UKs physical landscape:

Uplands: in the north: Grampian mountains (steep + sparsely populated) & in the west: Snowdonia (has steep glaciated valleys)

Lowlands: in the south: Downs & Weald (wide valleys, agricultural land) & Cheshire plains (flat, fertile land for dairy farming; formed from deposition of sediment by glaciers)

UKs geology:

Igneous rocks in the north e.g. granite
Formation: magma in mantel cools & crystallises

Sedimentary rocks in the south e.g. clay
Formation: layers of sediment undergo lithification (compaction & cementation)
Limestone is formed from plankton, clay is made from mud = is softer

Metamorphic rocks in the north east e.g. schist & shale
Formation: when igneous rocks under high heat & pressure harden e.g. shale -> slate -> schist

Past tectonic processes:

Active volcanoes: 520 mil years ago, UK was closer to a plate boundary where magma was forced into the mantel & cooled = igneous rocks

Plate collisions: rocks were folded & uplifted, creating mountain ranges (uplands) e.g. in the Lake District and high heat & pressure = metamorphic rocks formed in northern Scotland

Plate movements: UK was in the tropics & higher sea levels meant it was partly underwater (limestone formed in warm, shallow seas) e.g. in the Peak District
Chalks & clays formed in the south in swamps (are less erosion resistant = form lowlands)

Rock types:

Granite: erosion resistant (forms uplands), joints (cracks) weather away faster, impermeable so creates moorlands (waterlogged land & acidic soil)

Slate: layered = weak planes so although erosion-resistant, splits into thin slabs
Schist: has bigger crystals & splits into flakes
Both: form upland landscapes & are impermeable = waterlogged & acidic soils

Carboniferous limestone: carbonation weathering at joints = gorges + limestone pavements (flat land with deep cracks) form & is permeable = dry valleys & resurgent rivers form

Chalk: hard, forms escarpments (hills) in lowlands, is permeable = water flows through it & emerges as a spring
Clay: soft, easily eroded, forms wide flat valleys in lowlands, impermeable so water flows over the surface = rivers & streams

UKs ice coverage:

Glacial periods = UK covered in an ice sheet
Ice eroded landscapes = U-shaped valleys carved in Lake District
Material was deposited by glaciers (as they melted) so glacial melt water & deposits e.g. till (mixture of clay, sand & rocks) cover east England

Landscape-altering physical processes:

Weathering: the breaking down of rock
Erosion: the wearing away of rock e.g. ice eroded V-shaped valleys, causing U-shaped valleys
Post-glacial processes: ice melted = rivers are larger & erode landscape quicker
Slope processes: the mass movement of rock/sediment
Climate: cold = freeze-thaw weathering, warm = more rivers & streams

Upland landscape: Snowdonia
High rainfall & impermeable rocks = streams erode corries which are weathered further = scree slopes
Large U-shaped valleys eroded by ice = steep sides

Lowland landscape: The Downs & Weald
Flat area of clay is between 2 chalk escarpments
River Arun meanders on the impermeable clay, widening the valley floor
UKs wet climate: heavy rain causes flooding, deposits silt on the valley floor = flood plain is formed
Dry valleys (streams flow underground in permeable chalk) form during glacial periods (freeze-thaw weathering & glacial snow melts)

Human landscape processes:

Agriculture:
Clearing forest land for cattle
Hedgerows mark out fields

Landscapes & farming :

Arable: flat land with fertile soil for crops in east England
Dairy: warm & wet areas in the south are used for grass fields
Sheep: land stripped (young trees are eaten before they mature)

OS maps: shows field boundaries + drainage ditches & forestry plantations (+management)

Forestry:
Management of woodlands (for timber, recreation or conservation)
UK has limited deciduous woodland
Coniferous forests planted for timber have an unnatural landscape (trees planted in straight lines, felling strips land)

Settlement:
Land was concreted over for buildings & roads = drainage patterns were disrupted
Rivers diverted through underground channels (which were straightened/ had embarkments built to prevent flooding)
Main cities function as ports e.g. London & Manchester so underwent urbanisation

Weathering: the break down of rocks (where they are)

Mechanical:
1. Sea water gets into cracks
2. Water evaporates, crystals form
3. Cracks expand under high pressure

Chemical:
1. Sea water/ rain water = weak carbonic acid as has CO2 dissolved in it
2. Carbonic acid dissolves rock (made of calcium carbonate)

