AQA GCSE GEOGRAPHY UNIT 1

Living with the Physical Environment Exam

REVISION RESOURCE 3

SECTION C

Physical Landscapes in the UK

UK's Relief and Landscapes

Relief – term to describe physical features of the landscape.

This includes:

- Height above sea level
- Shapes of landscape features
- Steepness of slopes

- Relief of an area mainly determined by **geology** (rocks that form landscape).
- Tough, resistant rocks (e.g. granite) form **mountain ranges**, like Arran in Scotland.
- Weaker rocks (e.g. clay) form **low-lying plains**.

Landscape – an area whose character is the result of the action and **interaction** of natural and human factors.

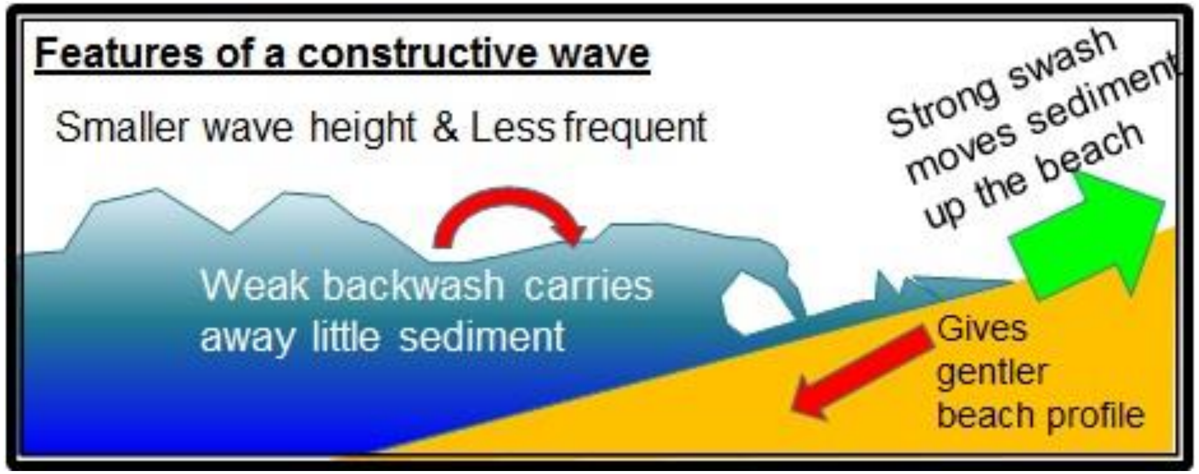
A wide variety of rock types are responsible for creating our varied landscapes.

UK has a very extensive river system. Most rivers have their sources in mountain ranges or hills and flow to the sea.

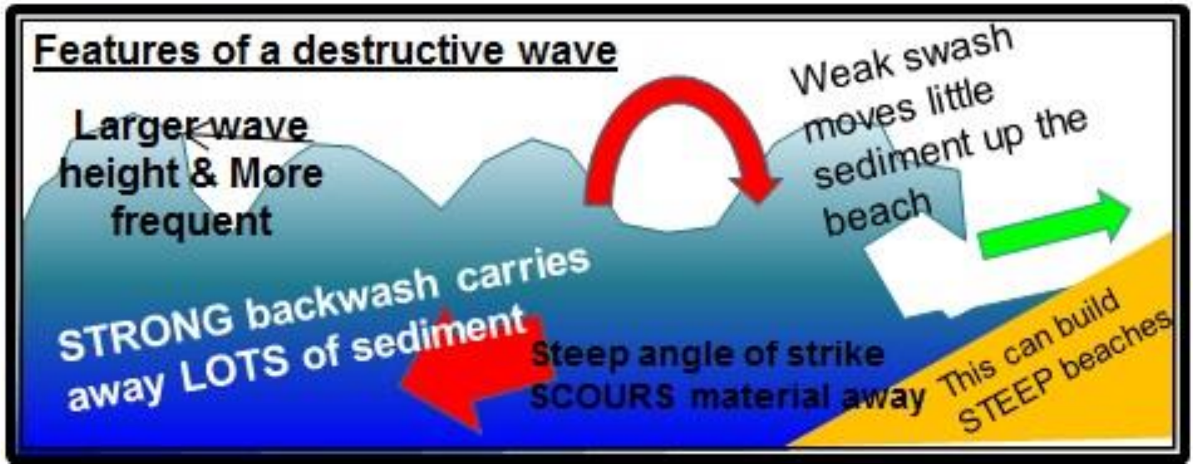
Physical Atlas Map of the UK

Wave Types and Characteristics

- **Waves** are formed by wind blowing over sea.
- **Friction** with surface causes ripples to form and develop into waves.
- **Fetch –** the distance the wind blows across the water.
- Longer the fetch = stronger the wave.
- Can also be formed by a **tectonic hazard** (**tsunami**).



- **Forward movement** of water when waves approach the shore.
- Forward movement of water as waves **break and surge** up the beach.
- Seabed **interrupts** circular movement of water.
- As water becomes shallower, circular movement becomes **elliptical**.
- Causes **crest of wave** to rise up and collapse onto the beach.
- **Swash –** water that rushes up the beach.
- **Backwash –** water that flows back towards the sea.



Weathering

Case Study – Beachy Head, 2001

- Dramatic rockfall
- During wet winter of 2000, **chalk rock** became **saturated** with water
- **April 2001 –** huge slab of chalk broke away and collapsed into the sea.

What causes cliffs to collapse?

Cliffs collapse because of different types of **weathering**.

Weathering - the **weakening** or decay rocks in their place on, or close to, the ground surface.

Mechanical (physical) weathering – disintegration of rocks. Piles of scree (rock fragments) at foot of cliffs.

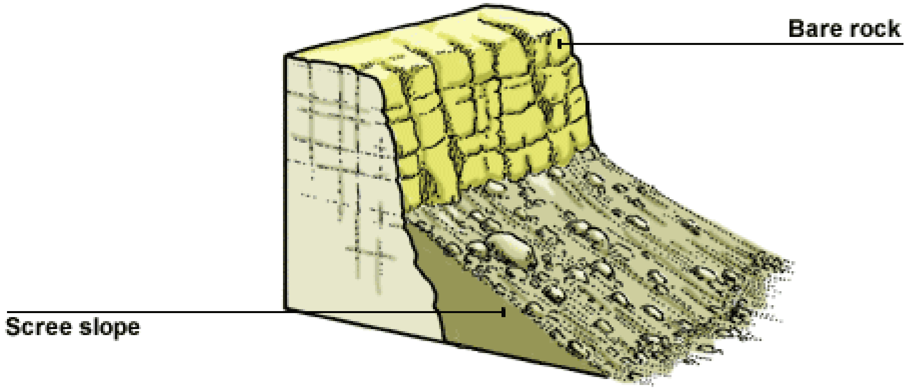
Chemical Weathering – caused by chemical changes. Rainwater (slightly acidic) slowly dissolves certain rock.

Biological Weathering– actions of plants and animals.

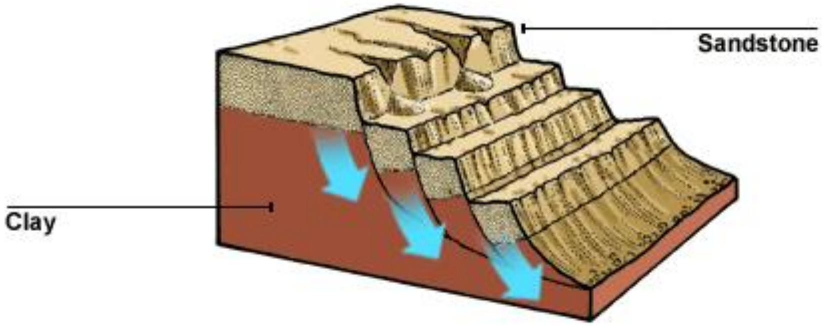
Weathering Process	Description
Freeze-Thaw (mechanical)	• Water **collects** in cracks/holes in rock • **Night –** water freezes and expands • **Day –** water thaws and seeps deeper into rock • **Repeated action** causes break off of rock
Salt Weathering (mechanical)	• Seawater contains **salt** • When water **evaporates**, leaves salt crystals behind • In cracks/holes these crystals grow and **expand** • Puts **pressure** on rocks and flakes break off
Carbonation (chemical)	• Rainwater absorbs CO_2 from air and becomes **slightly acidic** • Contact with alkaline rock (chalk) causes rock to **dissolve**

Mass Movement

Mass Movement – downward movement or sliding of material under the influence of gravity.



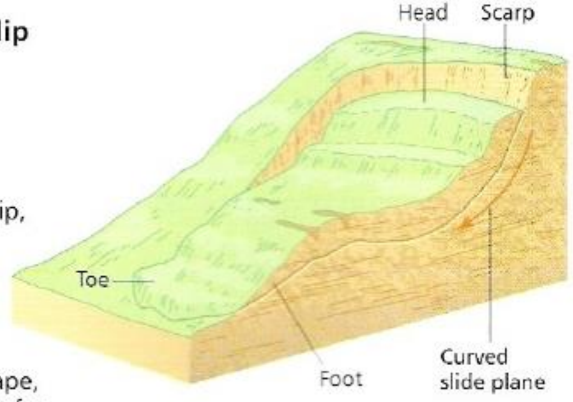
Rockfall is the rapid, free-fall of rock from a steep cliff face. Rock fragments fall from the face of the cliff because of the action of gravity. This is made worse by freeze-thaw action loosening the rock. Bare, well-jointed rock is very vulnerable to rockfall - water enters the joint, freezes and expands, cracking the rock. A scree slope of fallen rock is formed at the bottom of the cliff.

