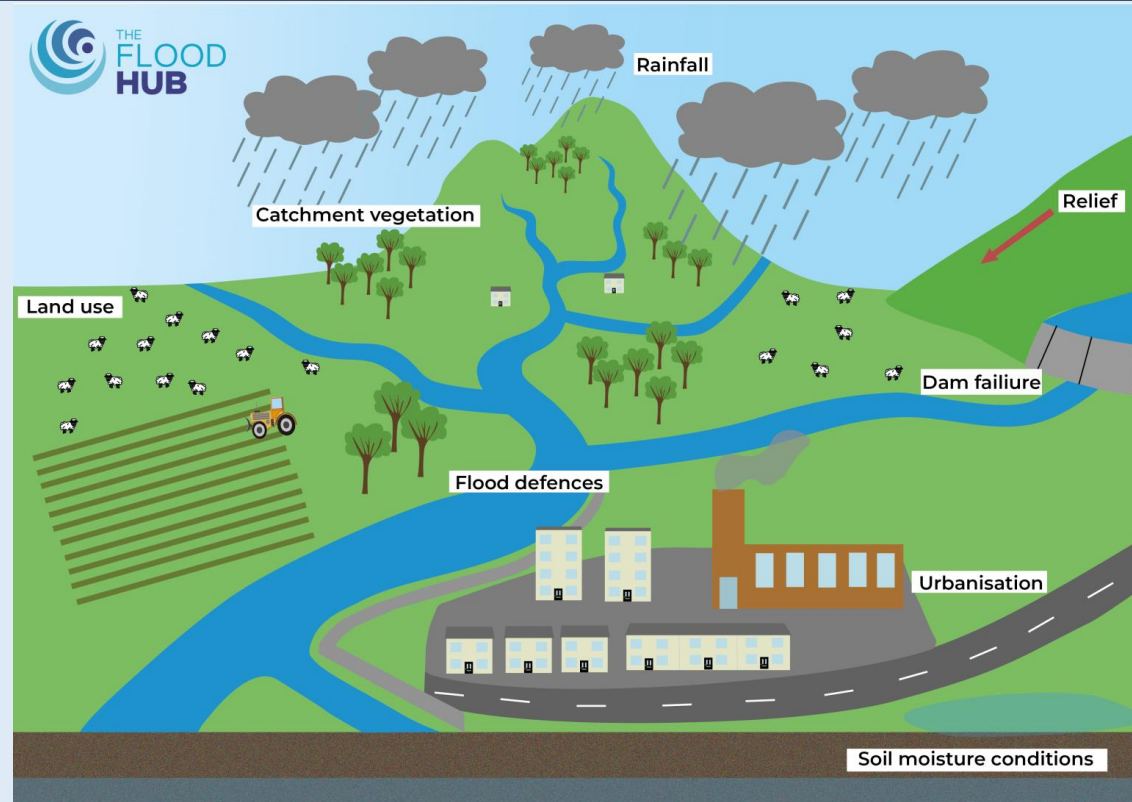
