Rivers

HYDROLOGICAL CYCLE

RIVER PROCESSES

EROSION where rocks are worn away and the land changes shape.

TRANSPORTATION where eroded material is carried by the river downstream.

DEPOSITION where transported material is dropped when the river loses energy, such as when it enters the sea.

DRAINAGE BASIN

SOURCE
The origin of the river

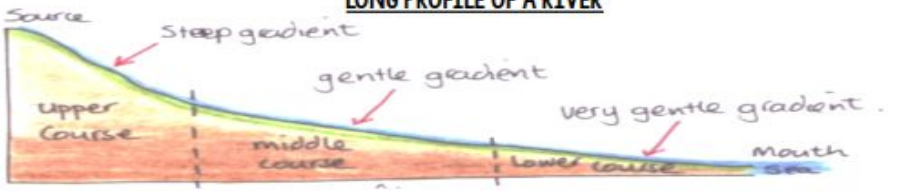
CONFLUENCE
The point at which two rivers meet.

TRIBUTARY
Smaller streams/rivers that flow into a larger one.

FLOODPLAIN
Flat land along the river that is prone to flooding.

MOUTH
The end where the river meets the sea.

LONG PROFILE OF A RIVER

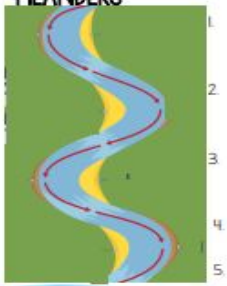


THE MIDDLE COURSE

FEATURES

Wider, shallower valleys, meanders, and oxbow lakes

MEANDERS



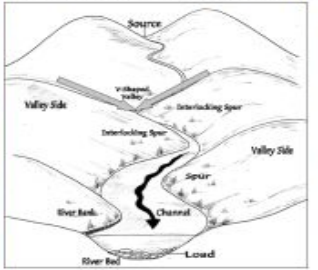
1. The formation of meanders is due to both **deposition** and erosion and meanders gradually move downstream.
2. The force of the water **erodes** and undercuts the river bank on the outside of the bend where water flow has most energy.
3. On the inside of the bend, where the river flow is slower, material is **deposited**, as there is more friction.
4. Over time the horseshoe become tighter, until the ends become very close together. As the river breaks through the ends join, the loop is cut-off from the main channel.
5. The cut-off loop is called an **oxbow lake**.

OXBOW LAKE

THE UPPER COURSE

FEATURES

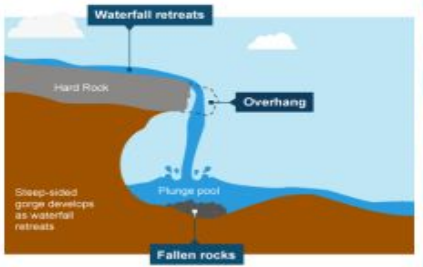
Steep-sided V-shaped valleys, interlocking spurs, rapids, waterfalls and gorges.



When a river is near its source, it often develops a V-shaped valley as the river erodes down (this is called **vertical erosion**).

At the same time, weathering breaks up material on the valley slopes. Weathered material from the valley sides gets deposited in the river.

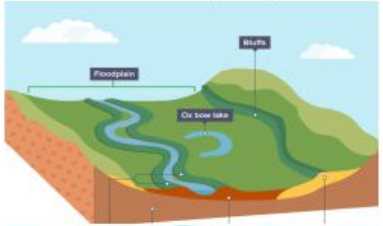
1. The soft rock erodes more quickly, **undercutting** the hard rock.
2. The hard rock is left **overhanging** and and eventually collapses.
3. The fallen rocks crash into the **plunge pool**. They swirl around, causing more erosion.
4. Over time, this process is **repeated** and the waterfall moves upstream.
5. A steep-sided **gorge** is formed as the waterfall retreats.



THE LOWER COURSE

FEATURES

Wide flat-bottomed valleys, floodplains and deltas



A floodplain is the area around a river that is covered in times of flood. It is a very fertile area. This makes floodplains a good place for agriculture. A build-up of alluvium on the banks of a river can create levees, which raise the riverbank.