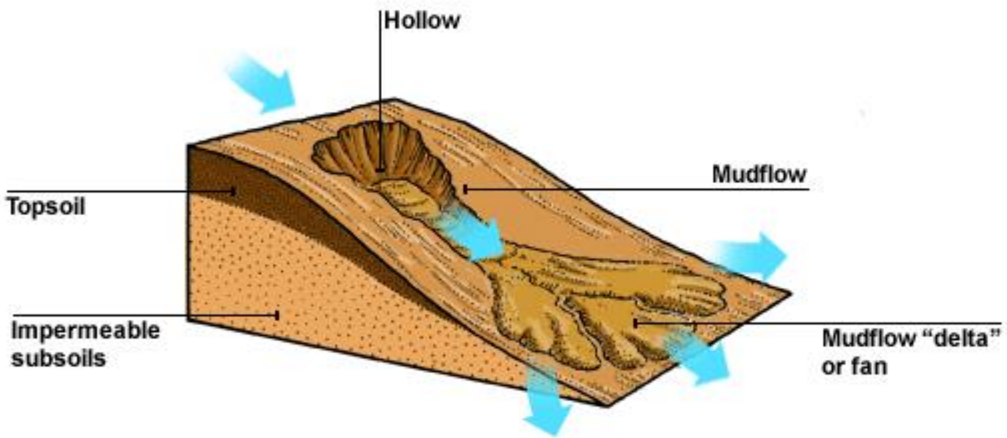


Landslips or landslumps are occasional, rapid movements of a mass of earth or rock sliding along a concave plane. They can occur after periods of heavy rain, when the water saturates overlying rock, making it heavy and liable to slide. Undercutting of a steep slope by river or sea erosion weakens the rock above, also making a slump likely.

c Rotational slip

A rotational slip, or landslip, differs from a landslide in that the slide plane is concave in shape, causing more of a rotational movement.





Mudflow occurs on steep slopes over 10°. It's a rapid sudden movement which occurs after periods of heavy rain. When there is not enough vegetation to hold the soil in place, saturated soil flows over impermeable sub soil, causing great devastation and endangering lives.

Coastal Erosion

There are several different processes of coastal erosion:

Solution
The dissolving of soluble chemical rocks e.g. limestone.

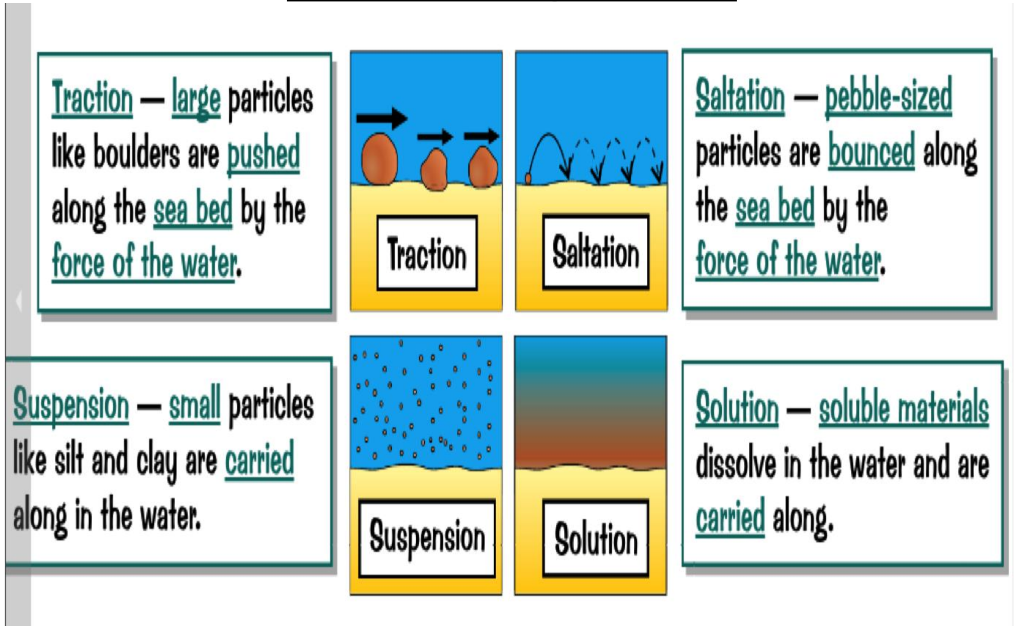
Attrition
Rock fragments carried by the sea knock against one another causing them to become smaller and more rounded.

Hydraulic Power
Power of the waves as they smash into the cliffs. Trapped air forced into holes/crack in rock, eventually causing it to fall apart. This is called ***cavitation***.

Corrasion
Fragments of rock are picked up and hurled by the sea at a cliff. The rocks act like tools; scraping and gouging to erode the rock.

Abrasion
Sandpapering effect of pebbles grinding over a rock platform, often causing it to become smooth.

Coastal Transportation



Longshore Drift – Sediment moved along the beach in a zigzag pattern. Forms spits and beaches.

Coastal Deposition – Sediment moved along the beach in a zigzag pattern. Forms spits and beaches.

Coastal Erosion Landforms

Landform – a feature of the landscape that has been formed or sculpted by either erosion, transportation or deposition.

Factors Influencing coastal landforms:

- **Tough rocks** create cliffs and headlands as they are **resistant** to erosion (e.g. chalk and granite)
- **Softer rocks** form bays as more **easily eroded** (e.g. clay and sands)
- **Geological structure –** way rocks are folded and tilted
- **Faults –** cracks in rocks
- **Tectonic pressures** can cause rocks to **snap** rather than fold
- Faults form lines of **weaknesses** in rocks, easily carved out by the sea

Headlands and Bays

Different types of rock at the coastline will erode at **different rates**.
Weaker bands of rock (e.g. clay) erode more easily to form ***bays***.
As bays are sheltered, **deposition** takes place and sandy beaches form.
Tougher bands of rock are eroded much more slowly.
They stick out into the sea to form ***headlands***.

Remember:

- Cliffs, meanders and deltas are all **landforms**
- **Processes** (e.g. longshore drift) are **not** a landform
- A **geological feature** is **not** a landform

Coastal Erosion Landforms

Cliffs and Wave-Cut Platforms

1. When waves break against a cliff, **erosion** close to the high tide line will wear away the cliff to form a ***wave-cut notch***.
2. Over a long period of time, notch becomes deeper until it **undercuts** the cliff.
3. Eventually, cliff cannot support its own weight and it **collapses**.
4. A continual sequence of this will see the cliff gradually retreat and will be replace with a **wave-cut platform**.
5. **Wave-cut platform** – gentle, sloped platform that is typically quite smooth due to abrasion. May be scarred with rock pools.

Caves, arches and Stacks

- **Lines of weakness** in a headland are very vulnerable to erosion.
- Energy of the waves wears away the rock at line of weakness to form a ***cave***.
- Overtime, erosion may lead to **back-to-back caves** that breakthrough to form an ***arch***.
- **Arch** is gradually enlarged by erosion at the base by weathering processes acting on the **roo**f.
- Eventually, roof will wear away to form isolated pillar of rock called a ***stack***.

Coastal Deposition Landforms

Beaches

Beach – deposits of sand and shingle at the coast.

Sandy beaches are mainly found in **sheltered bays**. The waves entering the bay are **constructive waves**. They have a strong swash and build up the beach.

Pebble beaches are found in high-energy environments where finer sand is **washed away** and pebbles are left behind. These mostly come from nearby eroded **cliffs**.

Bars

Bar - longshore drift causes a spit to grow right across a bay, trapping a **freshwater lake**.

An offshore bar forms further out to sea. Waves **deposit** sediment due to **friction** with seabed.

Build-up of **sediment** offshore causes waves to break at some distance from the coast.

Spits

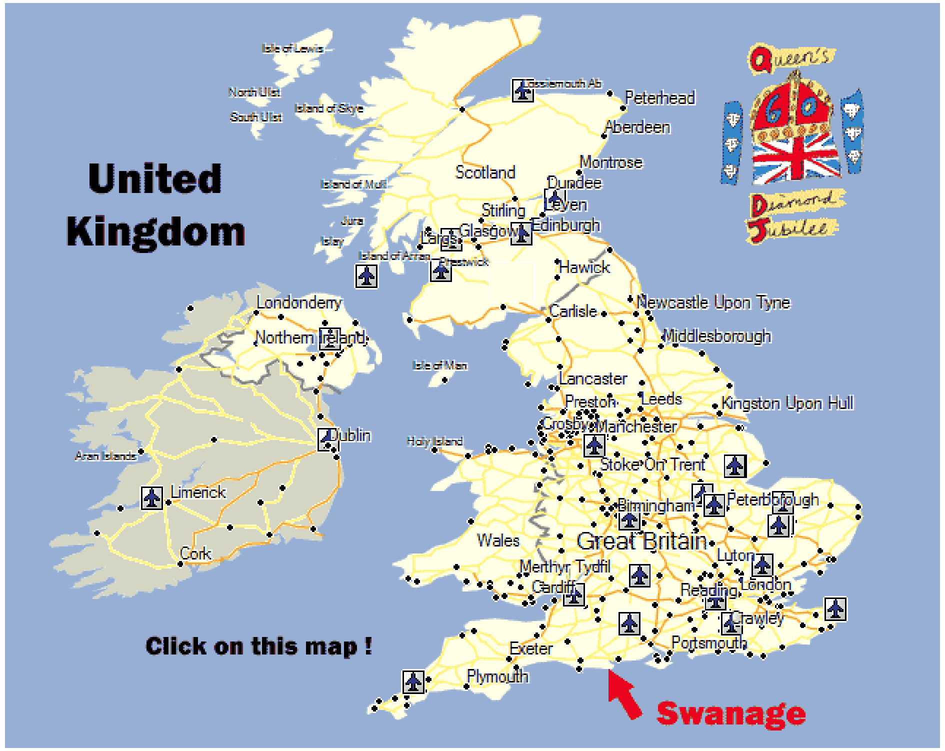
Spit – long, narrow finger of **sand or shingle** jutting out into the sea from the land.