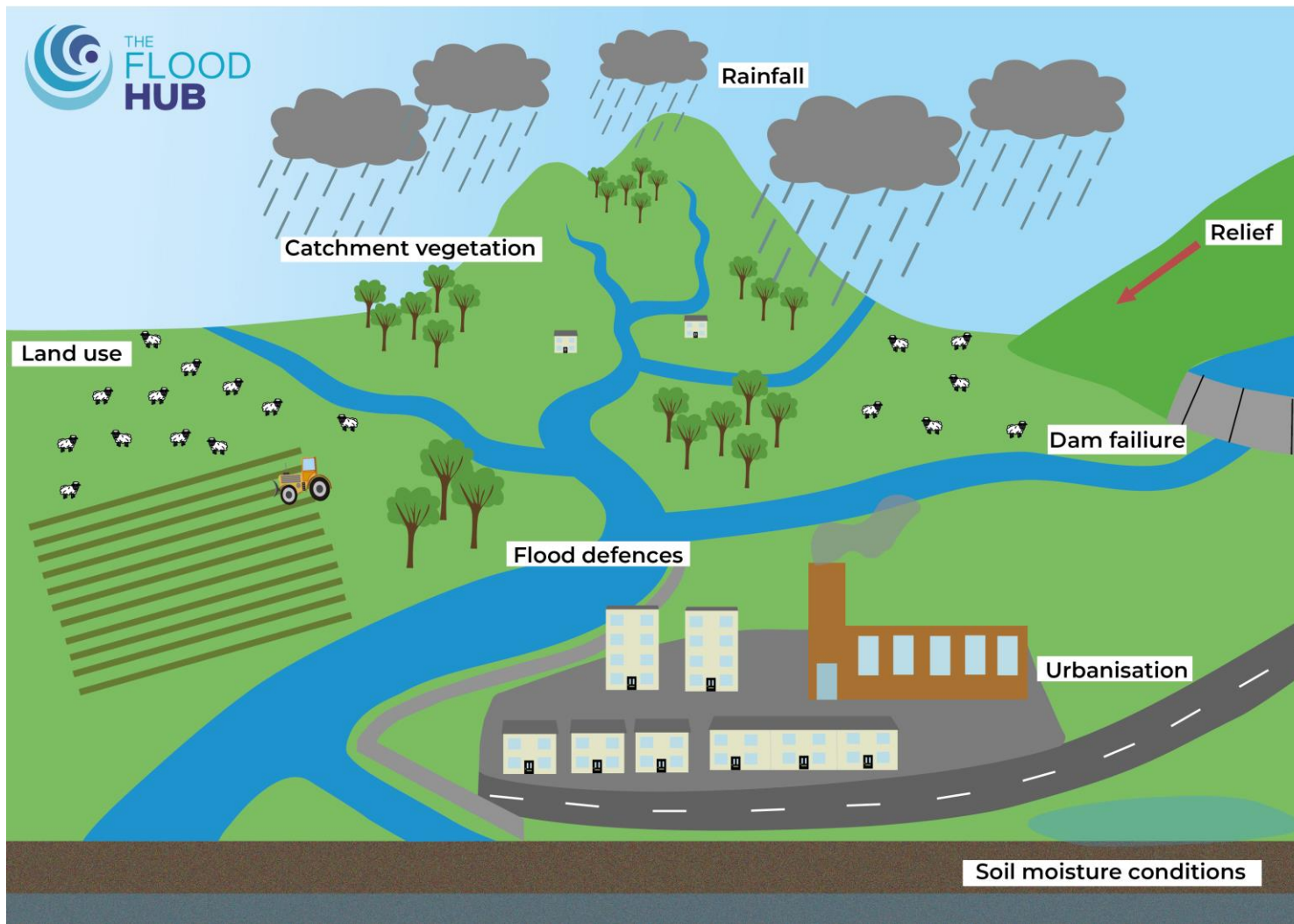