FLOODING

A flood occurs whenever a river overflows its banks (exceeds its 'bankfull' discharge) However, a flood becomes a problem when the water rises to a level where it threatens property and/or life. Rivers usually flood due to a range of physical factors

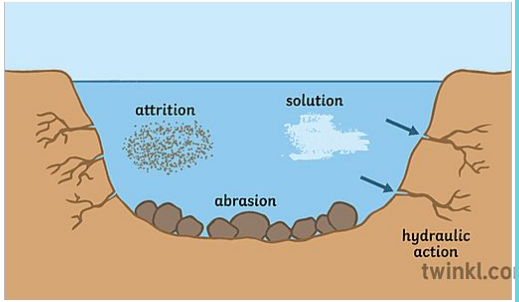
These physical factors can be divided into **climatic factors** and **drainage basin** characteristics. **Human intervention** can also make flooding worse

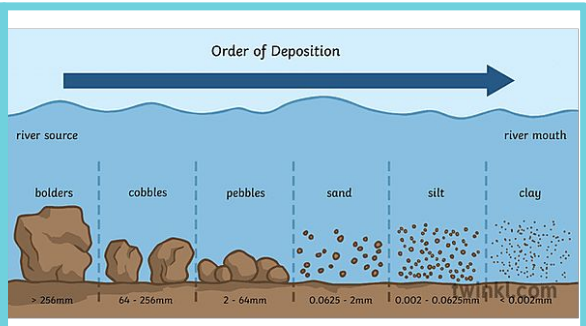
HUMAN CAUSES OF FLOODING

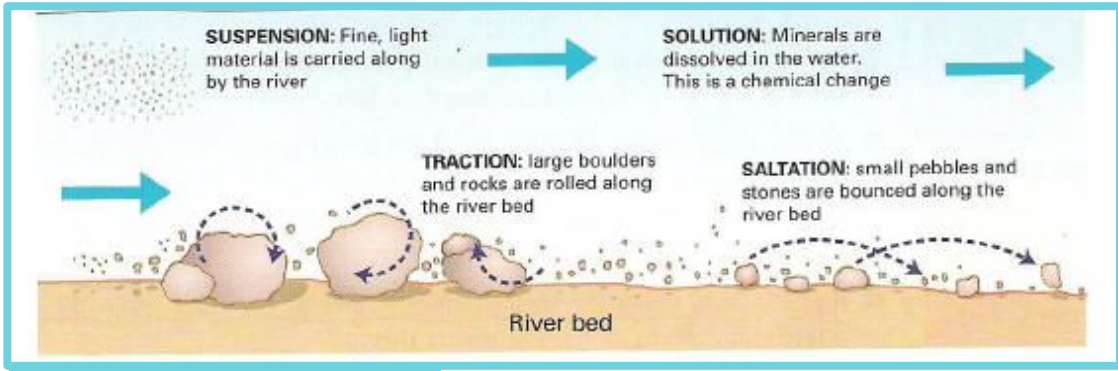
PHYSICAL CAUSES OF FLOODING

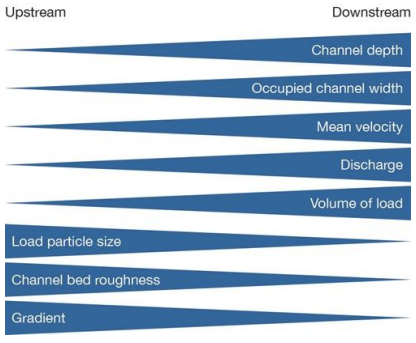
KEYWORDS

CAUSE	SOURCE		DEPOSITION	WATERSHED
EFFECT	MOUTH	CONFLUENCE	MEANDER	V-SHAPED VALLEY
RESPONSE	LONG PROFILE	WATERFALL	OXBOW LAKE	
DRAINAGE	FLOODPLAIN	EROSION	DELTA	HYDROLOGICAL CYCLE









