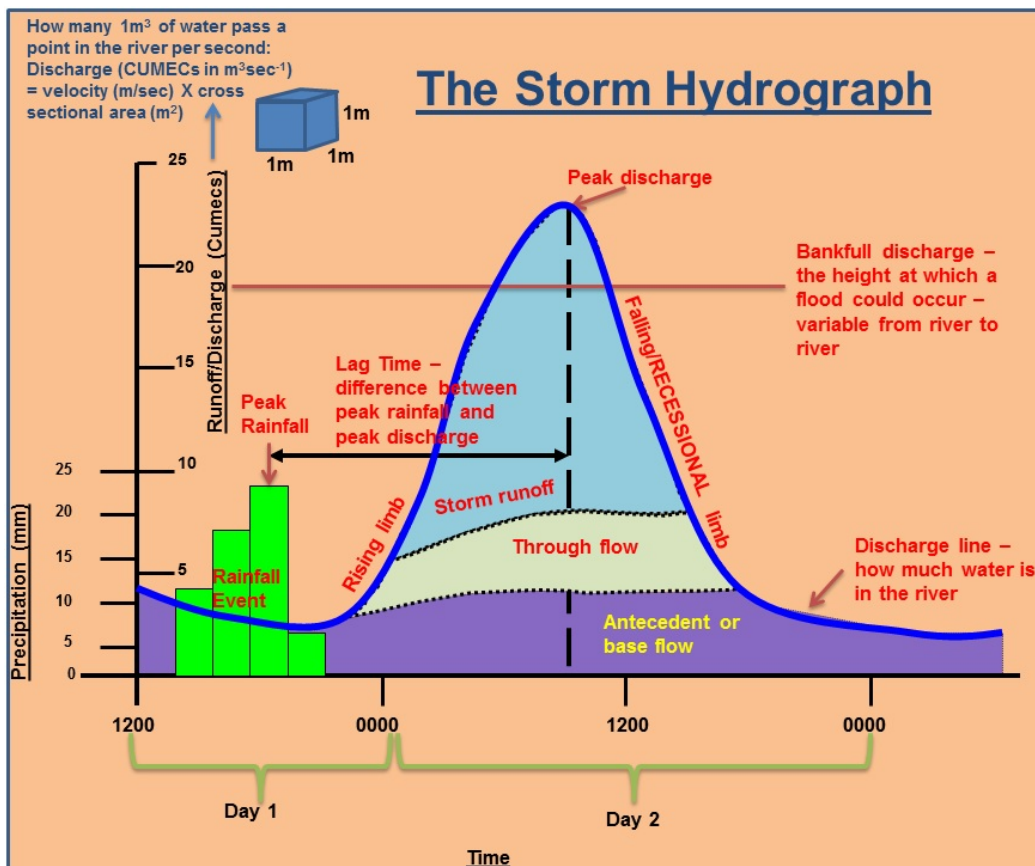
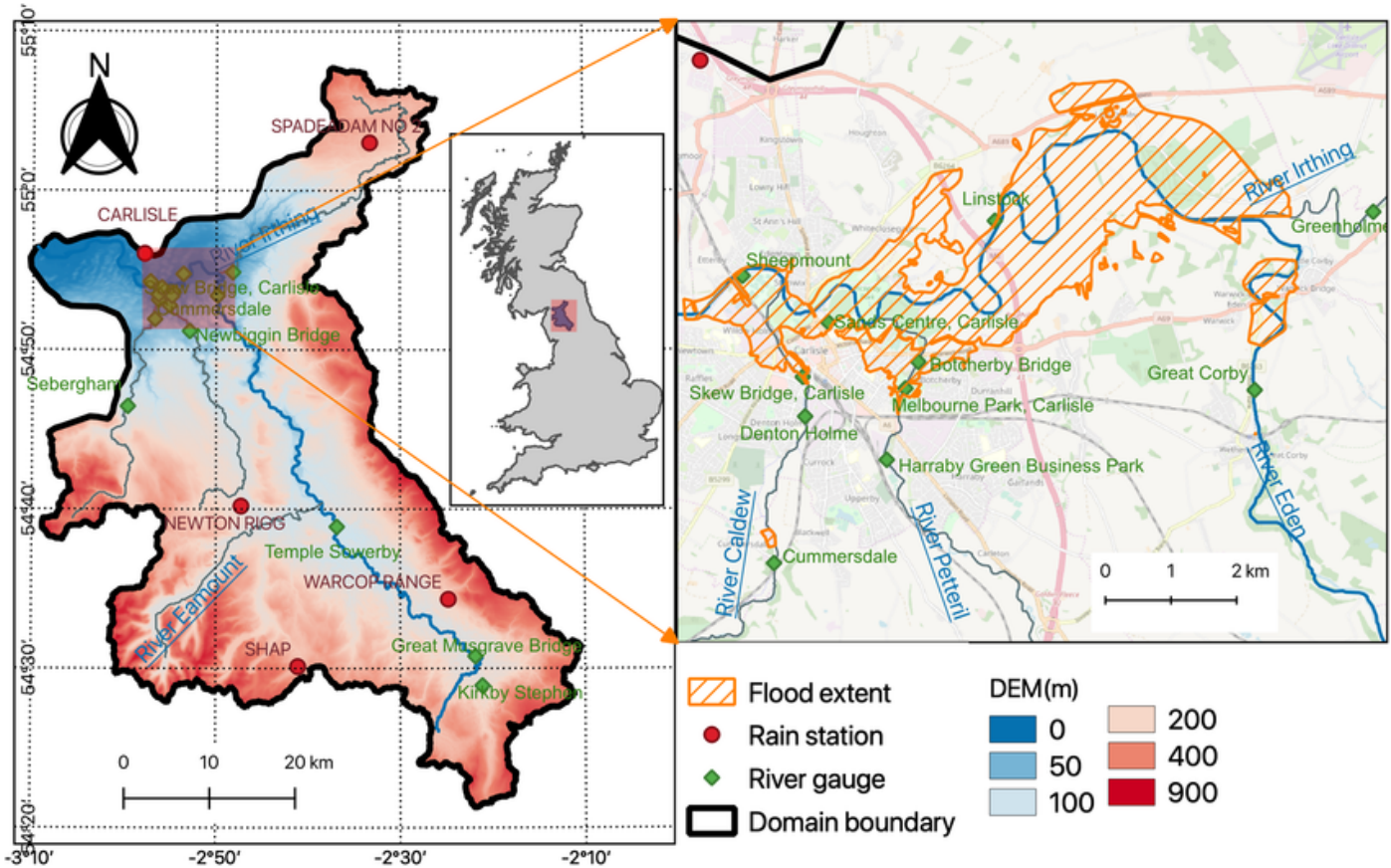