Factors contributing to the flood risk



What factors contribute to the risk of flooding?

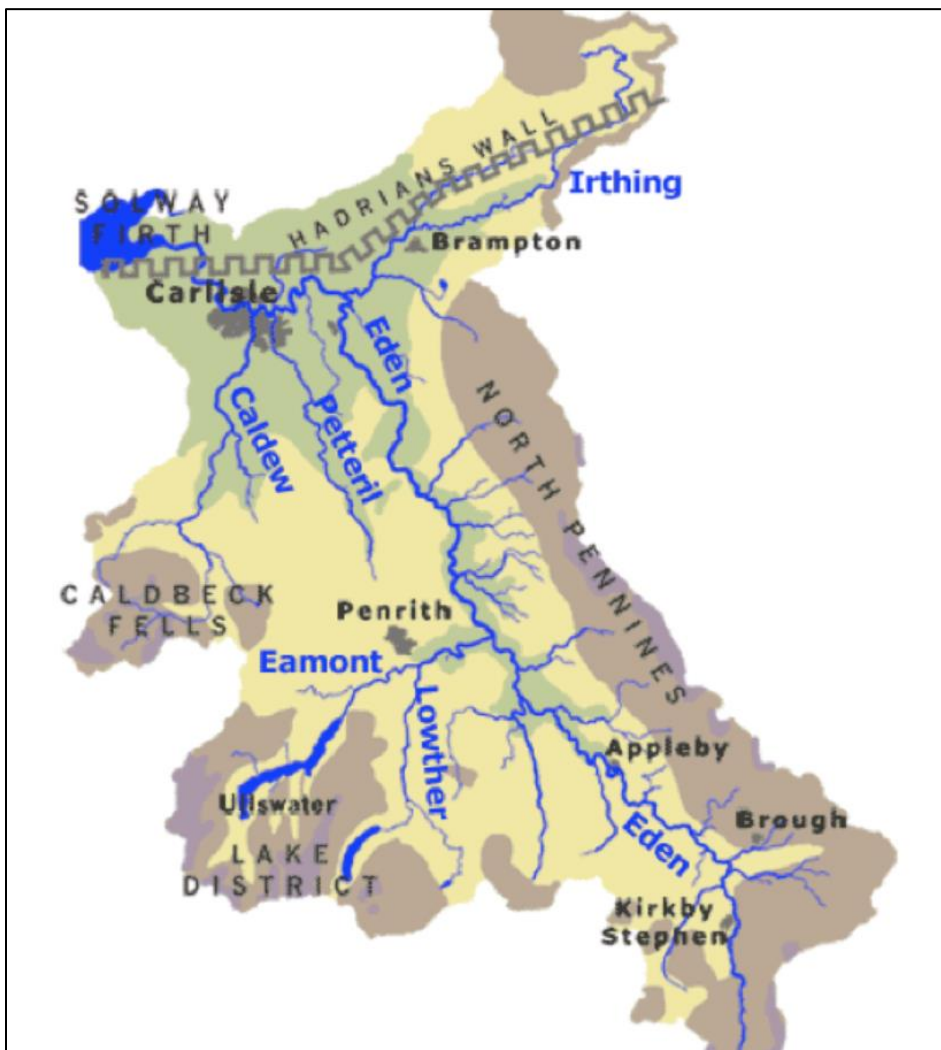


There are several factors that contribute to the risk of flooding:

- Physical: geology, relief, rainfall, vegetation, soil moisture
- Human: land use, urbanisation, flood defences

Some factors increase the risk of flooding whereas others decrease the risk.