River Dee Case Study

Natural factors changing the river	Human factors affecting the river
Upper Course: • River Dee's source is on the slopes of Dduallt in Snowdonia • Source is 460 metres above sea level • Rainfall here exceeds 3000mm and runoff is high from steep upland slopes • Hard igneous rock, resistant to erosion • Narrow, shallow channel full of angular rocks, so velocity is low • Vertical erosion forming V-shaped valleys (helped by sliding and slumping) Middle Course: • Wider, flatter valley creating areas of floodplains • Lateral erosion, formation of meanders • Several tributaries join the river increasing the discharge Lower Course: • Annual rainfall is less than 750mm • The river flows through areas of softer rock such as sandstone • Wide, deep, smooth river channel- high velocity • Lateral erosion and transportation continue, sediment load is high • Mouth in the Irish Sea, an estuary (affected by tides) General Factors: • Climate change, on average 20% more discharge as a result by 2100 • One metre sea level rise by 2100 affecting estuary	Upper Course: • Forestry (planting areas of forest) reduces surface runoff • Sheep farming - exposed pasture areas and soil erosion • Reservoirs (supplies water to 3 million people) controls river discharge downstream • Llyn Brenig reservoir collects 327,000 cubic metres of water a month Middle Course: • Near settlement of Bangor, earth embankments built to protect farmland and properties from flooding • Land drainage pump system at Worthenbury helps reduce excess flood waters Lower Course: • Dairy farming and arable farming • Between 1972 and 1976 8km underwent Channelisation between Chester Weir and its estuary to improve navigation General Factors: • Increasing urban population within the catchment area EG: Chester • Increased risk of flooding • 1% flood event would affect 4200 properties, in 2100, it would affect 6400

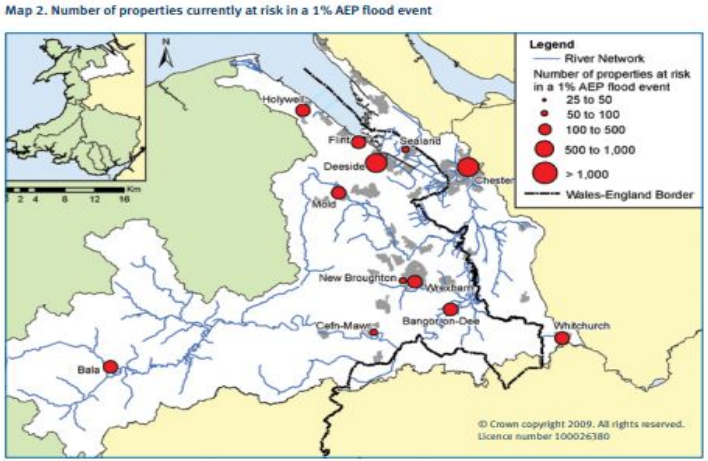


Table 5. Policy options

→ Policy 1

Areas of little or no flood risk where we will continue to monitor and advise

This policy will tend to be applied in those areas where there are very few properties at risk of flooding. It reflects a commitment to work with the natural flood processes as far as possible.

→ Policy 2

Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions

This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk.

→ Policy 3

Areas of low to moderate flood risk where we are generally managing existing flood risk effectively

This policy will tend to be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly in the future. However, we keep our approach under review, looking for improvements and responding to new challenges or information as they emerge. We may review our approach to managing flood defences and other flood risk management actions, to ensure that we are managing efficiently and taking the best approach to managing flood risk in the longer term.

→ Policy 4

Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change

This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

→ Policy 5

Areas of moderate to high flood risk where we can generally take further action to reduce flood risk

This policy will tend to be applied to those areas where the case for further action to reduce flood risk is most compelling, for example where there are many people at high risk, or where changes in the environment have already increased risk. Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

→ Policy 6

Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists), but would only be implemented in specific locations within the area, after more detailed appraisal and consultation.

Approaches in each sub-area

We have divided the River Dee catchment into 10 distinct sub-areas which have similar physical characteristics, sources of flooding and level of risk. We have identified the most appropriate approach to managing flood risk for each of the sub-areas and allocated one of six generic flood risk management policies. These are shown in Map 3 and Table 5.

To select the most appropriate policy, the plan has considered how social, economic and environmental objectives are affected by flood risk management activities under each policy option. Policy analysis and selection is based on flood risk across the entire CFMP area and not just the key locations referred to earlier.

Map 3. Sub-areas in the River Dee CFMP