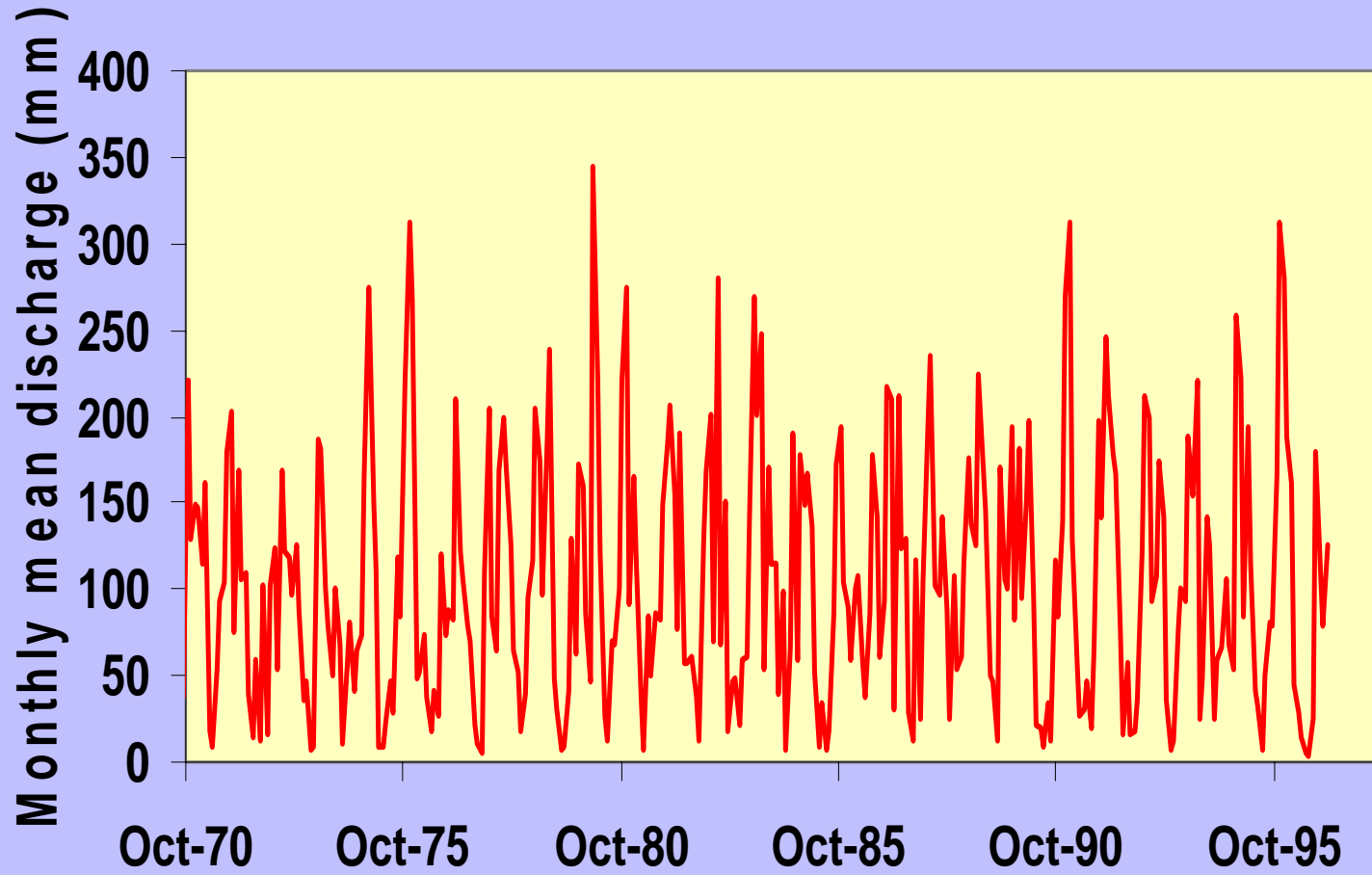
Outline

- **Patterns of streamflow in upland catchments (hydrographs)**
- **Climatic controls**
- **Runoff processes**
- **Long-term changes (climate change, human impact)**

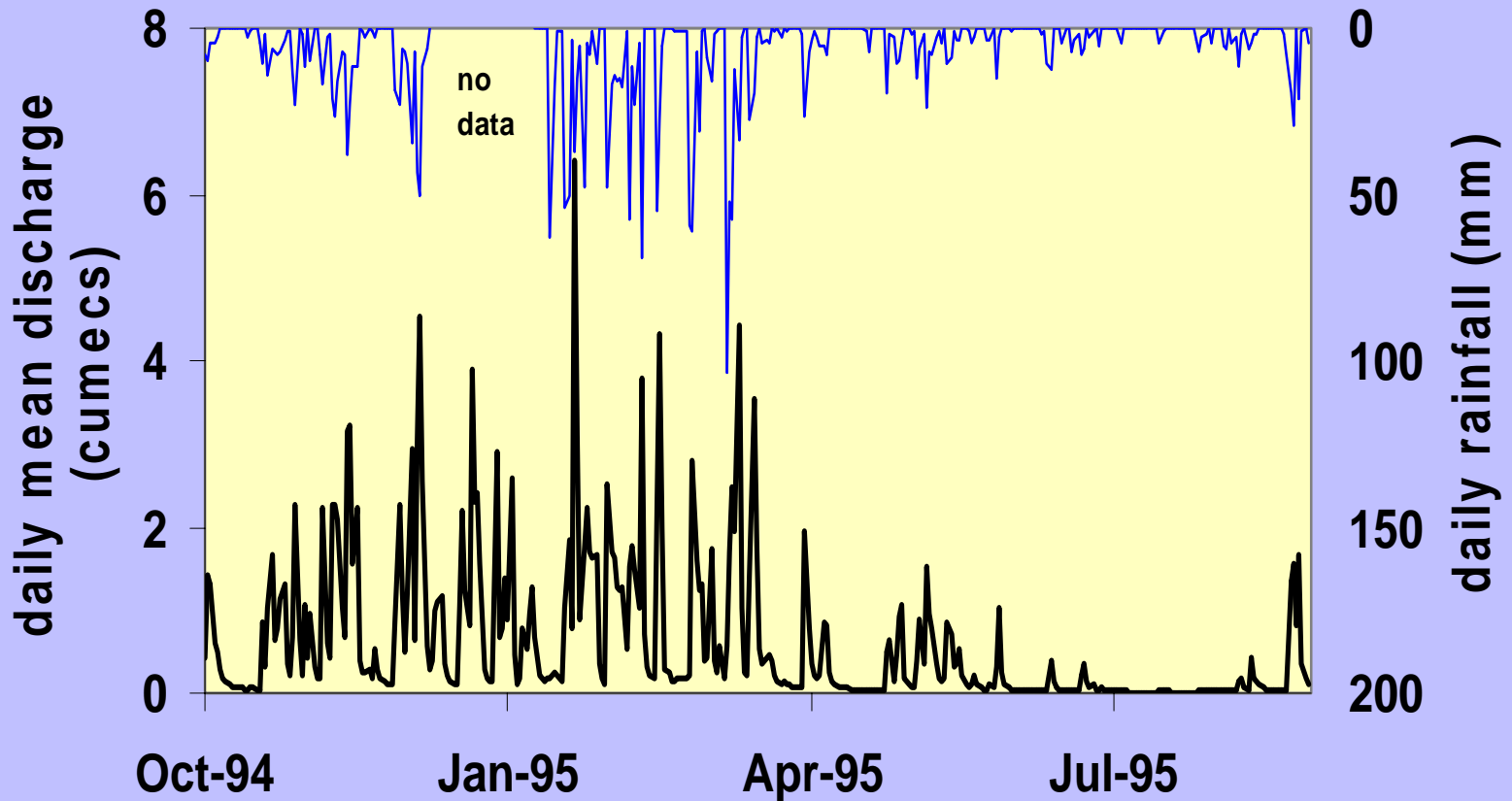
River Wear at Sunderland Bridge



Harwood Beck (Upper Tees)