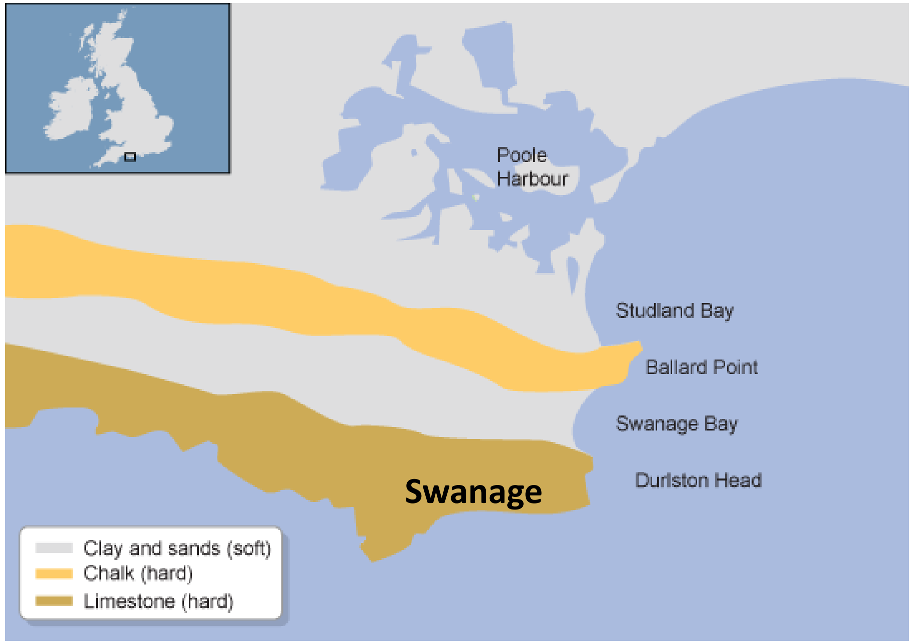
Form on coasts where there is significant **longshore drift**. If coastline changes orientation and bends sharply, sediment is then **deposited** out to sea. As it builds up, it forms an extension from the land. Strong winds or **tidal currents** can cause end of spit to become curved. This is called a ***recurved end***.

In **sheltered water** behind the spit, deposits of mud build up. Extensive **saltmarsh** has formed as vegetation has started to grow in the mud. Saltmarshes are extremely important **wildlife habitats**.

Coastal Landscapes

Case Study - Swanage





The rocks on in Swanage have been **folded and tilted** so that bands of different rock types reach the coast.

Headlands and bays form where are **alternating bands** of more and less resistant rocks.

Seaside town in **Dorset** on the **south coast** of England.

In a **sheltered bay** and has a broad **sandy** beach.

Has many **landforms** of coastal erosion and deposition.

Discordant coastline – an indented coastline.
Concordant coastline – relatively straight section of coastline.

To the north of Swanage is **Poole Harbour**, a natural harbour. Large amounts of deposition has taken place in this large **sheltered bay**. There are **2 spits** at mouth of the harbour.

At **Stutland**, there are lagoon, saltmarshes and sand dunes. The area is known for its wildlife.

Managing Coasts

Coasts need to be managed so a **balance** can be formed between the needs of people and forces of nature. People living at the coast need to be **protected** from flooding, especially as sea levels are expected to rise.

Soft-Engineering

1. Try to work with **natural** coastal processes
2. Tend to be **cheaper** than hard engineering
3. May require more **maintenance**
4. Generally more **sustainable** and are the **preferred** option

Management Options

Hard Engineering – using artificial structures to control natural processes.

Soft Engineering – less intrusive, more environmentally-friendly methods that work with natural processes.

Managed Retreat – Allows controlled retreat of coastline, often allowing sea to flood over low-lying land.

Hard-Engineering

1. Been used for **centuries**
2. **Controls** actions of sea and protects property
3. **Examples:** sea walls, groynes, rock armour and gabions.

Managing Coasts – Hard Engineering

Name	Description	Cost	Advantages	Disadvantages
Groynes	Timber or rock structures built out to sea. Trap sediment being moved by longshore drift and enlarge the beach. Wider beach acts as buffer to reduce wave damage.	£150,000 each (at every 200m)	• Wider beach popular with tourists • Useful structures for fishermen • Not too expensive	• Interrupting longshore drift starves beaches further along coast. Increased erosion elsewhere.
Rock Armour	Piles of large boulders dumped at foot of a cliff. Rocks force waves to break, absorbing their energy and protecting cliffs.	£200,000 per 100m	• Cheap and easy to maintain • Often used for fishing	• Can be expensive to transport rocks • Does not fit with local geology
Gabions	Wire cages filled with rocks that can be built to support a cliff or provide buffer against the sea.	Up to £50,000 per 100m	• Cheap to produce and flexible design • Can improve drainage of cliffs	• Unattractive • Cages last 5-10 years before they rust out
Sea Wall	Concrete/rock barrier against the sea, placed at foot of cliffs of at top of beach. Curved face to reflect waves back to the sea.	£5000-10,000 per metre	• Effective at stopping the sea • Has walkway for people to walk on	• Very expensive and high maintenance

Managing Coasts – Soft Engineering

Name	Description	Cost	Advantages	Disadvantages
Beach Nourishment	Addition of sand or shingle to an existing beach to make it higher or wider. Sediment is usually obtained offshore locally so it blends with existing beach material.	Up to £500,000 per 100m	• Cheap and easy to maintain • Blends in with existing beach • Increases tourist potential by creating bigger beach	• Needs constant maintenance
Dune Regeneration	Sand dunes are effective buffers to the sea. Easily damaged by trampling. Marram grass can be planted to stabilise dunes. Fences can be built to stop people walking on them.	£200-£2000 per 100m	• Maintains natural environment • Popular with people and wildlife • Relatively cheap	• Time-consuming to plant grass and fence off areas • Damaged by storms • People may enter fenced-off areas
Dune Fencing	Constructed on sandy beaches along seaward face of existing dunes. Encourages new dunes to form which protect existing dunes.	£400-£2000 per 100m	• Minimal impact on natural systems • Can control public access to protect other ecosystems	• Can be unsightly • Regular maintenance needed • Can be damaged by storms

Managing Coasts – Managed Retreat

Managed retreat – Allows **controlled retreat** of coastline, often allowing sea to flood over low-lying land.

Form of **soft engineering** as it allows natural processes to take place.

In the long-term it is a more **sustainable** option. As sea levels rise, it is going to become an increasingly popular option.

Evaluation Point
Some experts argue that managed retreat does not consider **impact** on local people.

There may be a **long-term impact** on: tourism, trade, infrastructure and businesses, as well as rehousing costs.

Case Study – Medmerry, near Chichester, West Sussex

- Flat, **low-lying coastline** mainly used for farming and caravan parks.
- Land used to be protected by a **low sea wall** but in need of repair.
- Building a new sea wall a **very expensive** option.
- Land was of **low value** so sea was allowed to break through current defences.
- Cost **£28 million** and controlled breaching of sea wall took place in **November 2013**
- Scheme will eventually: create a new saltmarsh, help protect surrounding farmland, establish wildlife area

Managing Coasts – Lyme Regis

Lyme Regis is a small coastal town on the south coast of England. It is famous for its **fossils** and is a popular tourist destination.

Issues

- Town built on unstable cliffs
- Rapid coastline erosion
- Many properties destroyed
- Sea wall breached many times

How is it being managed?

Lyme Regis Environmental Improvement Programme set up in early 1990s to provide long-term coastal protection and reducing the threat of **landslips**.

To **reduce conflict** between community groups (property owners, farmers etc), there were **consultation meetings** where the public were kept informed about construction work.