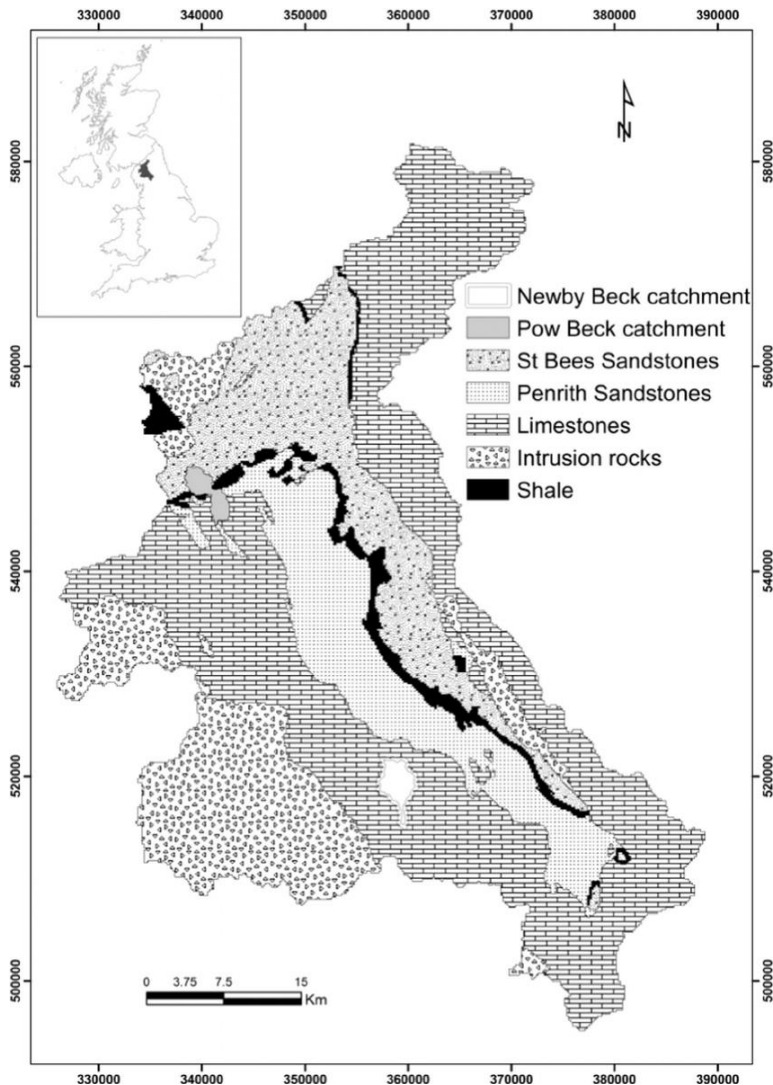
Catchment of the River Eden



- This map shows the catchment (drainage basin) of the River Eden, which covers an area of about 2,400 square km.
- The river flows roughly north-west from its source above Kirkby Stephen in the Pennines to the Solway coast.
- There are many tributaries that transport water rapidly from the surrounding uplands. The River Eden has a high drainage density.

Source: [River Eden](#)

Geology



Source: Ockenden, M.C., Deasy, C.E., Benskin, C.M.H., Beven, K.J., Burke, S., Collins, A.L., Evans, R., Falloon, P.D., Forber, K.J., Hiscock, K.M. and Hollaway, M.J., 2016. Changing climate and nutrient transfers: Evidence from high temporal resolution concentration-flow dynamics in headwater catchments. *Science of the Total Environment*, 548, p.325-339.

- The Eden's catchment is mostly underlain by relatively impermeable rocks, such as shales and low-porosity sandstones in the lowlands and igneous (intrusion) rocks in the Lake District.
- Unable to percolate, water collects and flows over the surface to form the river's many tributaries. This increases the risk of flooding.
- The Pennine fells at the edges of the catchment are limestone. Whilst this is a permeable rock, water is transferred rapidly through joints and cave systems increasing the risk of flooding downstream.

Source: https://www.researchgate.net/figure/Bedrock-geology-of-the-Eden-River-catchment-showing-Permo-Triassic-sandstones-in-the_fig2_291338298