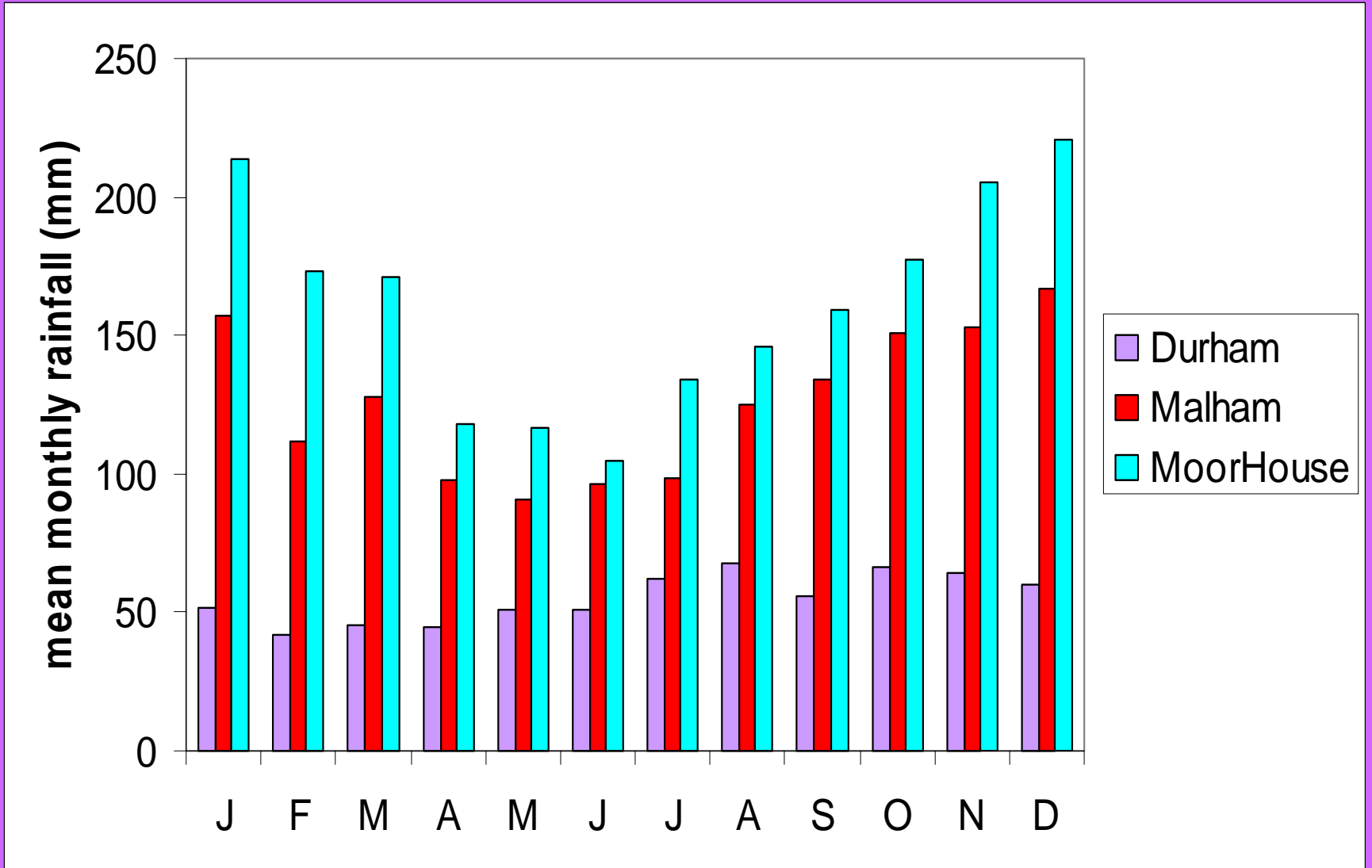


Trout Beck discharge : water year 1995

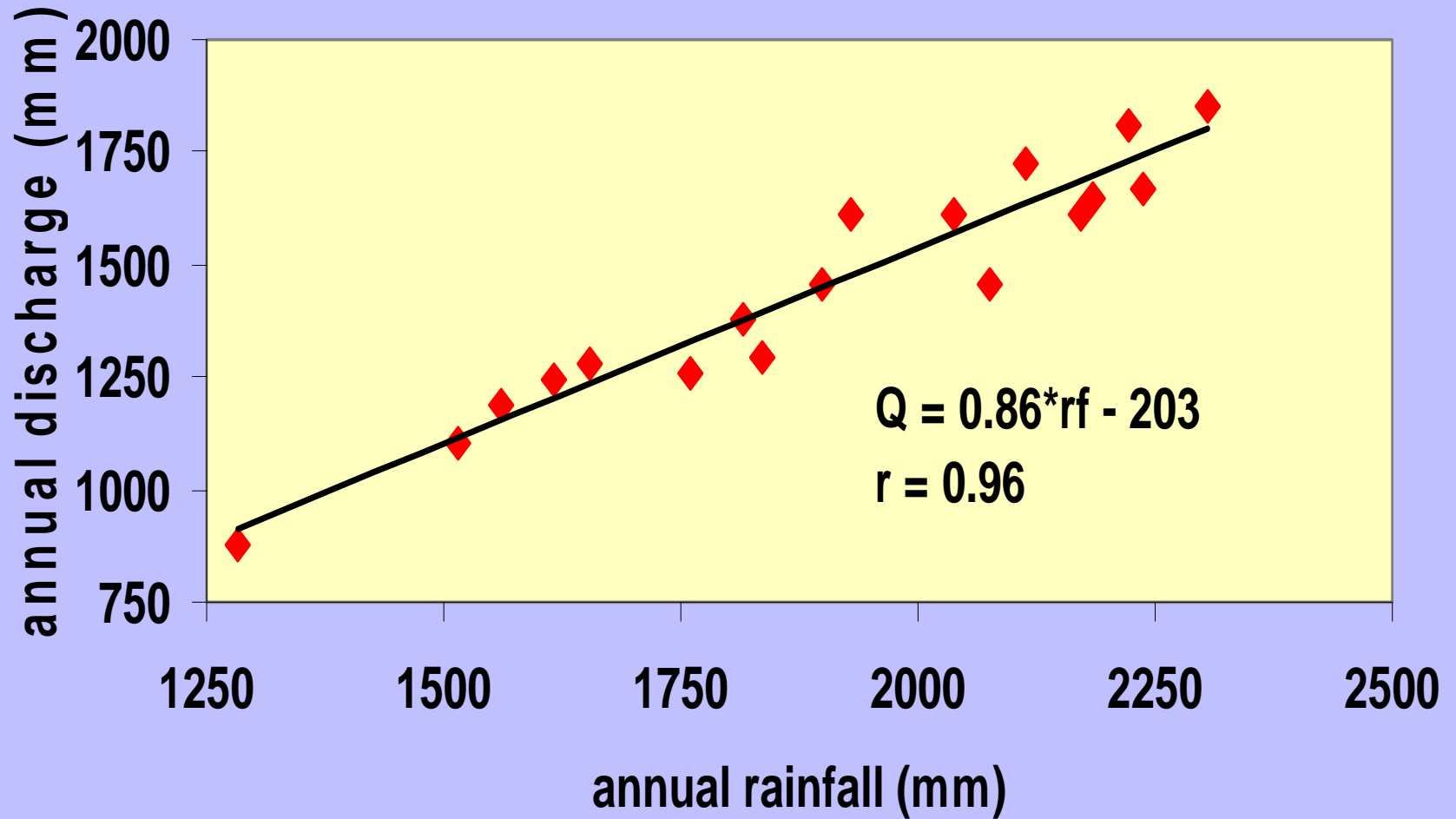


Outline

- Patterns of streamflow in upland catchments (hydrographs)
- **Climatic controls**
- Runoff processes
- Long-term changes (climate change, human impact)