Phase 1 (1990s-2000s)

- New sea wall and promenade constructed
- 2003-4: £1.4million emergency project completed to stabilise cliffs
- Hundreds of large nails used to hold rocks together and improve drainage

Phase 2 (2005-7)

- Construction of new sea walls
- Wide sand and shingle beach created to absorb wave energy
- Extension of rock armour at The Cobb to absorb wave energy

Phase 3 (not undertaken)

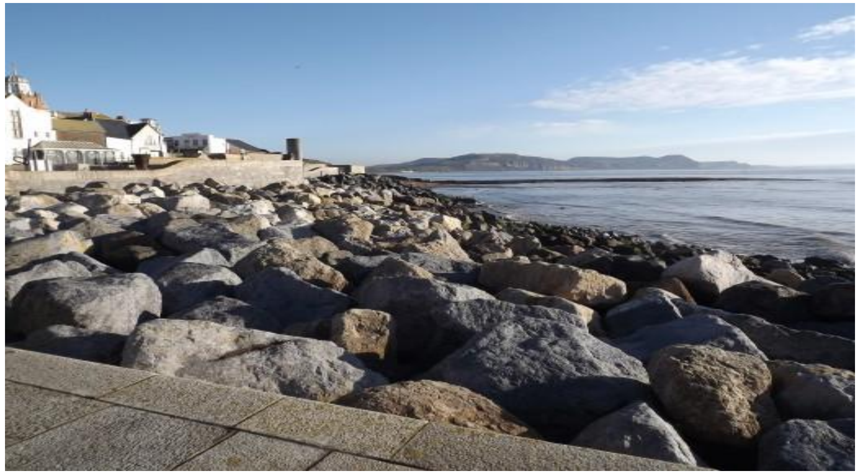
- Plan to prevent landslips was seen to be too costly for the benefits

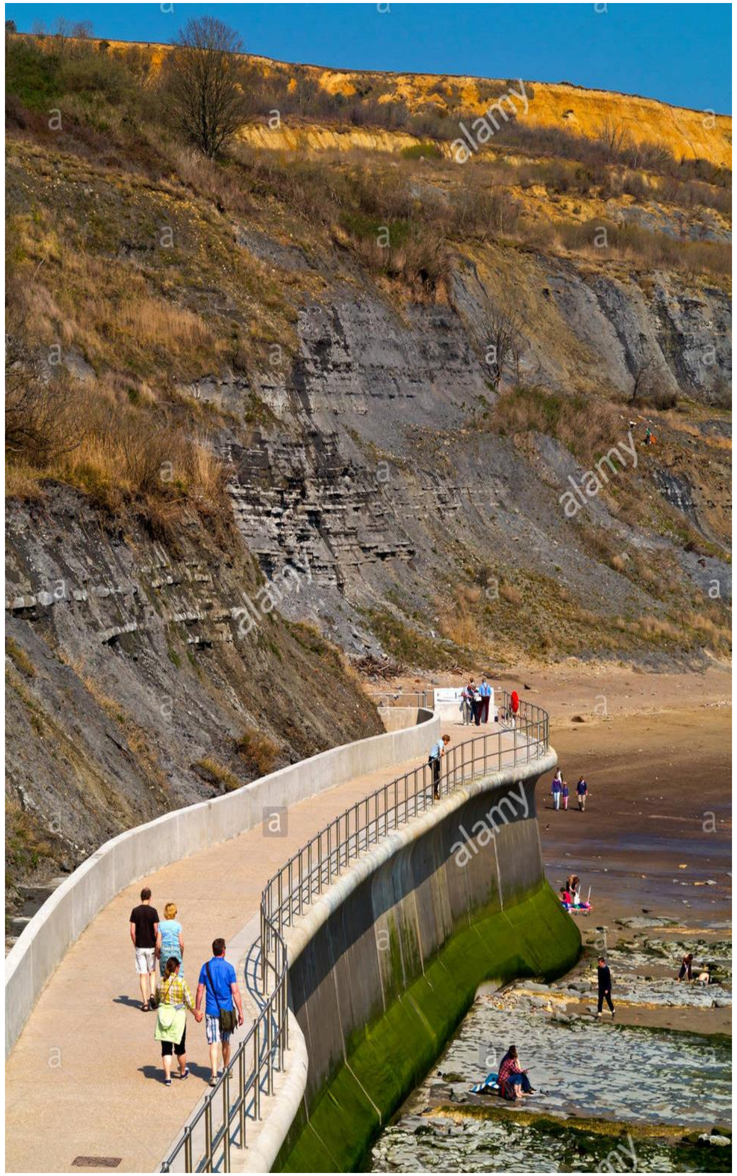
Phase 4 (2013-15)

- New 390m sea wall in front of existing wall
- Extensive nailing, piling and drainage to provide cliff stabilisation and protect 480 homes

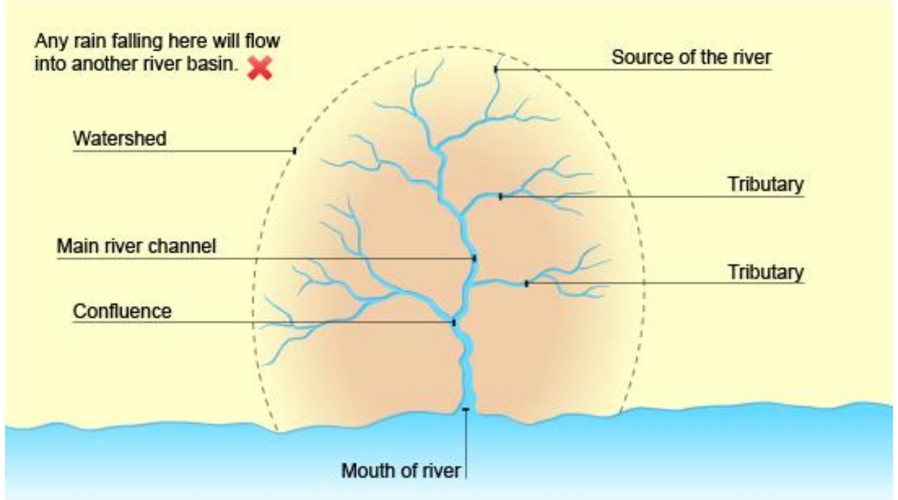
Managing Coasts – Lyme Regis

Positive Outcomes	Negative Outcomes
• New beaches have increased visitor numbers and seafront businesses are thriving. • New defences have resisted recent winters. • Harbour is better protected which benefits boat owners and fishermen.	• Increased visitor numbers have led to traffic congestion and increased litter. • Some believe the new defences are an eyesore and spoil the natural landscape. • New sea wall may interfere with coastal processes and affect neighbouring areas of coastline. • Stabilising cliffs will prevent landslips that could uncover important fossils.

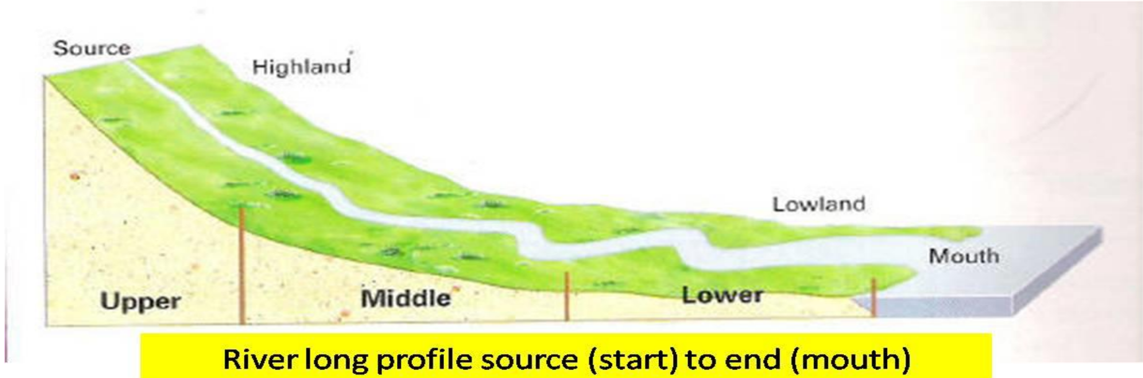




Rivers



Drainage Basin – area of land drained by a river or its **tributaries**.



River long profile source (start) to end (mouth)

Key Terms

Watershed – edge of river basin
Source – start of the river
Tributary – small stream that joins larger river
Confluence – where a tributary joins a larger river
Mouth – end of a river, where it joins the sea

Long Profile of a River

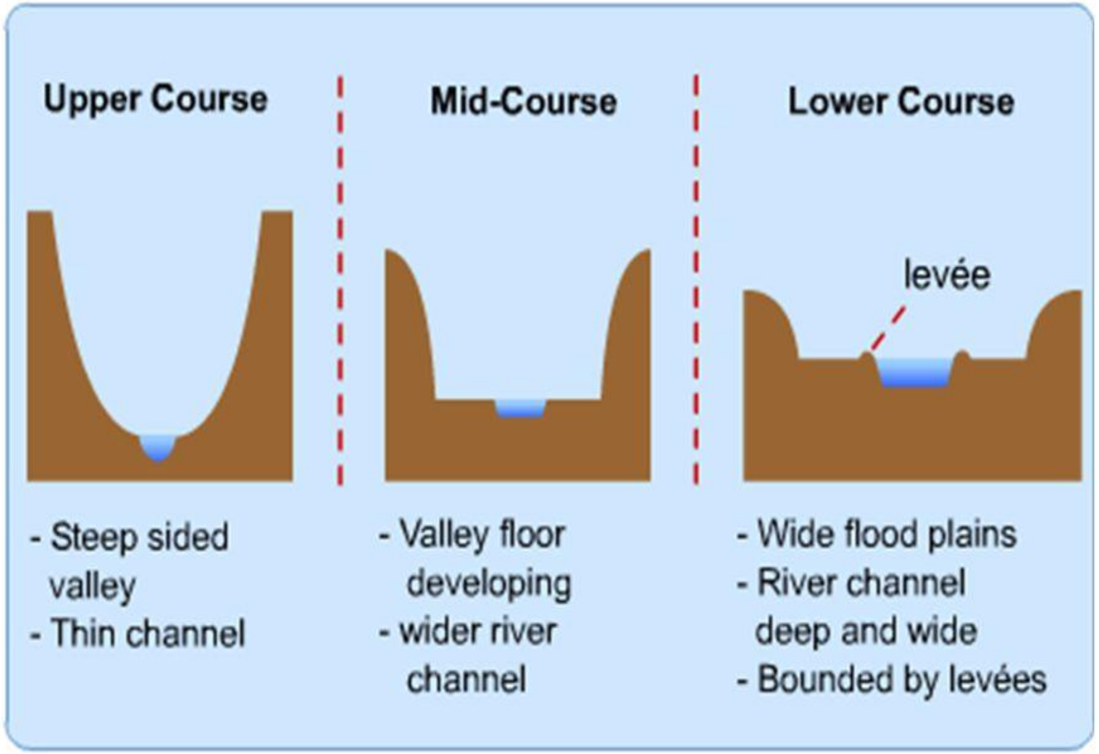
Near the **source**, a river flows over steep slopes with an **uneven** surface. It often flows over a series of waterfalls and rapids. Highland areas are usually composed of **hard igneous rocks**, which are ideal for forming such features.