Biological:
1. Plants grow in cracks of rocks
2. Cracks expand

Mass movement: shifting of material down a slope (force of gravity acting on slopes is bigger than the one supporting it) = coats retreat rapidly

Slides: material shifts in a straight line
Slumps: material shifts with a rotation
Rockfalls: material breaks up & falls down the slope

Erosion: breaking down & movement of rocks

Hydraulic action:
1. Waves crash against rocks
2. Air is compressed in cracks
3. Pressure widens cracks

Abrasion: eroded material scrapes & chips away at other rocks

Attrition: eroded material smash against each other, pebbles get round & smoother

Coastal landforms:

Concordat coastlines: alternating bands of hard & soft rock are parallel to the coast, rocks erode at the same rate

Discordant coastlines: alternating bands of hard & soft rock are perpendicular to the coast, rocks erode at different rates (more erosional landforms)

Hard rocks e.g. limestone & chalk are more erosion-resistant but Soft rocks e.g. clay & sandstone are less erosion-resistant so are eroded at a faster rate

Joints & faults = cracks in rocks = faster erosion

Headlands & bays form on discordant coastlines: less resistant rock erodes faster = bay (have a gentle slope) & hard rock erodes slower = headland (have steep sides)

Wave-cut platforms:

1. Waves erode foot of cliff
2. Wave-cut notch is enlarged
3. Rock above notch is unstable & collapses
4. Collapsed material is washed away, new notch forms
5. Repeated collapsing = cliff retreats
6. Wave- cut platform left behind after cliff retreats

Headlands:

1. Waves crash into rocks, enlarging cracks via hydraulic action & abrasion
2. Cave forms
3. Cave is deepened into an arch (it breaks through the headland)
4. Arch collapses
5. Stack formed (isolated from the headland)

E.g. Old Harry in Dorset

UK's climate's impact on erosion:

Warmer Summers: increased salt weathering as H2O evaporates quicker
Cold winters: strong winds & destructive waves intensify storms
Spring: intense rainfall causes cliffs to become saturated = mass movement
Prevailing winds (warm south westerlies) bring storms from the Atlantic to the south coast & cold northerly winds are common in the East

Destructive waves:
High, steep & high frequency
Backwash is stronger than swash = material is removed from the coast
Storms = increase erosional power of destructive waves = increased rate of coastal retreat

Constructive waves:
Low, long & low frequency
Swash is stronger than backwash = material is carried up the coast
Deposit (via deposition) more material e.g. gravel than they erode

Deposition: material carried by sea water is dropped on the coast

Transportation via LSD:

1. Waves follow direction of prevailing wind, hitting the coast at oblique angles
2. Swash carries material up the beach
3. Backwash carries material down the beach at right angles
4. Zigzags form along the coast

Spits:

1. LSD transports sand past the bend (at the mouth of a river) & deposits it in the sea
2. Strong winds curve the end of the spit (a recurved end)
3. Material accumulates behind the spit (is protected from waves)
4. Plants grow
5. Becomes a mud flat or salt marsh

Bars:

1. Spit joins 2 headlands together
2. Bar cuts off the bay between the headlands from the sea
3. Lagoon forms behind the bar

Identifying landforms:

Erosional:

Caves & arches = can't be seen (due to rock above them)
Stacks = blobs in the sea
Cliffs: little black lines
Wave-cut platforms = bumpy edges along coasts

Depositional:

Sand beaches = pale yellow
Shingle beaches = white/yellow speckles
Spits = beach carries on out to sea & is attached to land + a sharp bend in the coast

Human activity at the coast:

Direct: immediate result of human activity e.g. coastal defences prevent erosion
Indirect: happen due to direct effects e.g. coastal defences prevent erosion in one place but can increase it further along the coast

Agriculture:

Land isn't protected as has low economic value, sea can erode cliffs = a direct effect
Changing use of farmland affects stability of cliffs:
1. Clearing vegetation from grazing land (to make room for crops) exposes soil & underlying rock = no vegetation to bind soil to stabilise cliff tops = vulnerable to weathering
2. Marshland is reclaimed & drained = reduces natural flood barrier

Development:

Coasts = popular for work & tourism so have infrastructure developed

1. Lots of settlement = more coastal defences (to protect property) = less coastal erosion (direct)
2. But building on coastal lowlands = restricts sediment supply to beaches so they narrow = less erosional protection

Industry:

Quarries expose rock = moe vulnerable to erosion
1. Gravel extraction (for construction) from beaches = less natural protection = more erosional risk
2. Industrial growth at ports = more pressure to build on salt marshes (for flat land & sheltered water = ideal) but removes natural flood defence

Coastal management:

1. Alter sediment movement = less protective beach material down the coat = erosion
2. Reduce erosion = direct effect as prevents coastal retreat

Holderness Coast case study:

Background:
East coast of England
61km long (Flamborough head -> Spurn head)
1.8m of land lost/annum via erosion
Cliffs made of boulder clay = less erosion resistant (slumps when wet = collapses)
Narrow beaches = lack coastal protection
Faces prevailing winds = winds from Norwegian Sea (waves increase in power = north-east is battered by highly erosive waves)
LSD moves material south = cliff is exposed = coastline retreats

Coastal defences:

11km protected by hard-engineering strategies due to settlement, B1242 road & a gas terminal which supplies 25% of UKs gas (on edge of cliff)
Groynes built at Mappleton & a sea wall at Hornsea

Indirect consequences of coastal defences:

Groynes protect local areas but narrow beaches form along the Holderness coast = greater erosion downwards (Great Cowden risks farmland & caravan parks falling into the sea)
Material from erosion of Holderness coast transported south to Humber Estuary -> Lincolnshire coast usually but less eroded material being transported = increased flooding risk in Humber estuary (less material to slow the floodwater down)
Rate of coastal retreat along Lincolnshire coast has increased as less material is being added
Bays are forming between protected areas = they're becoming headlands (are eroded more heavily) = maintaining defences is more costly

Coastal flooding:

Climate change = warmer temps = more areas of low pressure = more storms

Rising sea levels:
Threaten low lying coastal areas
Increase in sea levels = higher tides = flood coasts more frequently & more material is removed from beaches (more erosion as less natural protection)
Expose more coastline to erosion = narrower beaches as sea moves inland

Storm frequency:
Sea has more erosional power (soft rock erodes quicker) & energy to transport material further distances = areas without material are more vulnerable
Sea level rise = storm surges reach further inland

Social threats:

Flooding = destroys property
Coastal industries shut down = no local jobs
2014 storms in Dawlish = infrastructure damage
Less tourism = no livelihoods

Environmental threats:

Disruption to ecosystems: sea water has high salt content = kills animals & reduces fertility of agricultural land
Force of sea water uproots trees
Conservation areas are destroyed e.g. lagoon on Holderness coast are separated from the sea by a bar, if it erodes, the protected lagoons are destroyed

Coastal management:

Hard engineering: man made, interfere with natural processes (to control the flow of the sea)
Soft engineering: enhance natural protection
Both: reduce effects of flooding & erosion

Hard engineering:

Sea wall: concrete wall reflects wave energy
Pros: a barrier against flooding & prevents erosion
Cons: creates strong backwash (which erodes under the wall) & costly to maintain

Groynes: fences built perpendicular to the coast, they trap material transported by LSD
Pros: create wider beaches to slow waves = prevent erosion
Cons: starve beaches downwards so they narrow = more vulnerable to erosion

Soft engineering:

Beach replenishment: sand (from the lower seabed) is added to upper parts of the beach
Pros: creates wider beaches to slow waves, protects from erosion
Cons: taking sand from sea bed kills organisms, has to be repeated

Slope stabilisation: reinforcing slopes with concrete nails & metal netting
Pros: prevents mass movement by increasing the slope's strength
Cons: costly & difficult to install

Strategic realignment: removes existing defences, lets land behind flood
Pros: long term: land becomes marshland (new habitat) & behind the marsh, flooding is reduced
Cons: disagreements about which land is to be flooded e.g. flooding farmland effects farmer's livelihoods

Do nothing: erosion & flooding
Pros: free
Cons: infrastructure loss, no tourism, migration

Sustainability:

Defences have to be controlled so the coast further down doesn't flood, so workers & residents are happy & so tax payer money isn't 'wasted'
ICZM finds solutions to protect the coast & people's livelihoods so it's long term (can adapt to future needs & changes)