Trout Beck: rainfall, discharge and evaporation



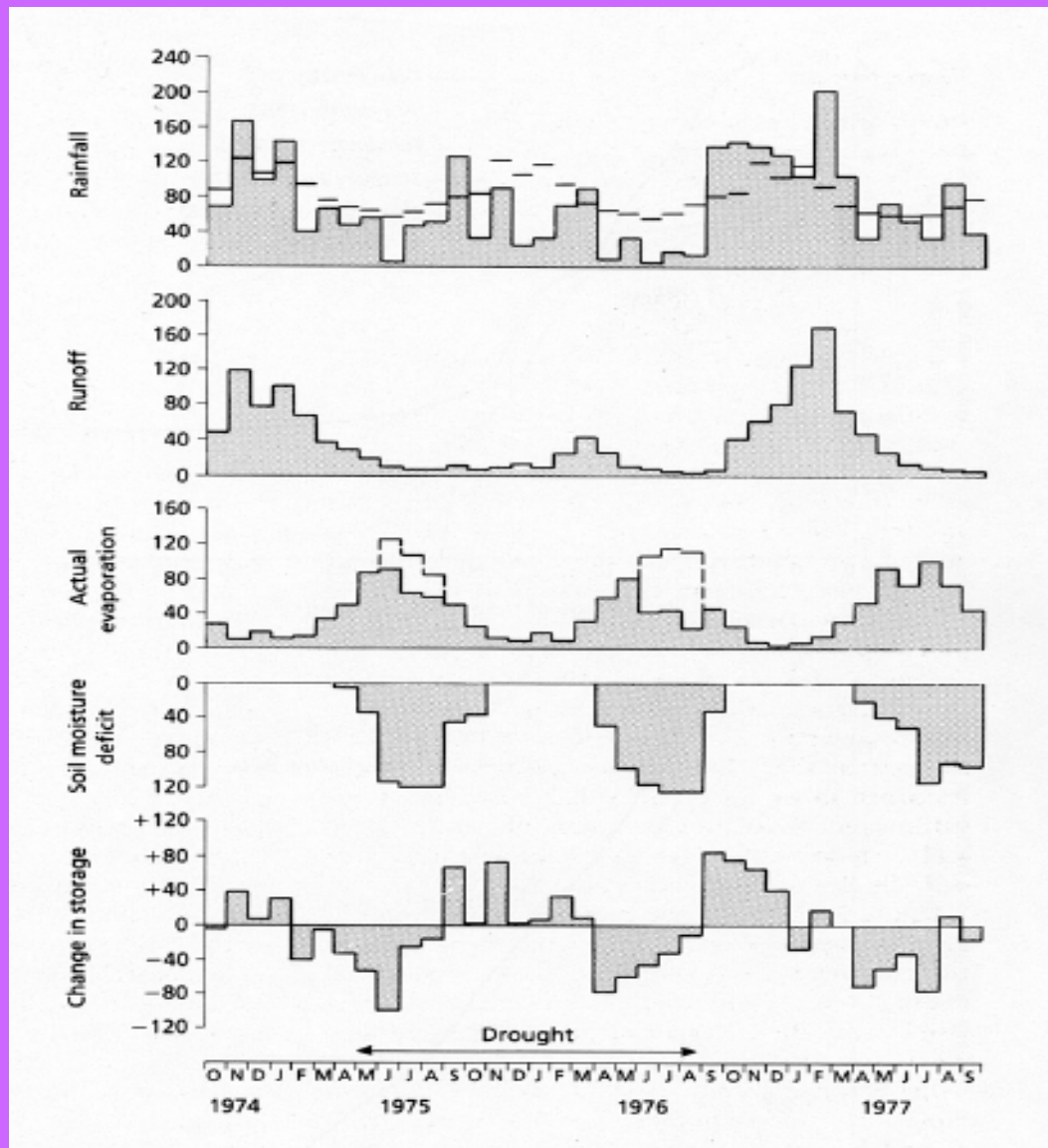
Water balance

- $R_f - Q = ET$
- Annual rainfall = 1901 mm
- Annual discharge = 1449 mm
- Evaporation loss = 452 mm