As a river flows down steep slopes the water performs **vertical erosion**. This form of erosion cuts down towards the river bed and carves out steep-sided V-shaped **valleys**.

As the river flows towards the **mouth**, the slopes become less steep. Eventually the river will flow over flat land as it approaches the sea.

Cross Profile of Rivers

Cross profile – imaginary slice across a river channel and its valley at a particular point.



Cross Profile of a River

Near the source of a river there is more **vertical erosion** as the river flows downhill, using its energy to overcome **friction**. As a result the channels are **narrow and shallow** and may contain large boulders and angular fragments eroded and weathered from the steep valley sides.

The **sediment** in the river creates **turbulence and friction**.

As the river approaches the mouth, velocity and energy increase due to **increased discharge**. The river performs more **lateral erosion** making the channel wider, and smoother and .

As a result there is less turbulence and friction, making the flow of water more **efficient**.

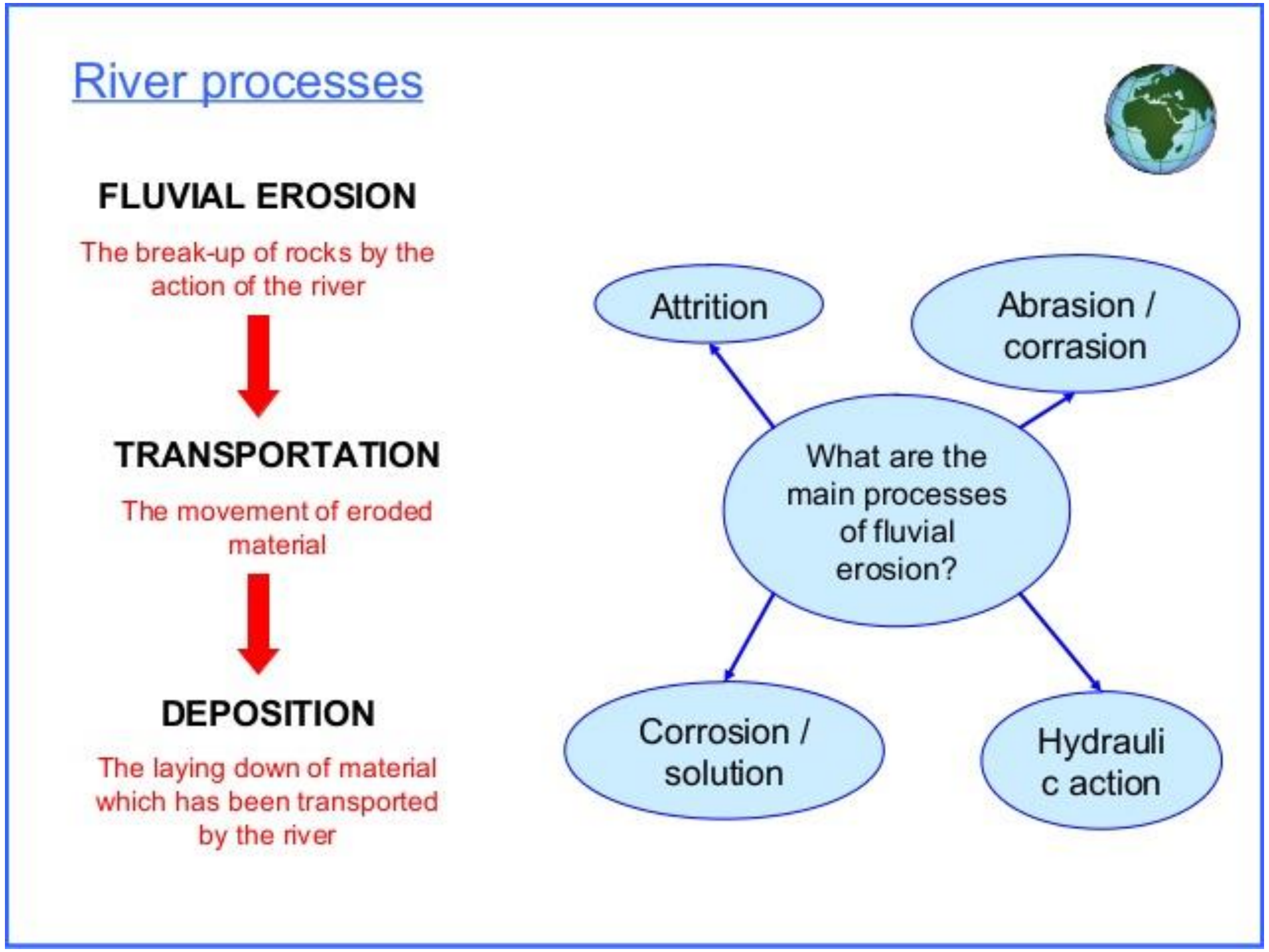
Fluvial (River) Processes

Cross profile – imaginary slice across a river channel and its valley at a particular point.

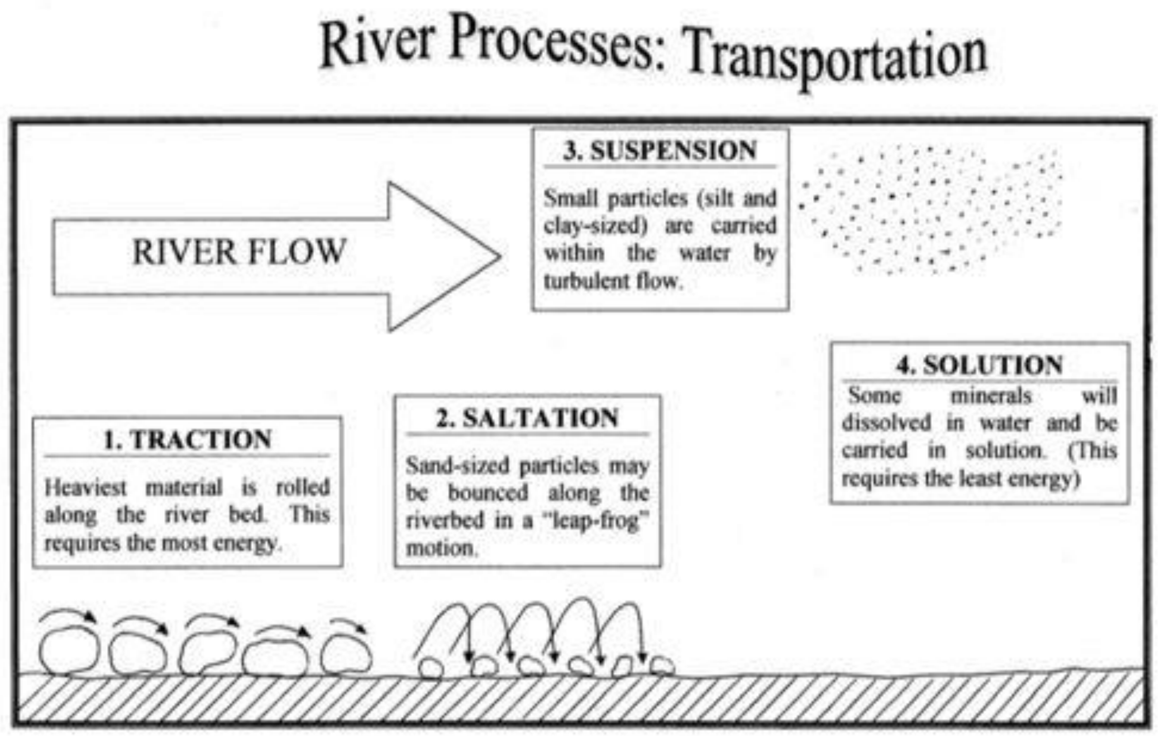
Vertical erosion – downwards erosion
Lateral erosion – sideways erosion

Definitions

- **Hydraulic Action**
This process involves the force of water against the bed and banks.
- **Abrasion/Corrasion**
This is the process by which the bed and banks are worn down by the river's load. The river throws these particles against the bed and banks, sometimes at high velocity.
- **Attrition**
Material (the load) carried by the river bump into each other and so are smoothed and broken down into smaller particles.
- **Solution**
This is the chemical action of river water. The acids in the water slowly dissolve the bed and the banks.