Relief



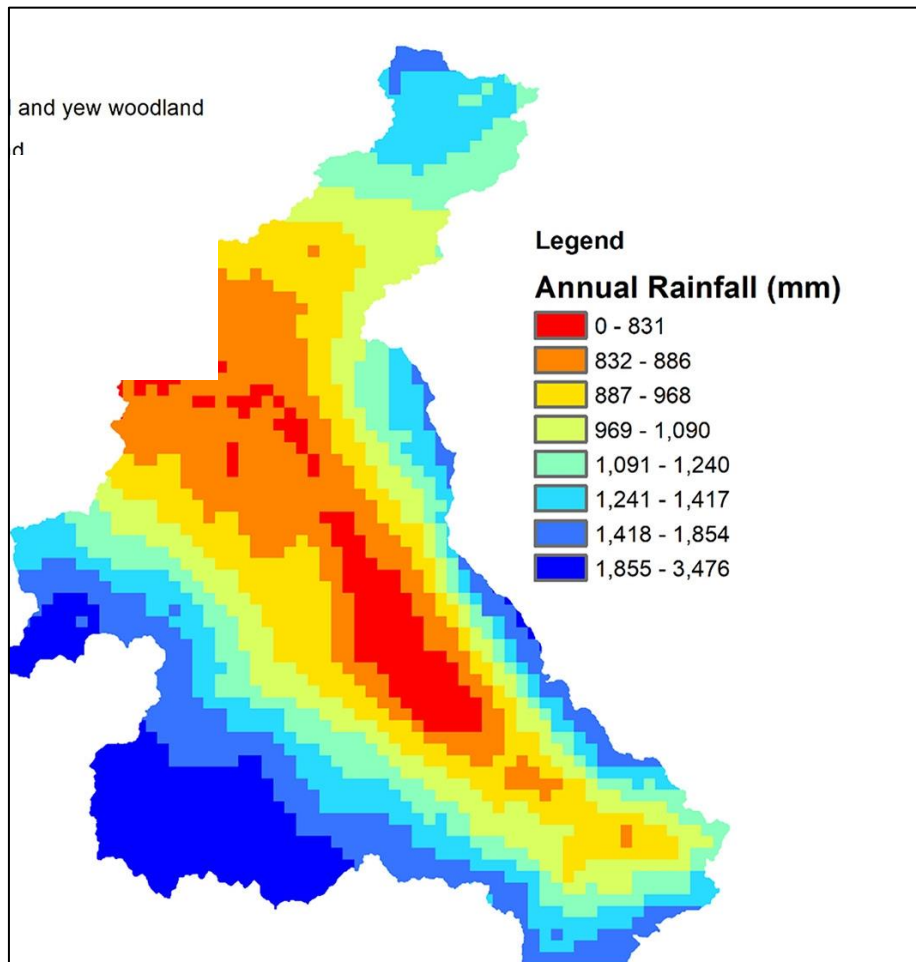
©Andrew/stock.adobe.com



Source: River Eden, near Great Ormside
[cc-by-sa/2.0 - © Paul Buckingham - geograph.org.uk/p/1702071](https://www.geograph.org.uk/p/1702071)

- The upper catchment is characterised by the steep slopes of Helvellyn and Skiddaw and the surrounding fells.
- The lower catchment is characterised by wide floodplains and wetlands.
- This means that water flows quickly from the uplands to the lowlands but then slows in response to the lower gradient, increasing the risk of flooding.

Rainfall



Source: <https://onlinelibrary.wiley.com/doi/full/10.1111/jfr3.12803>

Map: rainfall patterns (CEH GEAR dataset using the 1980–2010 mean, Tanguy et al., [2015](#)) in Reaney, S.M. (2022). Spatial targeting of nature-based solutions for flood risk management within river catchments. *Journal of Flood Risk Management*. 15. 3. p.e12803.

- The catchment receives some of the highest rainfall totals in England.
- Upstream of Penrith, the average annual rainfall exceeds 2800mm compared to 920mm for England and Wales.
- High rainfall and steep slopes combine to make the Eden a fast response ('flashy') river, reducing time available to issue warnings.

Vegetation



Source: [Visit Cumbria](https://www.visitcumbria.com/)