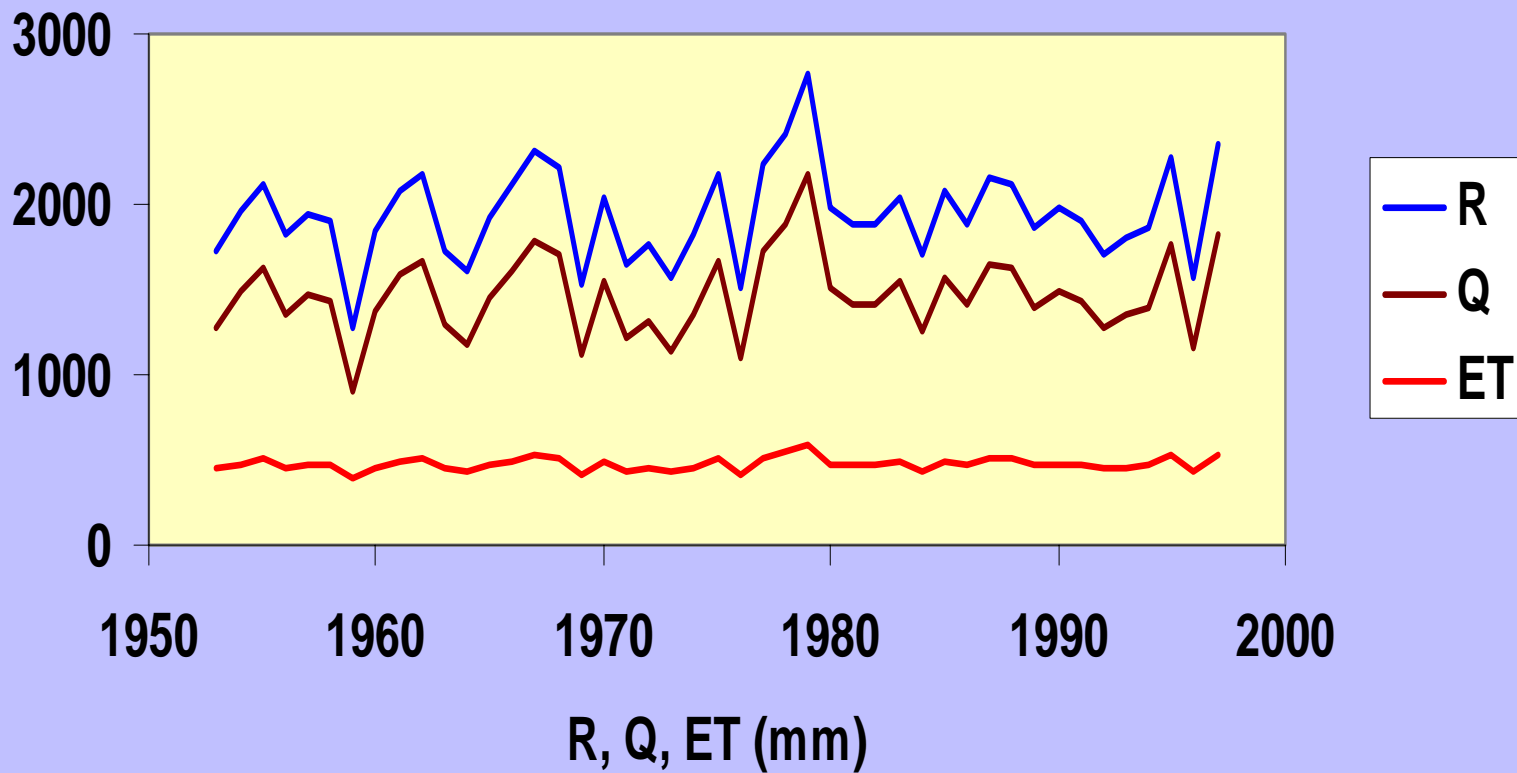
ET as % of R_f : 24%

Moor House data, 1958-1977

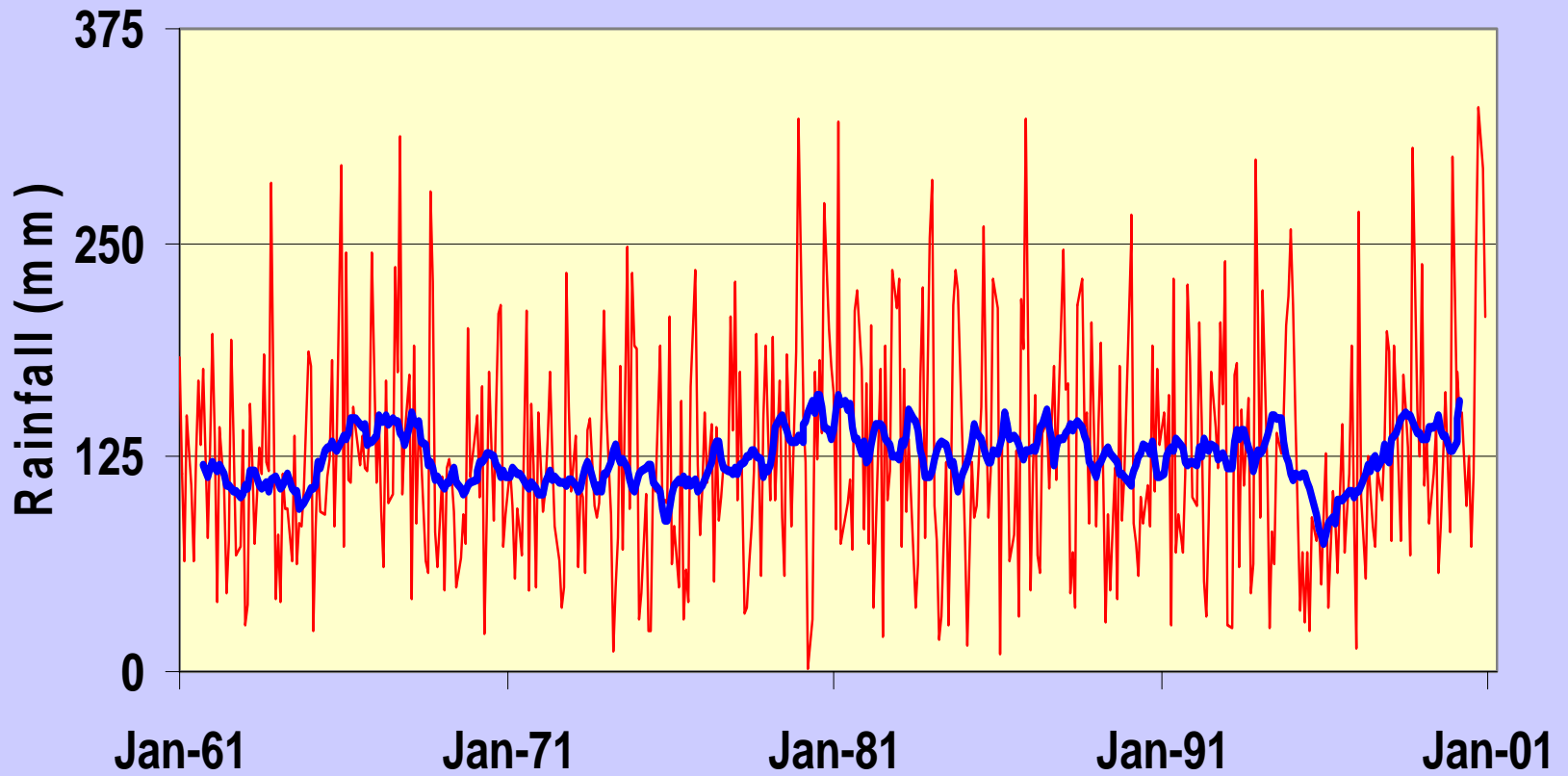
Water balance (lowland catchment)



Annual rainfall, river discharge and evaporation at Moor House (reconstructed series)



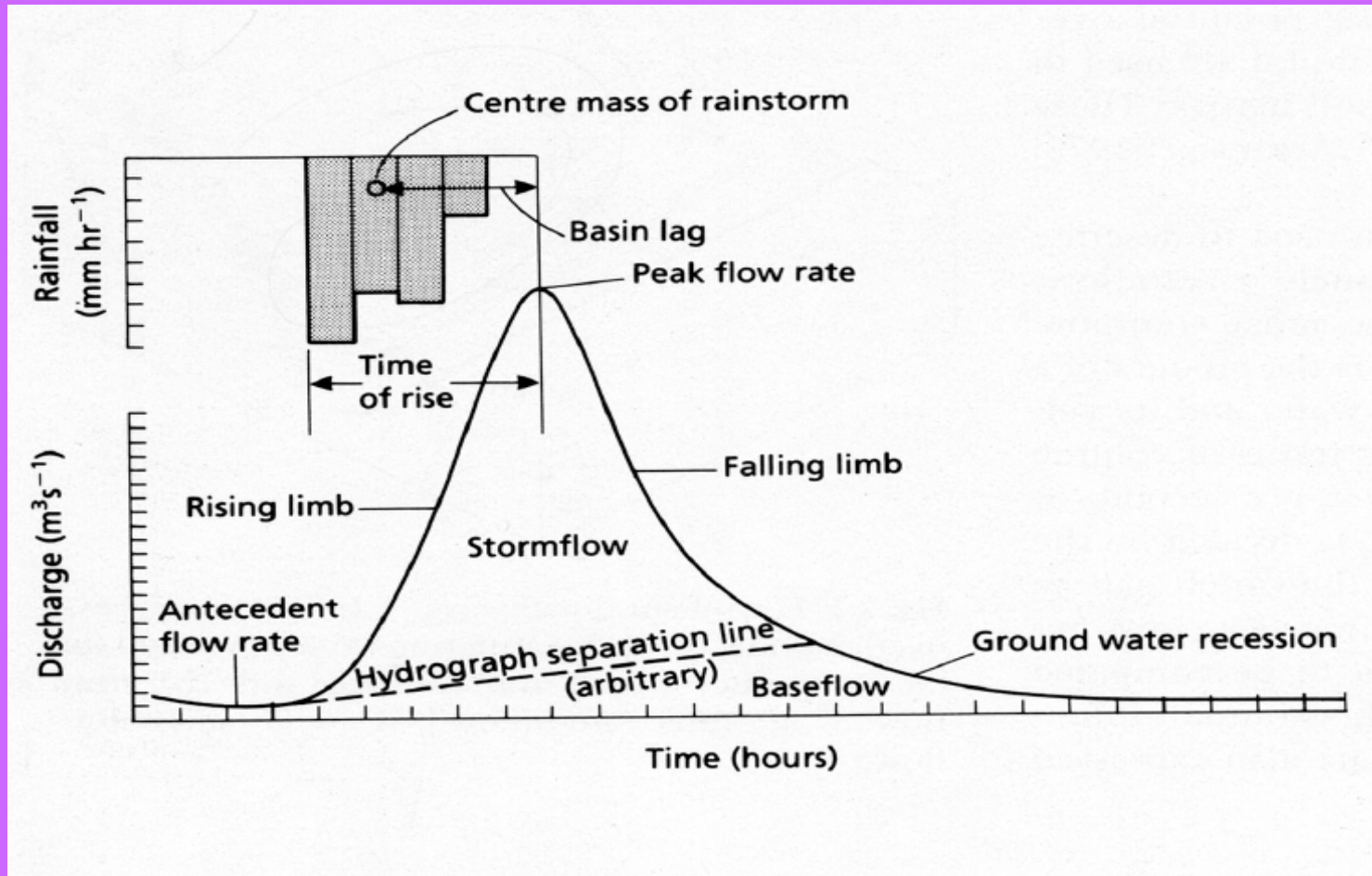
Monthly rainfall at Malham Tarn with 18-month running mean