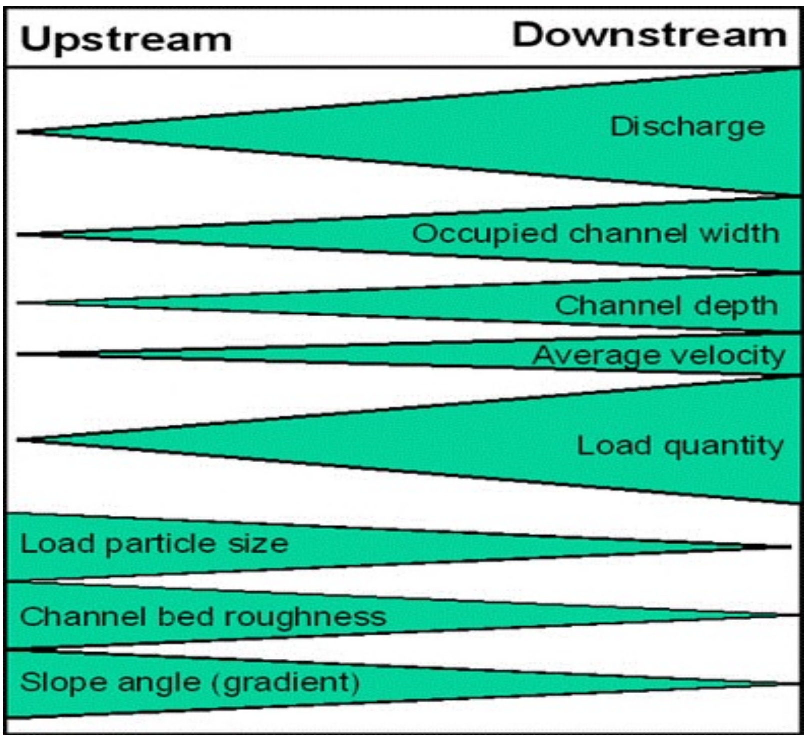
River landscapes:

Upper course: source
Steep gradient & channel is narrow & shallow due to vertical erosion
Large load size as limited erosion
V-shaped valleys due to vertical erosion (high turbulence so angular particles scrape along river bed, downwards)
Waterfalls: soft rock erodes faster, rapids develop via abrasion

Middle course:
Gentle gradient due to vertical & lateral erosion
Channel widens due to abrasion
Meanders: water's velocity increases

Lower course: mouth
Low gradient due to lateral erosion
Channel is widest with high load quantity: discharge & velocity increases (less friction from river bed due to abrasion)
Large discharge, sediment carried by suspension or solution
Flood plains due to deposition & deltas where river meets sea

E.g. the River Eden from Westmorland to Carlisle



River processes:

Weathering: breaks down rocks on valley sides

Freeze-thaw:
1. Water seeps into cracks of rocks
2. Water freezes & expands cracks
3. High pressure exerted on rock
4. Water thaws & contracts = pressure is released onto rock
5. Repeated process = rock breaks up

Erosion: in river channels

Hydraulic action: force of the water breaks particles away from the river channel
Abrasion: eroded rocks scrape at channel, wearing it away
Attrition: eroded rocks collide, particle size decreases towards the mouth (is transported further so is eroded more)
Solution: river water dissolves chalk & limestone

Transportation: how material is taken from source -> mouth

Traction: boulders pushed along river bed by water
Suspension: small particles e.g. clay carried by water
Saltation: rocks bounce along river bed due to force of water
Solution: soluble materials dissolve in water & are carried

Deposition:
River deposits (drops) material it's carrying as velocity decreases due to: volume of water falling, load quantity increasing, shallower water (inside bends) & river reaches its mouth

Erosional river landforms:

Waterfall:

1. Hard rock underlays soft rock at knickpoint
2. Soft rock erodes via abrasion = step forms
3. Hydraulic action erodes hard rock, deepening the step before it's undercut
4. Plunge pool forms
5. Notch forms
6. Overhang collapses as notch cannot support it
7. Gorge forms as waterfall retreats upstream

Interlocking spurs:

1. At upper course, rivers have low velocity so can't erode laterally
2. Water flows around sides of valleys
3. Hills interlock = interlocking spurs

Rapids:

1. Have multiple knickpoints
2. Soft rock erodes faster due to alternating velocity
3. Water is turbulent due to inconsistencies in flow

Meander:

1. Thawleg on outer bend (channel is deeper so less friction)
2. Abrasion occurs = river cliff
3. Helicoidal flow on inside of bend (slower current as more friction)
4. Eroded material deposited on inside of bend = slip-off slope

Ox-bow lakes:

1. Abrasion narrows neck of meander
2. Silt & clay build up due to flooding, neck is broken down
3. Channels separate = ox-bow lake

Depositional river landforms:

Flood plains: wide valley floor either side of river

1. River floods, velocity of water slows, material is deposited = flood plain is higher
2. Meanders migrate across the plain = wider flood plain
3. Meanders migrate downstream = valley floor flattens
4. Deposition on slip-off slopes (of meanders) builds up the flood plain

Levees: natural embankments along edges of river channel

1. Eroded material from floods deposited over flood plain
2. Heaviest, eroded material deposited closest to the river channel (gets dropped 1st, then slows down)
3. Deposited material accumulates = levees along edges of channel

Deltas: where river meets the sea

1. At the mouth, rivers lose velocity & deposit material when meeting with the sea
2. Material accumulates, blocking the channel (if sea doesn't wash it away)
3. Channel splits up into distributaries
4. Material builds up = low lying deltas form

Identifying river landforms:

Contour lines:
Numbers = height of land
Lines close together = steeper
River flows downhill (high to low contour lines)

Maps evidence landforms:

Upper course:
Waterfalls: close contour lines
High land & steep: concentrated contour lines
Narrow channel: thin line
V-shaped valleys: narrow valley floor, close contour lines

Lower course:
Gentle gradient: no contour lines
Meanders: across flood plain (no contour lines)
Wide channel: no contours on flood plain
Large meanders & ox-bow lake

Influences on river landscape & sediment load:

Climate:
Wetter climates = higher volume of water in the channel = high sediment load
High discharge = higher volume of water = more erosive power towards river bed = higher sediment load
Higher load size = more abrasion, forming:
V-shaped valleys via vertical erosion in upper course
Wide flood plains via lateral erosion in lower course
Transportation increases with higher discharge (river has more energy to carry material)
Weathering increases river's sediment load e.g. freeze-thaw weathering which increases likelihood of rock falls

Geology:
Hard rock = more erosion-resistant = lower sediment load = steeper valley sides
Soft rock = erodes faster = high sediment load = gently sloping valley sides
Waterfalls need layers of alternating rock
Interlocking spurs form when soft rock is eroded 1st, leaving hard rock sticking out

Slope processes:

Vertical erosion: valley sides are steeper so material moves down slopes
Mass movement adds to load quantity during cool, wet weather (freeze-thaw weathering & less rock stability)
Soil creep: soil moves down slopes due to gravity; water increases soil's weight = it expands & moves down the slope and when soil dries out, it contracts (adds fine material to river's load)

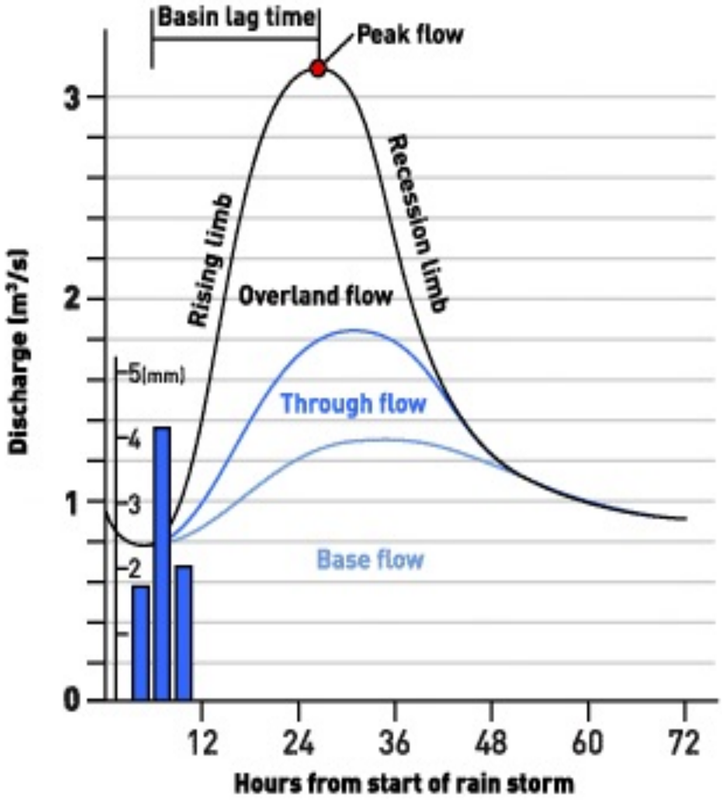
River discharge:

Volume of water that flows in a river/sec
(cubic metres/sec)