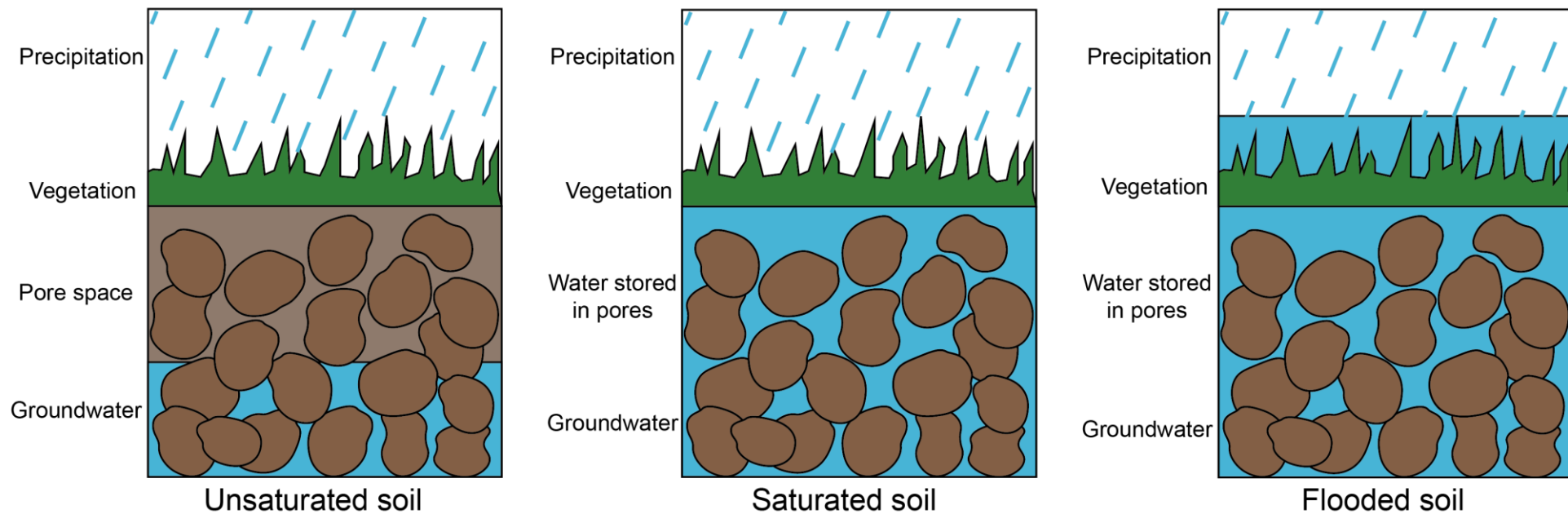


Source: River Eden, near Great Ormside
cc-by-sa/2.0 - © Paul Buckingham - [geograph.org.uk/p/1702071](https://www.geograph.org.uk/p/1702071)

- The Eden catchment is mostly rural farmland used for grazing livestock.
- In the higher catchment moorland vegetation captures and stores some of the heavy rainfall forming peaty bogs.
- In the lower catchment, grass pastures and woodlands store water and help to reduce the risk of flooding.