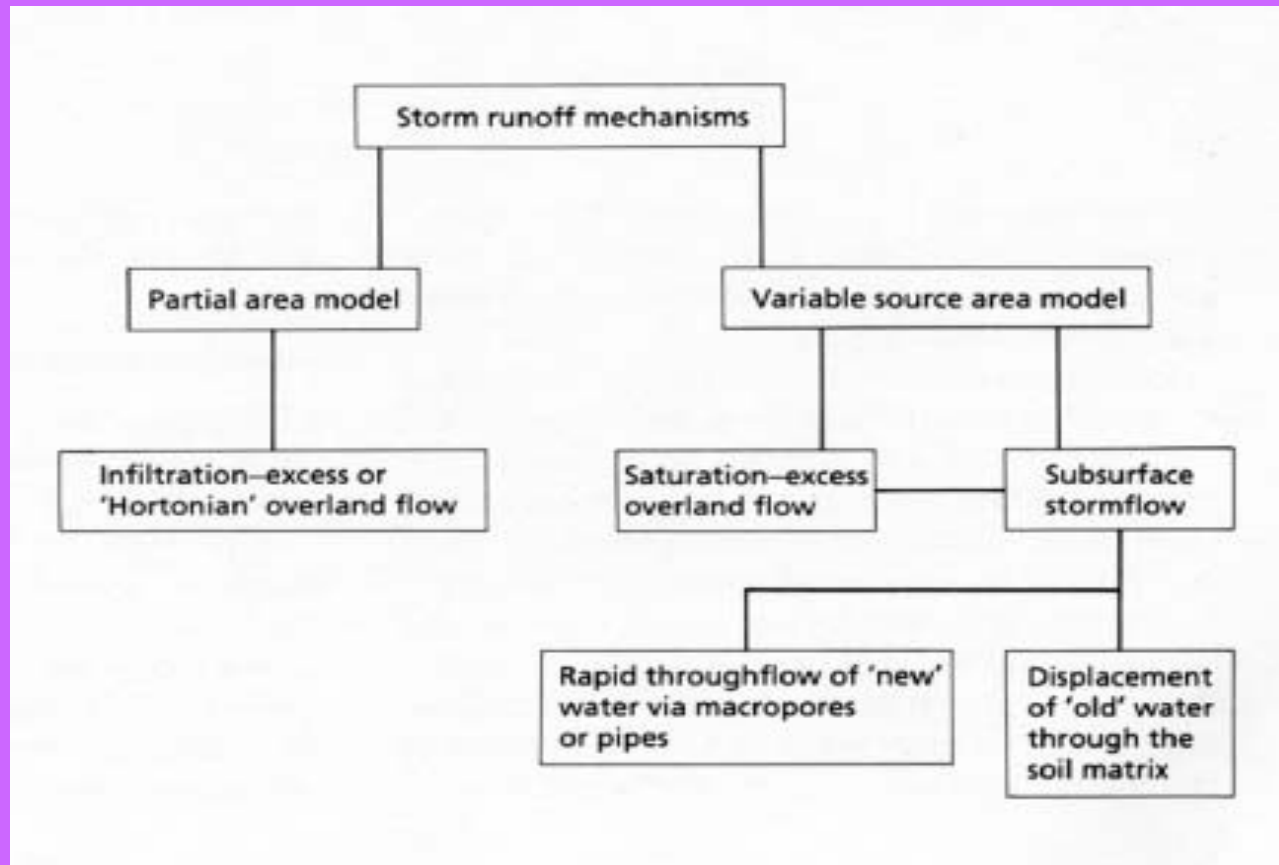
Outline

- Patterns of streamflow in upland catchments (hydrographs)
- Climatic controls
- **Runoff processes**
- Long-term changes (climate change, human impact)