Fluvial (River) Processes



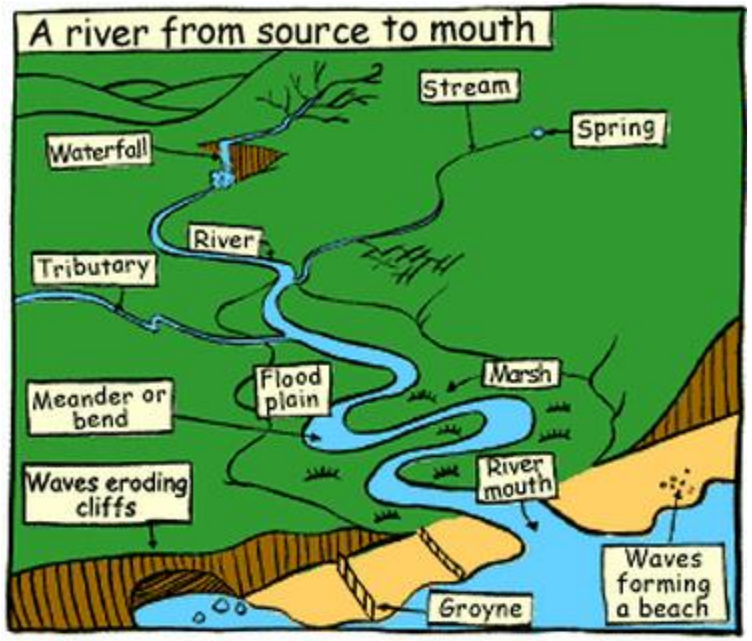
Size and total amount of load that be carried will depend on river's rate of flow – its **velocity**.

Fast flowing water is muddy as **velocity** picks up sediment. Slow flowing water is clear as little settlement is **transported**.

When does deposition occur?

- Occurs when **velocity** of river **decreases**
- No longer has enough energy to transport its sediment, so it's **deposited**
- Larger rocks deposited in **upper course** of river
- Only transported for very short distances, mostly by **traction**
- During periods of very high flow
- Finer sediment is carried further downstream mostly held in **suspension**
- Material will be deposited on river bed and banks when velocity is slowed by **friction**
- Large amount of deposition occurs at **river mouth**
- Interaction with tides with **gentle gradient** greatly reduced the river's velocity.

River Erosion Landforms



Upper course – erosion dominated to form landforms such as **interlocking spurs, waterfalls and gorges**.

Middle course – erosion and deposition combine to form **meanders and ox-bow lakes**.

Lower course – deposition dominates to form a **floodplain, levees and the river estuary**.

Interlocking Spurs – outcrops of land along a river course in a valley.

Near its source, the river doesn't have enough **power** to cut through these spurs and so flow around them.

Gorge – narrow, steep-sided valley found **immediately downstream** of a waterfall.

Formed by **gradual retreat** of a waterfall over hundreds or thousands of years.

Can also form from the **collapse** of underground caverns or melting glaciers (e.g. like at the end of the last glacial period)

River Erosion Landforms

Waterfalls – water falling from a height over a steep rock face.

When water flows over harder rock, it takes a long time to **gradually erode** the rock. This erosion forms **'steps'** in the long profile of the river and creates waterfalls.

When a river plunges over a waterfall it forms a deep and turbulent ***plunge pool***. Here, **abrasion and hydraulic action** are active and undercut the waterfall. Eventually, the overhang of rock collapses and the waterfall **retreats**. Eventually, this will leave a **steep-sided gorge**.

Waterfalls can also be found in glacial hanging valleys.

Meander – wide **bends** of a river found mainly in lowland areas.

Constantly change their shape and position as a result of **lateral erosion and deposition** in the river channel.

The ***thalweg*** is the line of fastest flow (**velocity**) within the river. It swings from side to side causing erosion on the outside bend and deposition on the inside bend. This process causes meanders to **migrate** across the valley floor over time.

River Erosion Landforms

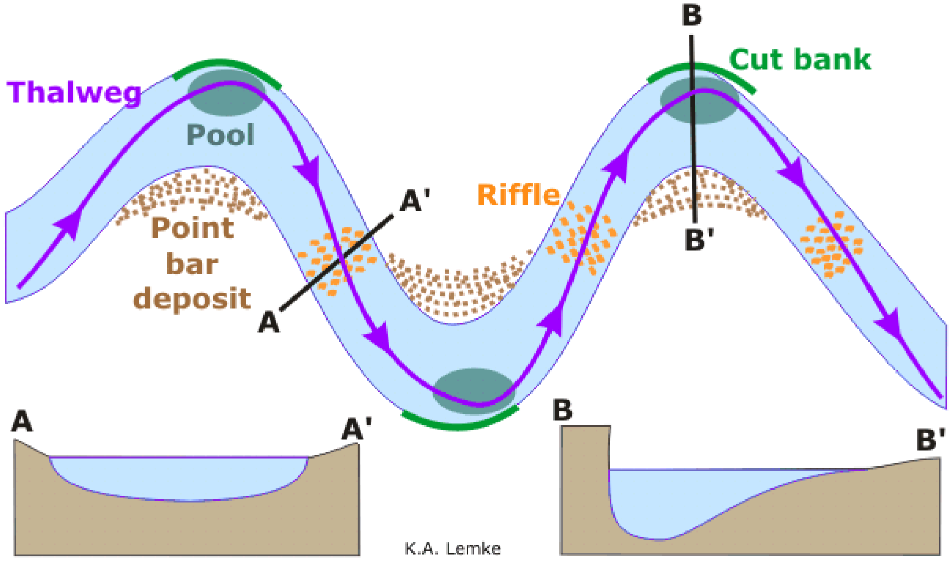
Pool – deeper, slow-moving section of a river.

Riffle – shallow, fast-moving section of a river.

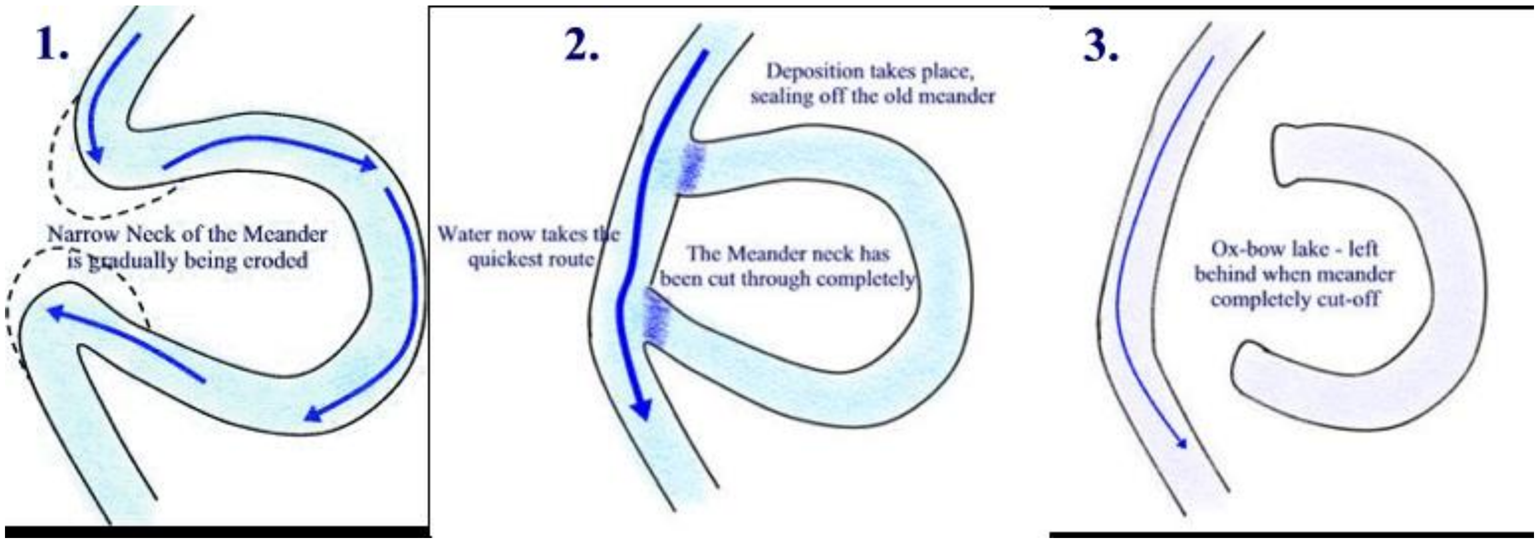
The faster-flowing **riffles** have deposits of coarser gravel and the calmer pools have **finer deposits**.

Pools develop close to **outside bend** of the meander. In high flow conditions this if the path of the **thalweg** and where most **erosion** takes place.

Riffles form between meander bends where a drop in velocity where a drop in velocity leads to **deposition** of coarser sediment.