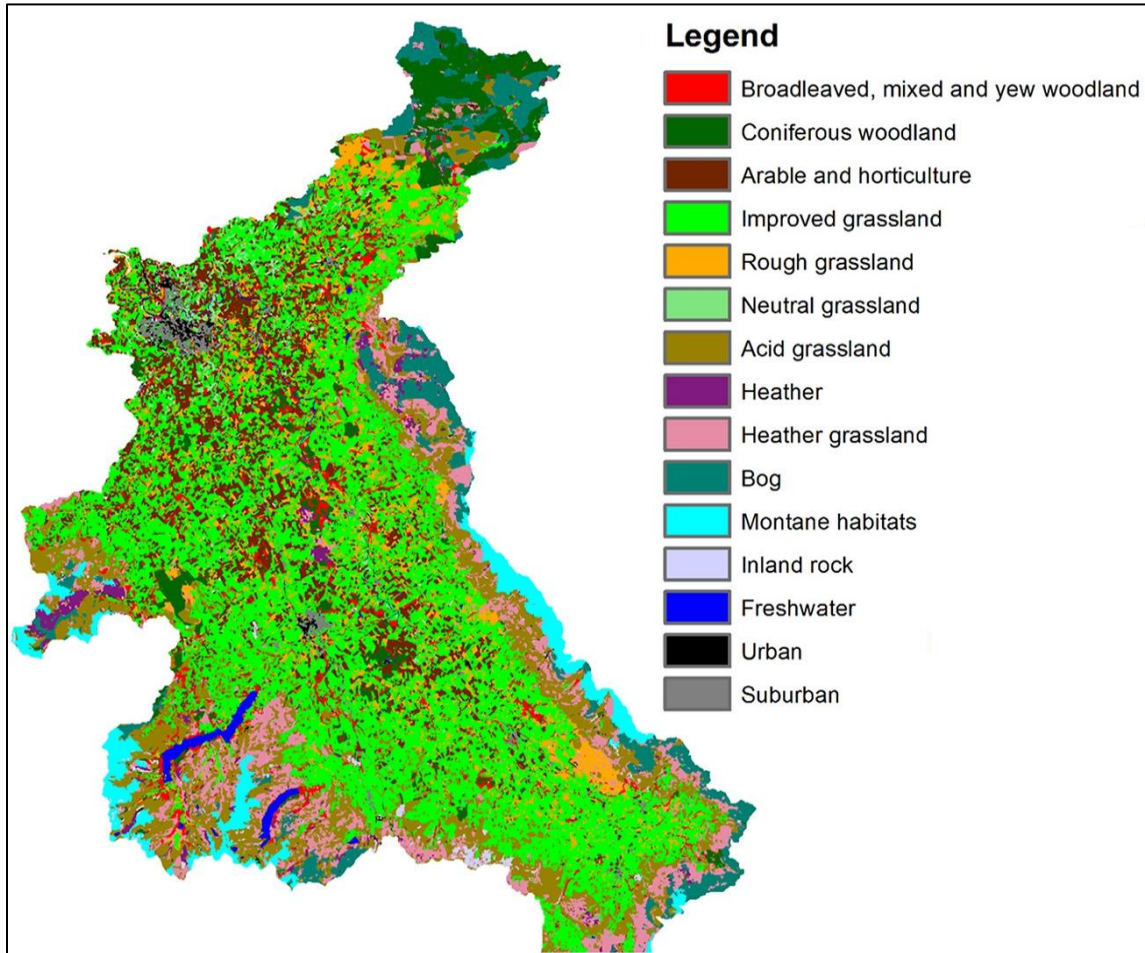
Soil Moisture

Soil moisture is an important factor contributing to the risk of flooding. In the Eden catchment, the heavy rainfall often causes soils to become saturated in the autumn. Further winter rainfall cannot soak into the soil. Excess water flows quickly as surface runoff increasing the risk of flooding.