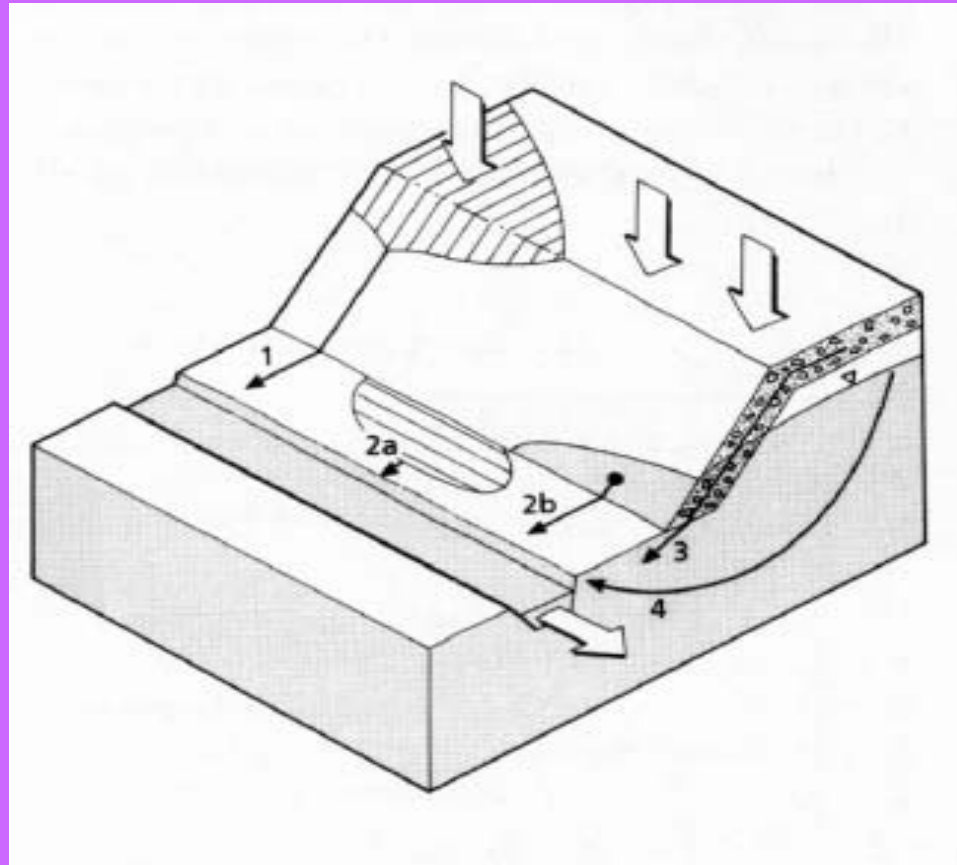
Hydrograph separation



Storm runoff mechanisms



Hydrological pathways



Storm runoff mechanisms

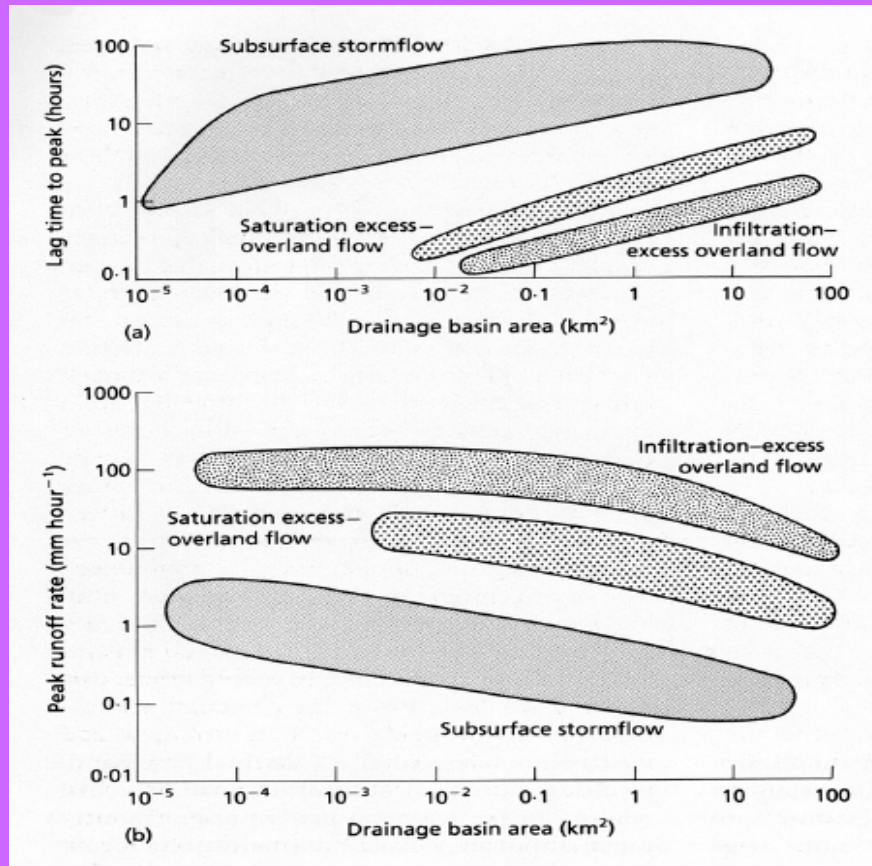


Infiltration-excess
overland flow



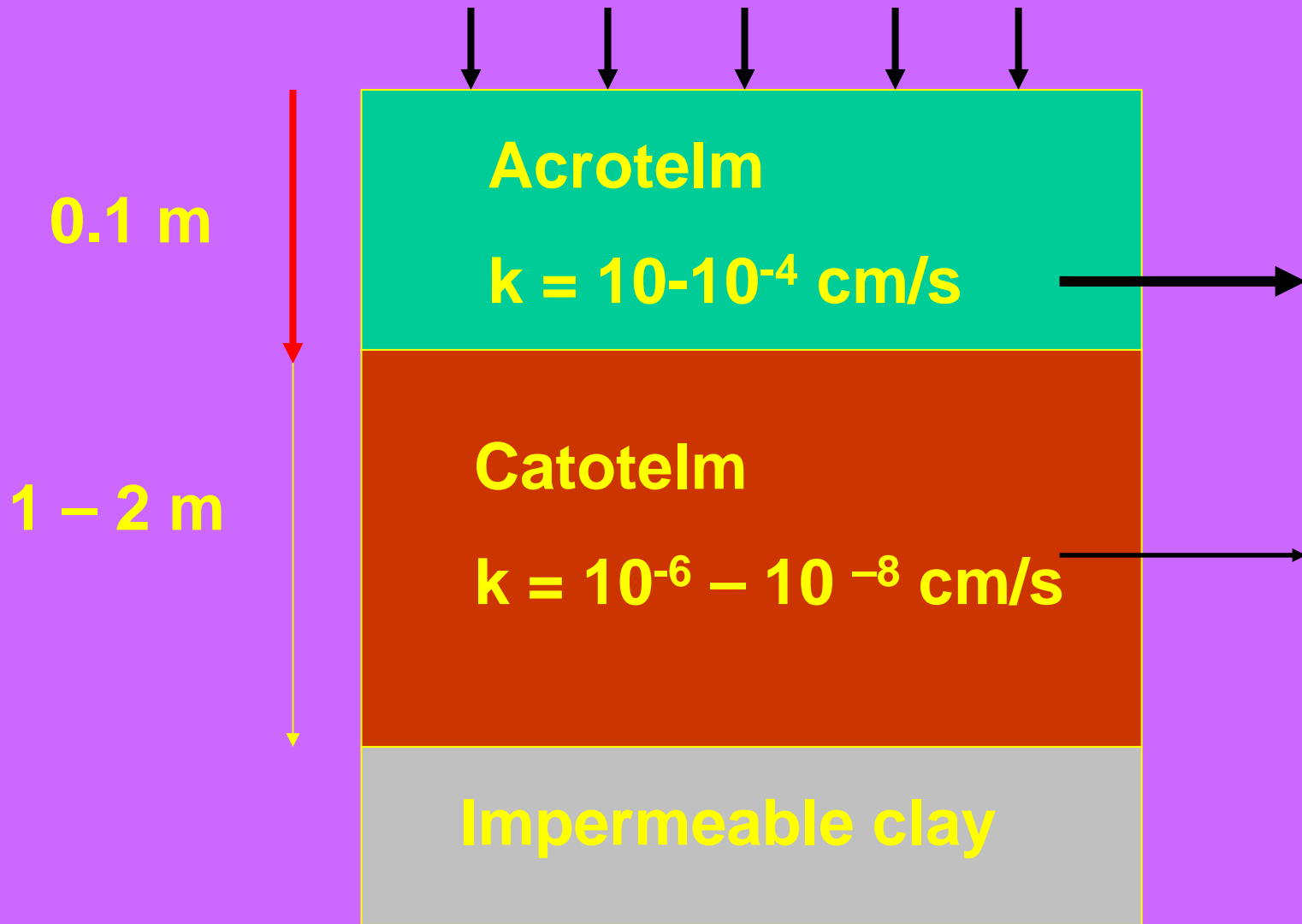
Saturation-excess
overland flow

Speed of runoff response

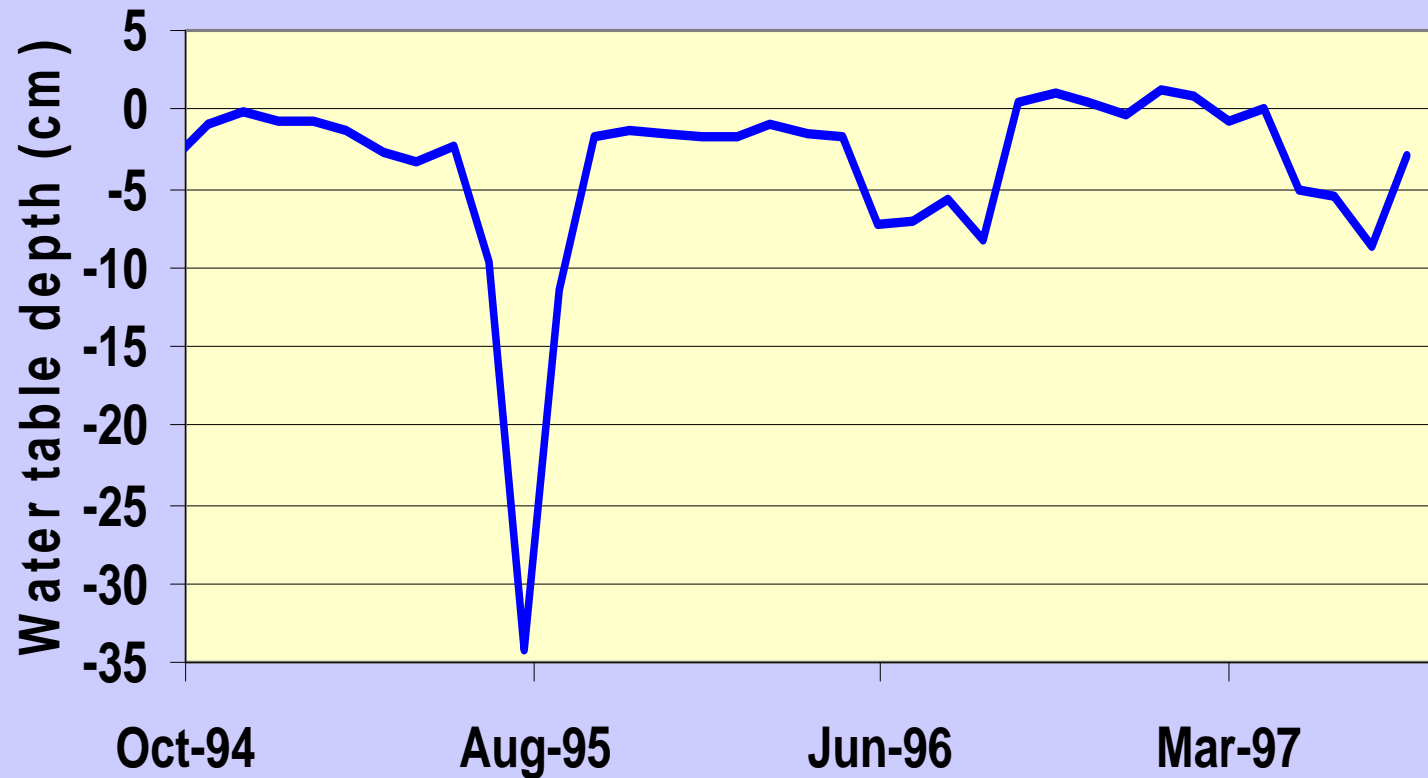


Shallow water tables in blanket peat



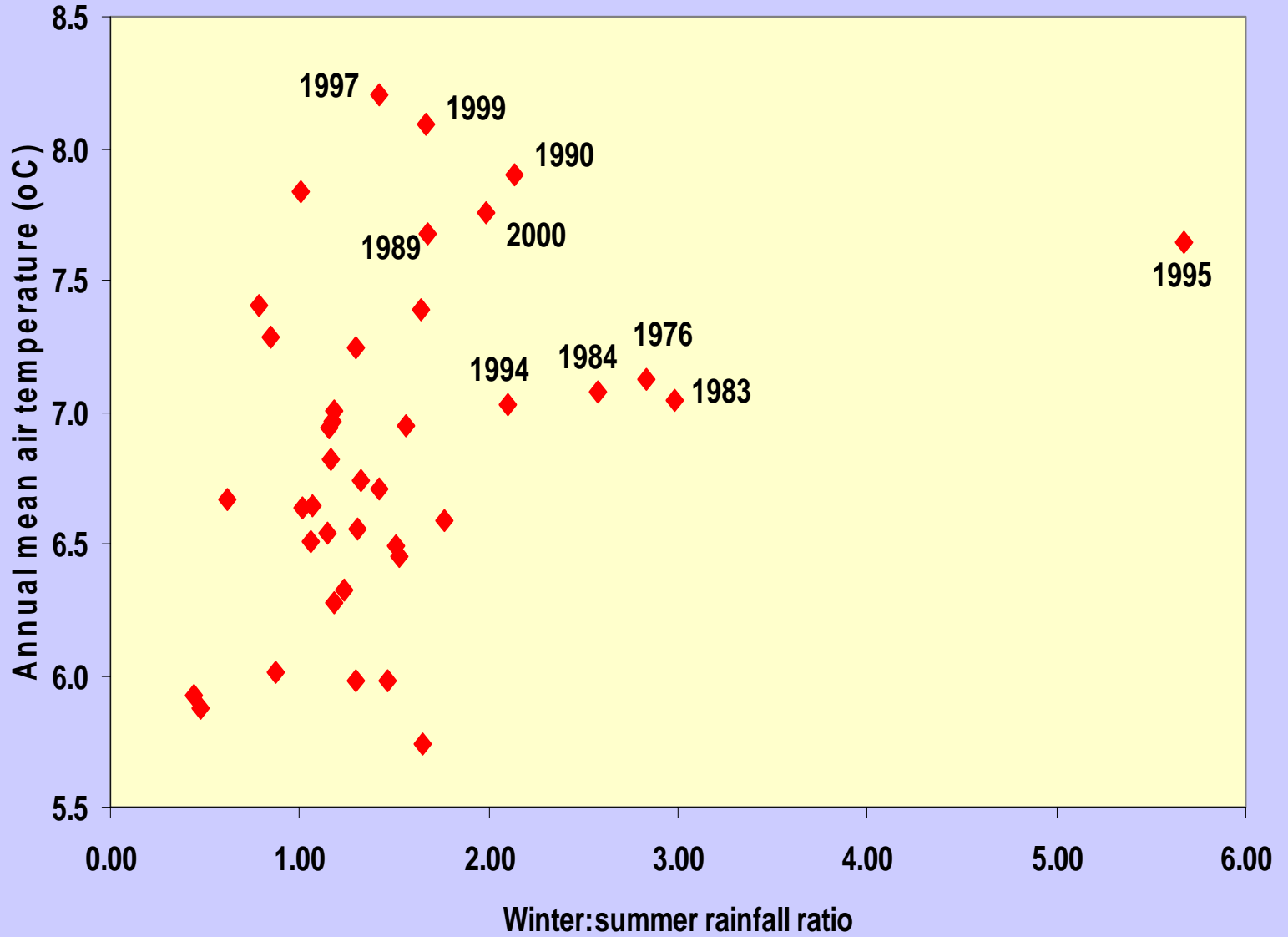