Ox-bow Lakes

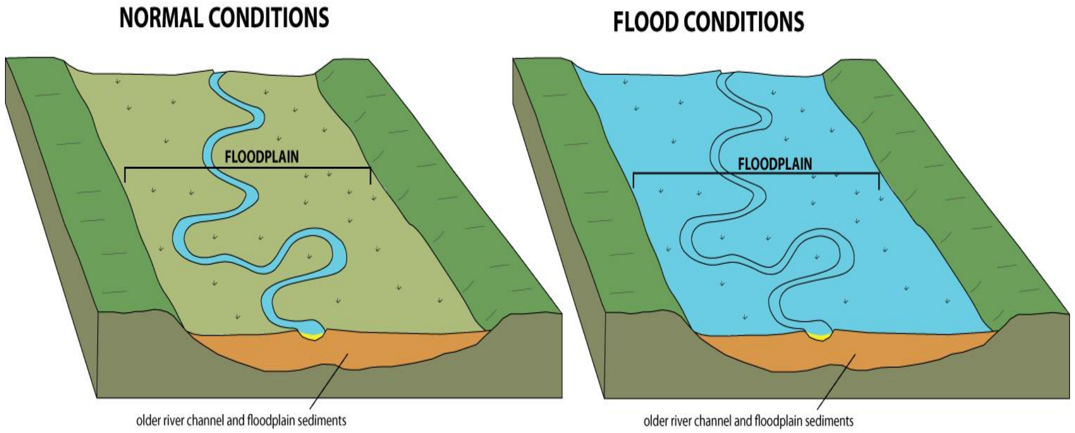


River Erosion Landforms

Floodplain – wide, flat area of marshy land on either side of a river.

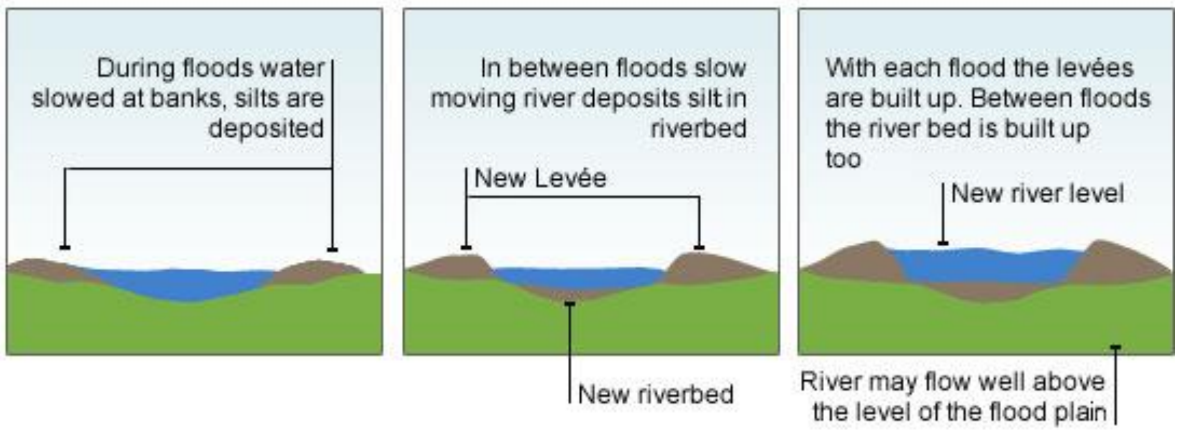
Mainly made of ***alluvium***, a sediment deposited by a river when it floods. This areas is **very fertile** so used for farming.

Meanders **migrate** across floodplain due to **lateral erosion**. When they reach the edge of the floodplain they erode the valley side. This is why floodplains are **wide**.



Levee – raised river bed found alongside a river in its lower course.

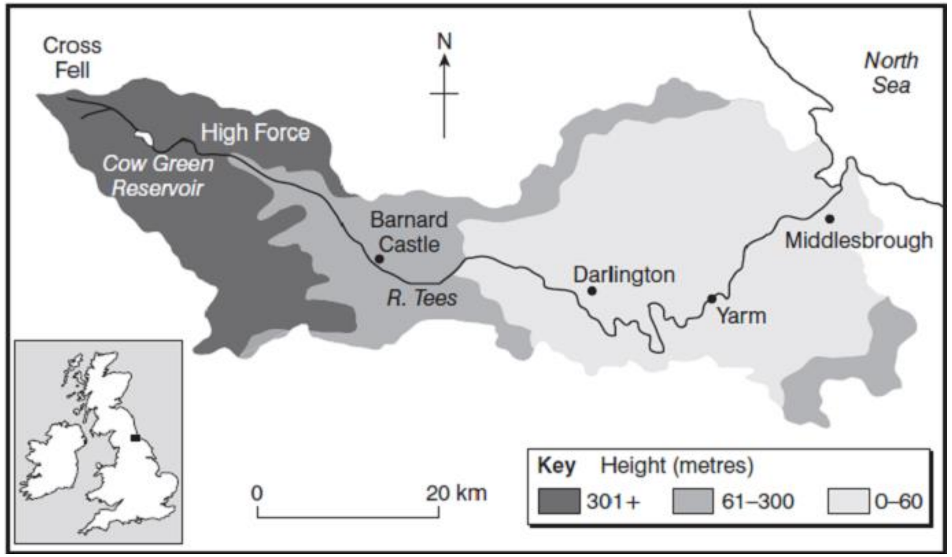
Formed by flooding over many years and a ridge of deposited sediment natural builds up the levees.



Estuaries – transitional zones between river and coastal environments.

They are affected by **wave action** as well as river processes. During a rising tide, river water is unable to be **discharged** into the sea. The **velocity falls** and sediment is deposited. At low tide, these deposits form ***mudflats***.

River Landforms – River Tees



The River Tees is a river in the **north east** of England. Its source is in the **Pennine Hills** (893m) and flows for around 128km to reach the **North Sea**.

High Force Waterfall and Gorge

- High Force waterfall is located close to Forest-in-Teesdale in the upper course of the river.
- River drops around **20m**.
- Continues through a **gorge**.
- Water was formed due to a hard band of **igneous rock** called ***dolerite***.
- Underlying rock is **limestone** which is weaker than dolerite.
- As the rive plunges over the waterfall, it **undercuts** the limestone to form an overhang.
- Collapses and waterfall retreats.

High Force Waterfall

River Tees meander

River Tees floodplain

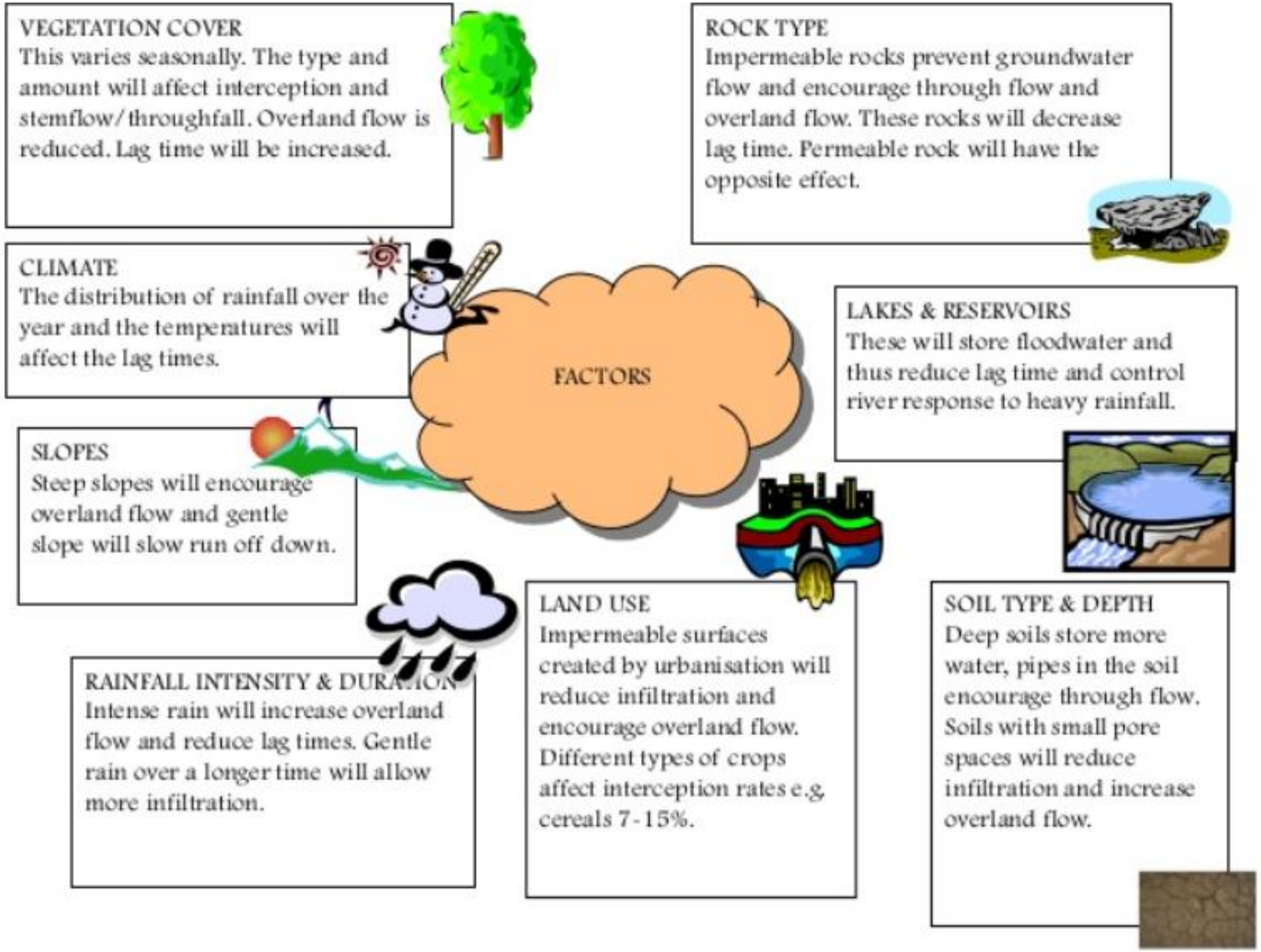
Factors Increasing Flood Risk

Flooding – where land that is not normally underwater becomes **inundated** (overwhelmed) with water.