Storm hydrographs show changes in river discharge during storms

1. Peak discharge: highest discharge
2. Lag time: delay between peak rainfall & peak discharge
3. Rising limb: the increase in river discharge as rainwater flows into the river
4. Falling limb: the decrease in river discharge as the river returns to normal level

Lag time happens as: rainwater doesn't land directly in the river channel so there's a delay
Rainwater gets into channels by: surface run off, infiltration or flowing slowly underground



Factors affecting storm hydrographs:

Physical:
Geology: impermeable rocks = water can't infiltrate = more run off
Soil type: impermeable soils (clays) can't absorb as much water as sandy soils = increases run off + shallow soils = become saturated quicker than deeper soils
Slope: steeper = less infiltration = higher run off
Drainage basin type: circular = shorter lag time & higher discharge than narrow basins (more water reaches the main river channel at the same time), narrow = water from the far end of the basin takes ages to reach the main channel
Antecedent conditions: wet & cold weather increases run off as water cannot infiltrate saturated/frozen soil

Human:
Urbanisation: water can't infiltrate into impermeable surfaces (tarmac or concrete) = more runoff, gutters & drains rapidly take runoff to rivers = increases discharge
Deforestation: trees take up water from the ground & store it = reduces runoff, logging = more water enters channel = increases discharge + no trees to intercept water = shorter lag time

More water flows as runoff = reduced lag time = discharge increases = steeper hydrograph (higher volume of water in channel in shorter time)

River flooding:

Volume of water in river spills over its banks into the flood plain

River Eden that runs through North Cumbria = prone to flooding

Physical:

Cumbria is on the west coast of the UK = faces south-westerly winds (mild & wet climate) = high rainfall
Eden basin borders the Lake District & North Pennines = impermeable rock reduces infiltration = high surface run off into the channel
Snowfall during winter melts & adds water to the channel

Human:

Carlisle = built-up area on its flood plain with no vegetation for infiltration = high surface run off
Woodland & heathland have been cleared from uplands near the Eden basin = increases surface run off
Eden valley was drained for farming suitability, drainage ditches = water flows rapidly into the river channel

Interaction of human & physical factors lead to Dec 2015 Eden basin floods in Carlisle:

Antecedent conditions: Nov 2015 = 2nd wettest month recorded so soil was saturated & river discharge was high
Heavy rainfall: Storm Desmond = 300mm fell in 24hrs
Short lag time: rainwater across the drainage basin rapidly reached the main channel at Carlisle
Blockages: debris carried by floodwater blocked channels, forcing water out of the river channel
Insufficient drainage: runoff from impermeable surfaces ran into drainage systems but they overflowed, making the flooding worse

River flooding:

UK increase in flooding:

Increased storm frequency:
Climate change creates more low pressure systems
More intense rainfall due to intense storms
More wet weather = ground is saturated

Land use change:
Population growth = expanding urban areas = more impermeable surfaces (concrete & tarmac) = higher surface runoff & water flows downstream
Building developments on flood plains = risky if flood defences fail

Impacts of flooding:

Social:
Deaths & injuries due to debris
Infrastructure damage
Floodwater contamination = no clean drinking water = diseases
Homelessness/loss of livelihoods due to property damage

Environmental:
Floodwater contaminated with sewage pollutes rivers & damages habitat
Farmland ruined with silt & sediment deposited after floods
Eroded river banks = widens river channel = increase deposition downstream
Force of water uproots trees

River management:

Hard engineering methods: man made structures that control the flow of water to reduce flooding

Examples:

Flood walls: artificial barriers built across banks to increase their height = channels hold a greater volume of water but costly & visually polluting

Embankments: high banks built on river banks, stop water flowing into built-up areas on the floodplain, costly, risk of SEVERE flooding if they break

Floodgates: stop flooding from storm surges & high tides, built on river estuaries , can be shut to prevent flooding of large areas of land in response to surge forecasts, costly & high maintenance

Demountable flood barriers: temporary protection against flooding, only put up when there's a flood forecast (risk being too late), costly but no visual pollution

Soft engineering strategies: schemes utilising natural flood defences

Examples:

Flood plain retention: maintaining the flood plain (not building on it) so it can store water but restricts development & can't be done in urban areas (too risky with expensive infrastructure to protect)

River restoration: making the river natural e.g. by removing man-made levees = river floods naturally (less risk of flooding downstream as discharge is reduced), river is left in its natural state = little maintenance required but can increase local flood risk which has problematic social impacts & proves troublesome for local ecosystems