**Depth to water table in blanket peat:
monthly averages at Moor House ECN site**

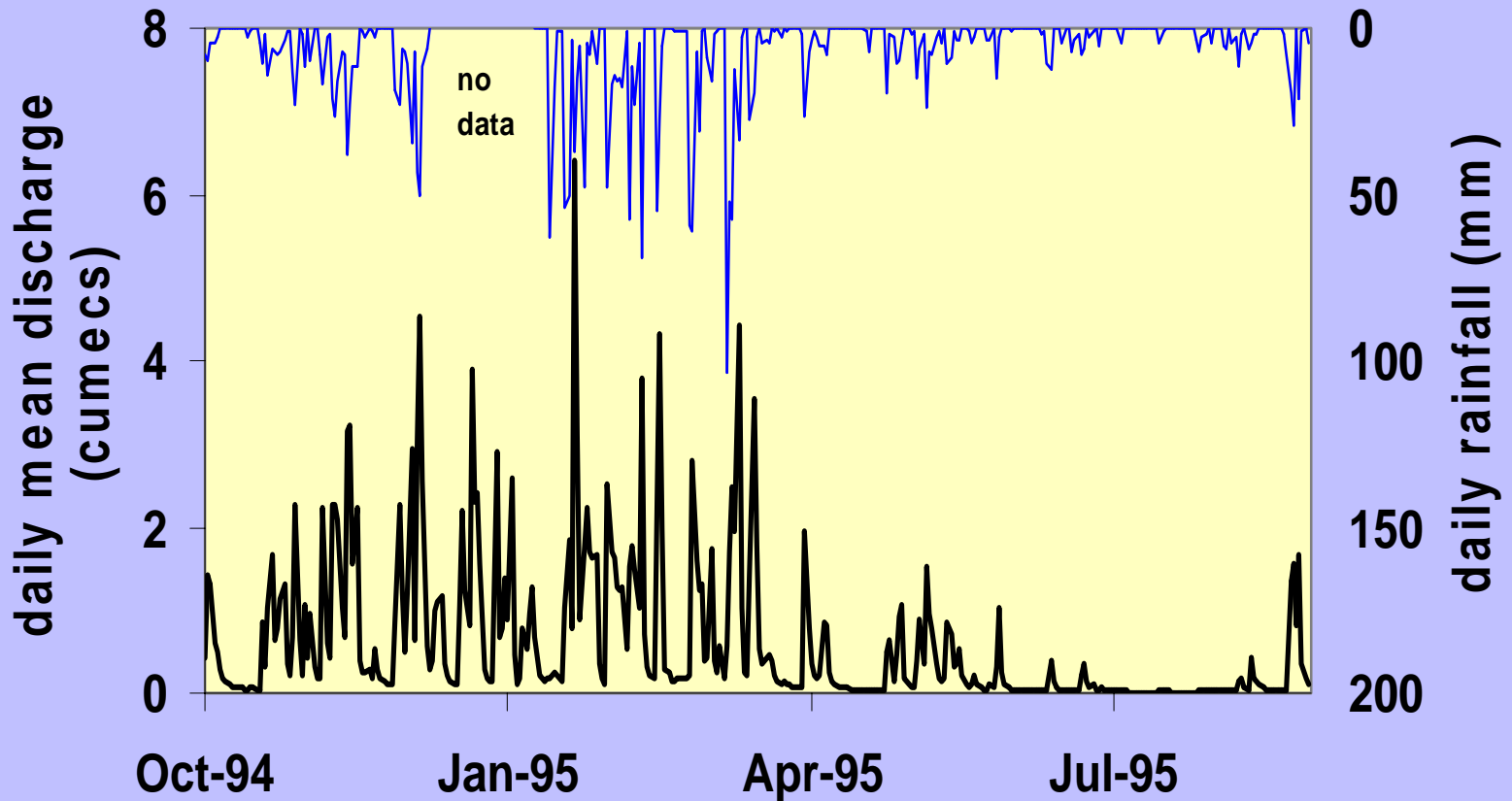


Outline

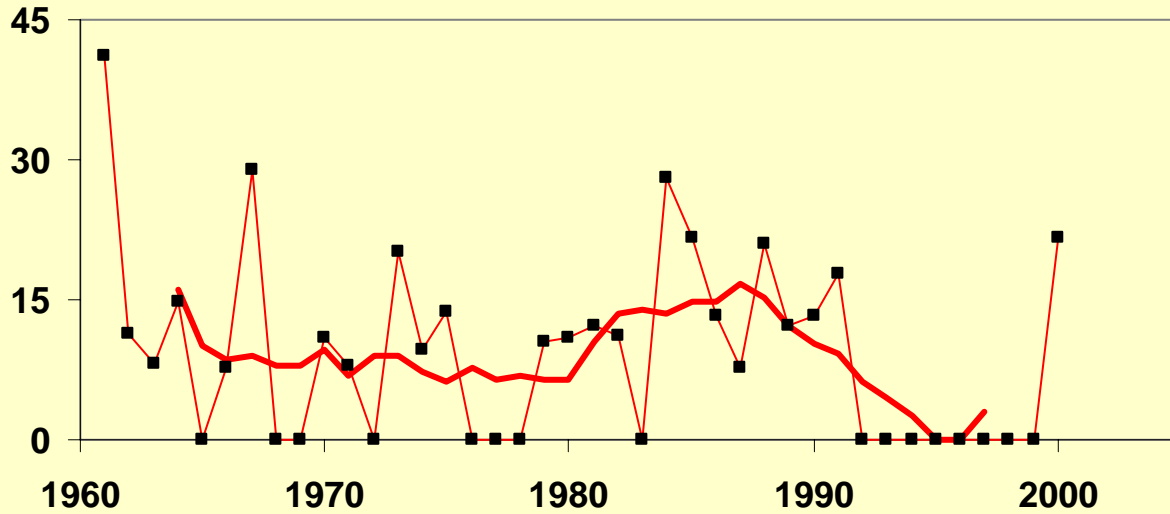
- **Patterns of streamflow in upland catchments (hydrographs)**
- **Climatic controls**
- **Runoff processes**
- **Long-term changes (climate change, human impact)**



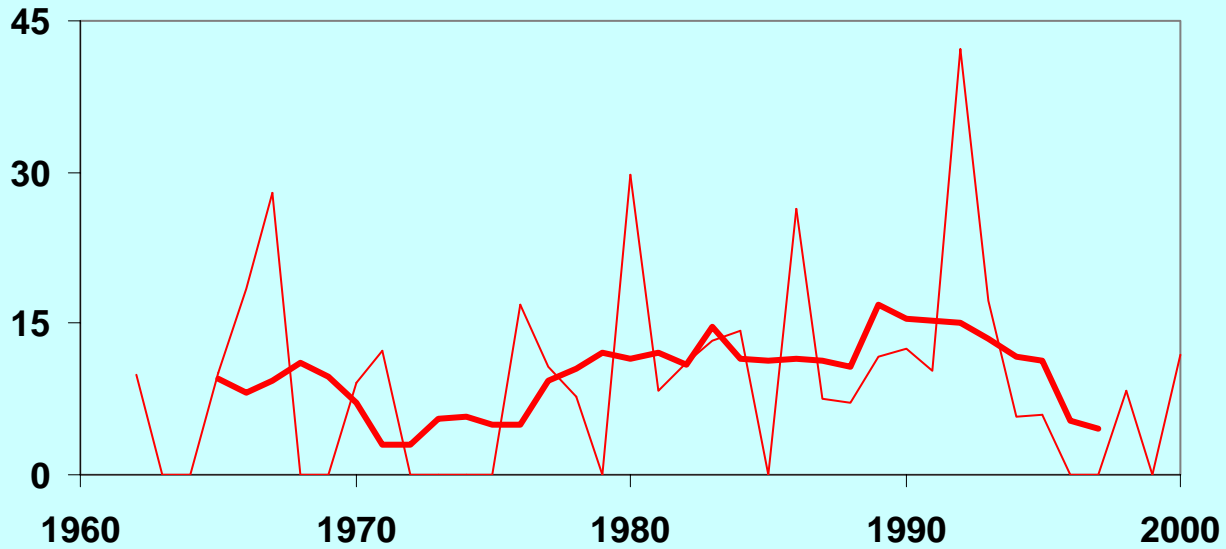
Trout Beck discharge : water year 1995