River floods occur when a **river channel** can no longer hold the amount of water flowing through it. Water **breeches** the banks and floods the floodplain.

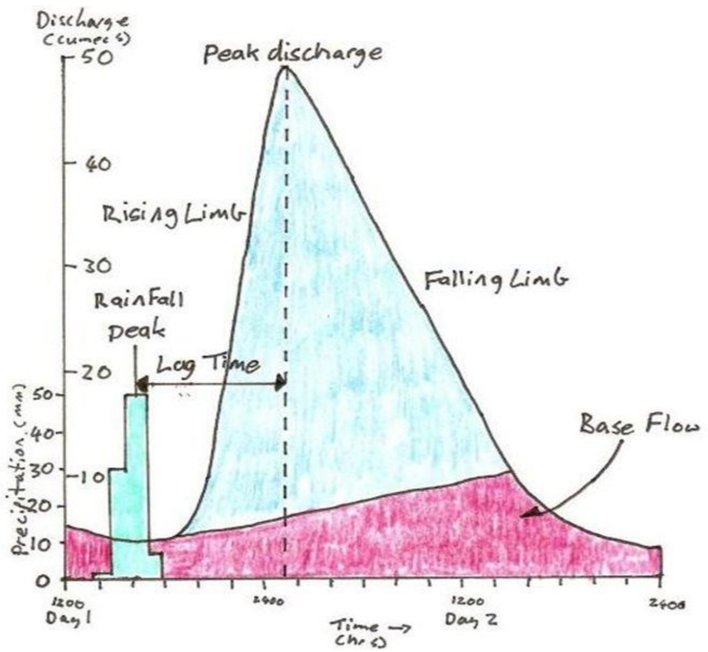
Floods usually occur after a long period of rainfall, often in the **winter**. Volume of water steadily increases until the channel can no longer cope.

Flash flood – sudden flood after a torrential storm.



River Landscapes

Hydrographs



- **Lag time** = time between peak rainfall and peak discharge.
- **Peak discharge** = point when river flow is highest.
- **Base flow** = water entering the river from beneath surface.
- **Rising limb** = part of graph when flow is increasing.
- **Falling limb** = part of graph when flow is falling.

Hydrograph – graph that plots **river discharge** after a storm.

It shows how discharge rises after a storm, reaches its peak and then returns to the normal rate of flow.

Time Lag – time (hours) between highest rainfall and highest discharge.

This shows how quickly water is transferred into river channel and is a key factor in flood risk. **Short time lag = greater risk of flooding.**

Characteristic	Short lag time, high peak	Low hydrograph, low peak
Basin Size	Small basins = rapid water transfer	Large basins = slow water transfer
Drainage Density	High density speeds up water transfer	Low density has a slower water transfer
Rock Type	Impermeable rocks = rapid overland flow	Permeable rocks encourage slow transfer by groundwater flow
Land Use	Urbanisation encourages rapid water transfer	Forests slow down water transfer because of interception
Relief	Steep slopes = rapid overland flow	Gentle slopes = slow down water transfer
Soil Moisture	Saturated (wet) soil = rapid overland flow	Dry soil soaks up water and slows water transfer
Rainfall Intensity	Heavy rain may exceed infiltration capacity of vegetation and lead to rapid overland flow	Light rain will transfer slowly and will soak mostly into the soil

Managing Floods – Hard Engineering

Hard engineering can be very **expensive**, but it is the preferred method of protecting land, homes, railway lines and water treatment works. The costs have to be weighed against the **benefits** in each case.

Costs – financial cost of the scheme, **negative impact** on environment and people's lives.

Benefits – financial **savings** by preventing flooding and environmental improvements.

Case Study – Clywedog, Wales

- Constructed in 1960s to prevent flooding of River Severn
- 70m high and 230m wide
- Stretches for 10km
- Fills up in the winter and is gradually released during the summer to keep a constant flow
- Some flooding still occurs further downstream

Method	Advantages	Disadvantages
Dam building Controls the discharge in the river by holding water back behind the dam in a reservoir.	By storing the water behind the dam in a reservoir it can be released to generate hydroelectric power.	Expensive to build When the dam is built settlements can be lost when the reservoir is created. Sediment is trapped behind the dam which can lead to erosion down stream
River engineering Widening or deepening the river channel	Altering the river channel will allow it to carry more water but it can be diverted to avoid vulnerable settlements.	Changing the river channel causes the water to be carried faster which increases the risk of flooding downstream.

Clywedog, Wales

Managing Floods – Hard Engineering

Name	**Description**	**Advantages**	**Disadvantages**
Channel Straightening	Involves cutting through meanders to create a straight channel. Some sections may be lined with concrete.	• Water flow sped up • Protects vulnerable areas from flooding • Concrete prevents banks from collapsing	• May increase flood risk downstream. • Problem isn't solved, just shifted elsewhere. • Very unattractive • Can damage wildlife habitats
Embankments	A raised river bank.	• River channel can hold more water before flooding occurs • Used often by towns to protect expensive property • Relatively cheap and sustainable	• Can be ugly • Banks often not built high enough
Flood Relief Channels	A man-made river channel constructed to by-pass an urban area.	• Flood water diverted in relief channel at time of high flow	• Expensive • Uses a lot of land

Managing Floods – Soft Engineering

Soft engineering aims to slow the movement of water into a river channel to help prevent flooding.

Floodplain zoning	Local authorities and the national government introduce policies to control urban development close to or on the floodplain.	• A very cheap way of reducing the risk of damage to property. • It is sustainable because it reduces the impact of flooding and building damage is limited. • Also because the floodplain has not been built on, surface runoff is less likely to cause flooding.	• There can be resistance to restricting developments in areas where there is a shortage of housing. • Enforcing planning regulations and controls may be harder in LICs.
Washlands 	The river is allowed to flood naturally in wasteland areas, to prevent flooding in other areas, for example, near settlements.	• Very cost effective as nothing is built. • Provides potential wetland sites for birds and plants. • The deposited silt may enrich the soil, subsequently turning the area into agricultural land.	• Large areas of land are taken over and cannot be built on. • Productive land can be turned into marshland.

Managing Floods – Soft Engineering

Soft engineering aims to slow the movement of water into a river channel to help prevent flooding.

Warning systems 	A network of sirens which give people early warning of possible flooding. The Environment agency uses TV, radio, email, fax, text and phone messages to keep people informed.	• A very cheap system. • Electronic communication is a very effective way of informing people. • Because the people have warning of floods they can move valuable belongings to a safer place.	• The sirens could be vandalised, so they are tested annually. • There might not be enough time for residents to prepare.
Afforestation 	Trees are planted in the catchment area of the river to intercept the rainfall and slow down the flow of water to the river.	• This is a relatively low cost option. • It improves the quality of the environment. • Soil erosion is avoided as trees prevent rapid run off after heavy rainfall. • Very sustainable.	• It is often conifers that are planted which can make the soil acidic. • Dense tree plantations spoil the natural look of the landscape. • It increases fire risks because of leisure activities in the forest.

Managing Floods at Banbury

Banbury is located in the Cotswold Hills, 50km north of Oxford.

Population of **45,000.**

On the **floodplain** of the River Cherwell, a tributary of the River Thames.

- Has a history of devastating floods.
- **1998 –** flooding led to closure of railway station, shut local roads and caused £12.5 million of damage. 150 homes and businesses affected.
- **2007 –** many homes and businesses affected by widespread flooding.

2012 – new flood defence scheme completed.

2.9km earth embankment build parallel to **M40** to create a **flood storage area**. Embankment has maximum height of 4.5m.

Flood storage area is located on natural floodplain of the River Cherwell.

Managing Floods at Banbury

Other Flood Defence Measures:

- Raising the A361 in the **flood storage area**
- Improvements to **drainage** beneath the road
- **Earth embankments** and **floodwalls** to protect property and businesses
- New **pumping station** to transfer excess rainwater
- Creation if **Biodiversity Action Plan habitat** with ponds, trees and hedgerows to absorb and store excess moisture.

Costs and Benefits of Scheme

Social	Economic	Environmental
• Raised A361 route will be open during a flood – **minimal disruption** to people's lives. • Local people's **quality of life** improved with new green areas and footpaths. • Reduced levels of **anxiety** over risk of flooding.	• Cost of scheme around **£18.5 million**. • Donors include: Environmental Agency and Cherwell District Council. • Benefits estimated at **£100 million** as 441 houses and 73 businesses protected.	• 100,000 tonnes of earth used to build the embankment. • Removal of earth led to creation of a small reservoir. • BAP habitat created ponds, trees and hedgerows. • Part of floodplain will be allowed to flood.