Source: The Flood Hub

Land Use

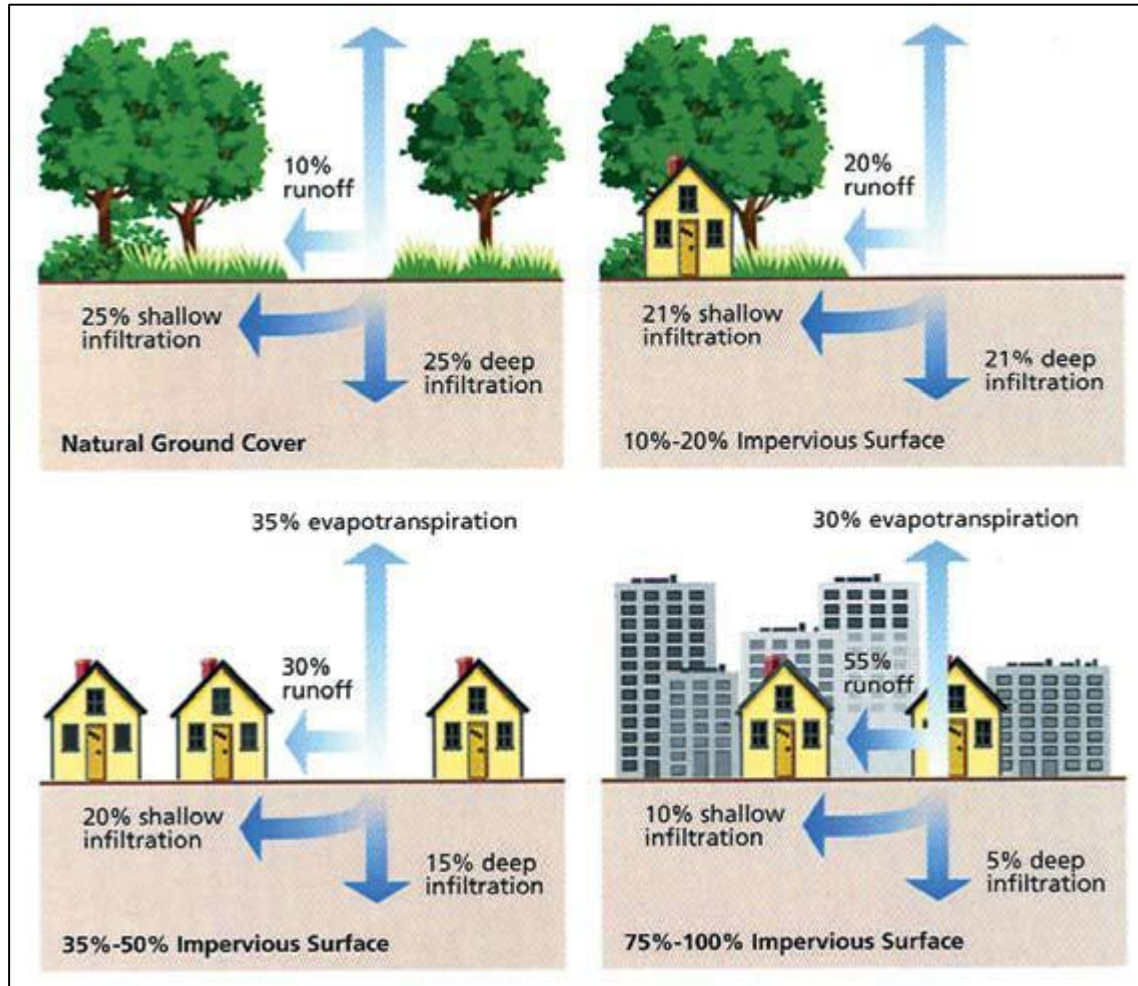


Source: <https://onlinelibrary.wiley.com/doi/full/10.1111/jfr3.12803>

Land cover (CEH Land Cover Map 2007, Morton et al., 2011) in Reaney, S.M. (2022). Spatial targeting of nature-based solutions for flood risk management within river catchments. *Journal of Flood Risk Management*. 15. 3. p.e12803.

- The Eden catchment is predominantly rural, with only 1% classified as urban.
- The main form of agriculture is livestock with grazing pasture. Farming is more intensive in the lower catchment than in the fells.
- About 250,000 people live in the catchment with the main settlements being Carlisle, Penrith and Appleby.
- Grassland helps to absorb and store water reducing the flood risk.

Urbanisation



Source: <http://www.opengreenspace.com/wp-content/uploads/2010/12/surface-runoff.jpg>

FISRWG, 1998

- The Eden catchment is mostly rural, with only 1% urban.
- However, urban areas – with largely impermeable surfaces, gutters and sewers – transfer water very rapidly into streams. This increases the flood risk downstream.
- Urban drainage systems can be overwhelmed during intense rainfall causing surface flooding.

Flood Defences



Source: Flood bank, Rockcliffe
[cc-by-sa/2.0 - © Andrew Smith - geograph.org.uk/p/822670](https://www.geograph.org.uk/p/822670)

- This photo shows an embankment on the River Eden protecting valuable farmland from flooding. The embankment increases the capacity of the river channel to cope with high flows.
- However, if embankments fail, the impact of flooding can be significant. Also, water can be trapped unable to flow back into the river when water levels fall.

The River Eden flood risk: a summary

Factors increasing flood risk

- Geology – the largely impermeable rocks increase surface runoff and the risk of flooding.
- Relief – steep slopes in the upper catchment increase the speed of water flow.
- Rainfall – high rainfall increases the risk of flooding.
- Soil moisture – saturated soils in the winter increases surface runoff and the flood risk.
- Urbanisation – in settlements such as Carlisle, impermeable surfaces can increase the risk of flooding.

Factors reducing flood risk

- Vegetation and land use – the predominantly rural catchment with land used for grazing livestock stores water and helps to reduce the risk of flooding.
- Flood defences – defences such as embankments generally reduce the risk of flooding.



Explore the Eden Catchment with GIS

The Eden Rivers Trust hosts excellent GIS interactive maps including a study of the catchment of the River Eden at <https://www.edenriverstrust.org.uk/secondary-schools/explore-the-eden-geography-of-the-eden-catchment/>

The resources include teachers' notes and student worksheets.