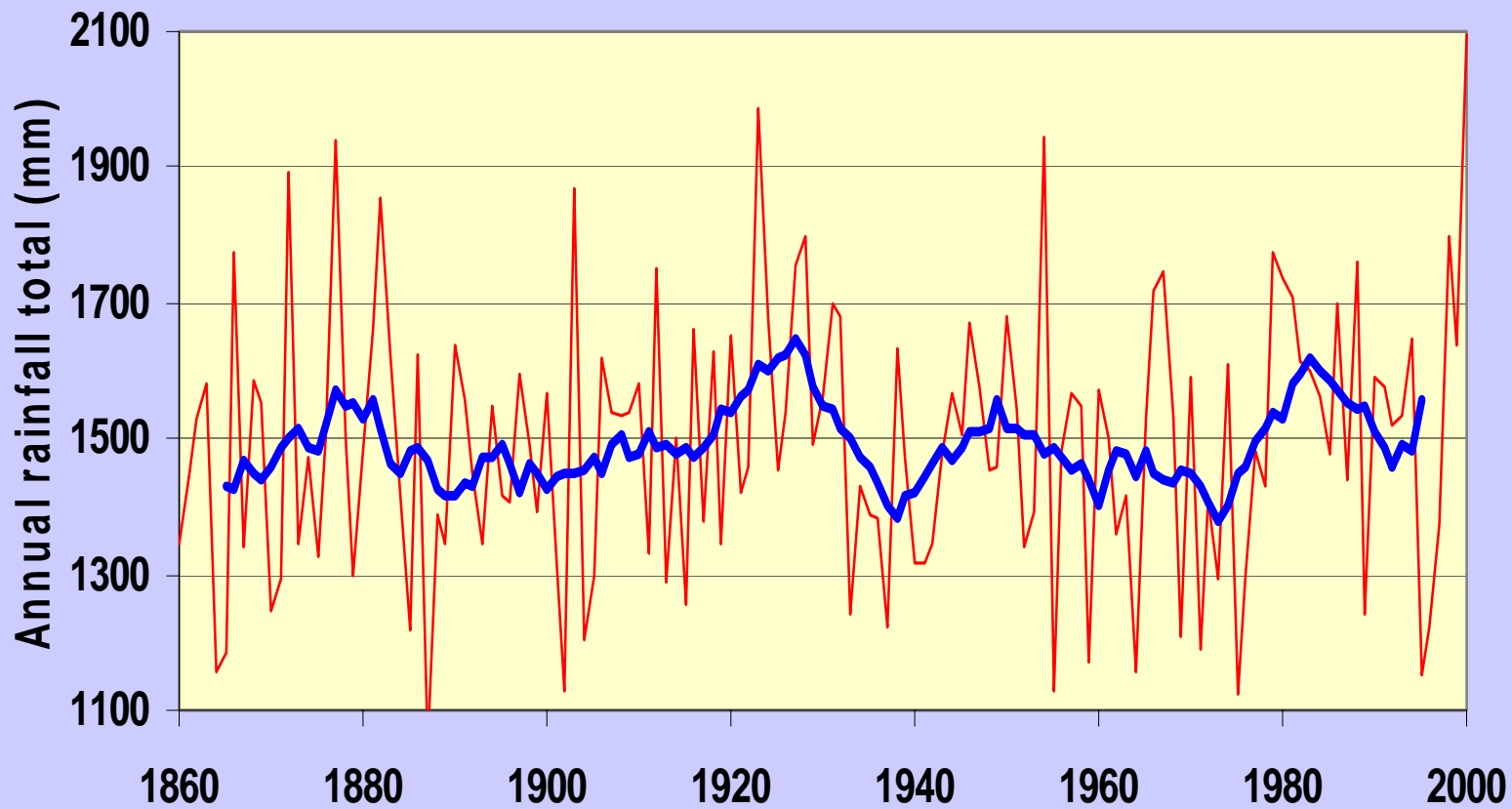
% summer rain from daily falls => 28.4 mm



% winter rain from daily falls => 33.1 mm



**Malham Tarn annual rainfall totals (mm) 1860-2000
with 11-year running mean**



Changes in land use or land management



Water or wood?



Water or wood?

	Wye (grass)	Severn (forest)
Precipitation (P)	2417	2300
Runoff (Q)	2047	1501
(P – Q)	370	799
Difference in losses		+429

(From Calder, 1990)



That's all folks!