# RIVER EDEN DRAINAGE BASIN / CATCHMENT : N W ENGLAND

The river Eden is situated in the NW of England between the hills and mountains of the Lake District to the west and the Pennines to the east.

It runs north west for around 80 miles with a catchment area / drainage basin of 2400 km<sup>2</sup>.

It exhibits a 'flashy' hydrograph in response to rainfall events, making floods likely.



A flashy hydrograph has :-

- A short lag time, between peak rainfall and peak river flow.
- A steep rising limb, showing the rapid rise in river levels.
- A high peak of storm flow / river discharge, that may be above the bankfull capacity of the river.
- A steep recession limb, as the river flow recedes to the normal base flow.

## **REASONS WHY FLOODS ARE LIKELY IN THE RIVER EDEN BASIN, A COMBINATION OF PHYSICAL AND HUMAN FACTORS**

- The catchment consists of the mountains and hills of the Lake District and the Pennines which cause heavy relief rainfall as the moist prevailing westerly winds rise over the hills.
- Rainfall, heavy prolonged rainfall events tend to occur in the autumn and winter due to westerly winds and depressions.
- By winter the antecedent rainfall has saturated the soil to its full field capacity (it is saturated and can accept no more water) leading to more overland flow, the fastest way water reaches the streams and rivers.
- Relief, the steep slopes of the catchment area / drainage basin make water flow rapidly downslope to the streams and rivers reducing the length of the lag time and steepening the rising limb.
- Large areas of the drainage basin are composed of impermeable shales which limits infiltration and promotes overland flow. Other areas have low porosity sandstone and even the highly permeable limestone bedrock areas have underground caverns and channels allowing water to move rapidly downstream.
- The drainage density (streams per unit area) is very high, which rapidly channels water downstream from all parts of the drainage basin.
- The upper catchment is composed of peaty moorland, with few areas being thickly forested. This leads to low levels of interception and little interception loss making it more likely that rainfall intensity will exceed the infiltration capacity of the soil leading to rapid overland flow.
- The lower catchment consists of wide floodplains and the river meanders slowly over this low lying, easily flooded land.
- Although only a small percentage of the catchment is urbanised, the river system does flow through 3 urban centres, Appleby, Keswick and in particular the densely populated Carlisle in the lower part of the valley. This offers impermeable surfaces that inhibit infiltration and promote rapid overland flow. With limited vegetation, and many gulleys and drains water is moved rapidly into the river.
- The lowest section of the river is tidal and it is possible that high tide levels may inhibit the ability of the river to move water rapidly out to sea, raising river levels considerably.
- The defence in the urban areas consists mostly of embankments and flood walls, which were strengthened and heightened after the floods of 2005, but were unable to deal with the unprecedented river levels and flood event caused by storm Desmond in late 2015

## THE 2015 'STORM DESMOND' FLOOD

- Storm Desmond, late December 2015, an intense depression moving in from the west was the 4th named storm of 2015-16. This caused the ground (soils and rocks) to be already saturated leading to a great deal of overland flow.
- Storm Desmond brought a record rainfall of 340mm in 24 hrs due to a west to east 'atmospheric river' of moist air over the Lake District and Pennine uplands.
- The river Eden at Carlisle reached a maximum discharge of 1500 cumecs (cubic metres per second), record river levels, considering the mean discharge here is only 50 cumecs.
- The flood defences in urban areas, particularly Carlisle, were overtopped and then the low lying flood plain was inundated.
- A total of : 15000 people were affected
  - 7500 properties were flood, many in the most deprived areas
  - 200 businesses were damaged
  - 45 schools were damaged and closed
- Grants to the affected people and properties affected reached £16million.
- Insurance payouts were high, although some people had found it difficult to get home insurance because of the flood of 2005.
- Other impacts included subsidence, road damage and closures, bridge damage and closures, power outages, and landslips.

## RIVER EDEN FLOOD MANAGEMENT

A combination of upstream, downstream and whole catchment approaches

Afforestation	Improving warning systems
Restore upland peatlands	Raising the defensive embankments
Rewilding rivers	Buffer strips and lower valley zoning
Ecosystem management	Community involvement
Adjusting farming practices	Community resilience, individual home protection

Whole basin initiatives :- computer modelling and simulations; cost/benefit analysis; nature reserves as flood zones.

**Think about how each of the above strategies can reduce the flashy nature of the hydrograph.**

