Syllabus: T.

Geographical enquiry	Geographical knowledge and understanding

1. Drainage basin hydrology and geomorphology

Suggested teaching time 6–8 hours

How physical processes influence drainage basin systems and landforms	The drainage basin as an open system with inputs (precipitation of varying type and intensity), outputs (evaporation and transpiration), flows (infiltration, throughflow, overland flow and base flow) and stores (including vegetation, soil, aquifers and the cryosphere). flow diagram hydrological cycle
	River discharge and its relationship to stream flow, channel characteristics and hydraulic radius. equations discharge HR Model CSA × mvs CSA/WP Trapezium Model
	River processes of erosion, transportation and deposition and spatial and temporal factors influencing their operation, including channel characteristics and seasonality
	The formation of typical river landforms including waterfalls, floodplains, meanders, levees and deltas. * diagram + explain

Erosion: Hydraulic Action, Attrition, Abrasion, Solution

Transportation: Traction, Solution, Saltation, Suspension

2. Flooding and flood mitigation

Suggested teaching time 6–8 hours

* Interpret * Draw * Explain

How physical and human factors exacerbate and mitigate flood risk for different places	Hydrograph characteristics (lag time, peak discharge, base flow) and natural influences on hydrographs, including geology and seasonality
	How urbanization, deforestation and channel modifications affect flood risk within a drainage basin, including its distribution, frequency and magnitude
	Attempts at flood prediction, including changes in weather forecasting and uncertainty in climate modelling
	Flood mitigation, including structural measures (dams, afforestation, channel modification and levee strengthening) and planning (personal insurance and flood preparation, and flood warning technology). * Soft / hard engineering
	• *Two contrasting detailed examples of flood mitigation of drainage basins* Pakistani Floods 2010 + Western European 2021

3. Water scarcity and water quality

Suggested teaching time 6–8 hours

* Define

The varying power of different actors in relation to water management issues	Physical and economic water scarcity, and the factors that control these including the causes and impacts of droughts, the distinction between water quantity and water quality
	Environmental consequences of agricultural activities on water quality, to include pollution (eutrophication) and irrigation (salinization)
	• *Detailed examples to illustrate the role of different stakeholders* Colorado
	Growing human pressures on lakes and aquifers, including economic growth and population migration
	Internationally shared water resources as a source of conflict. Colorado < USA, Mexico
	• *Case study of one internationally shared water resource and the role of different stakeholders in attempting to find a resolution*

* Physical Water Scarcity: when water consumption exceeds 60% of the usable supply
* Economic Water Scarcity: when a country physically has sufficient water to meet its needs, but requires add + storage and transport facilities

Stakeholders: eg...
- countries
- individual users
- agriculture
- culture/native
- government
- industry
- electric (hydro)
- tourism

4. Water management futures

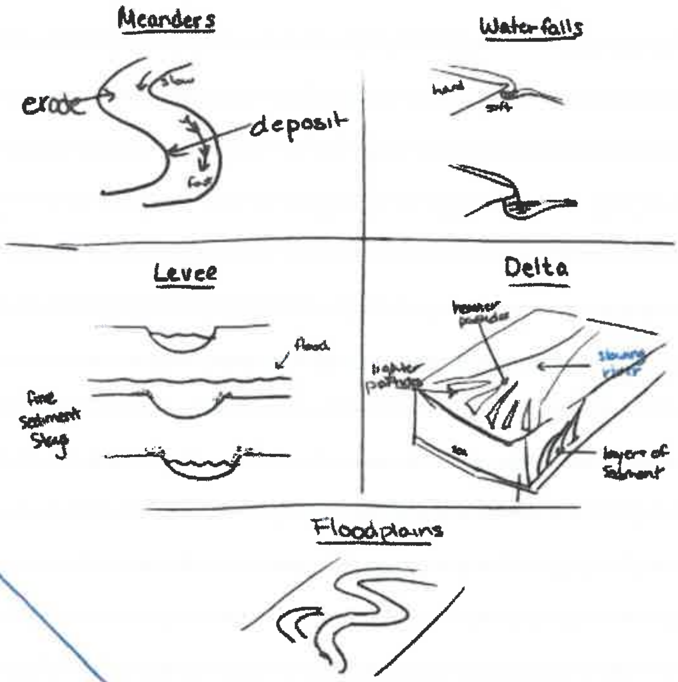
Suggested teaching time 6–8 hours

Future possibilities for management intervention in drainage basins	The importance of strengthening participation of local communities to improve water management in different economic development contexts, including sustainable water use and efficiency and ensuring access to clean, safe and affordable water
	Increased dam building for multipurpose water schemes and their costs and benefits
	• *Case study of contemporary dam building expansion in one major drainage basin* 3 Gorges Dam
	The growing importance of integrated drainage basin management (IDBM) plans and the costs and benefits they bring
	• *Case study of one recent IDBM plan* Thames River
	Growing pressures on major wetlands and efforts to protect them, such as the Ramsar Convention
	• *Case study of the future possibilities for one wetland area* Kissimmee

1.1 Hydrology + 1.2 Floods

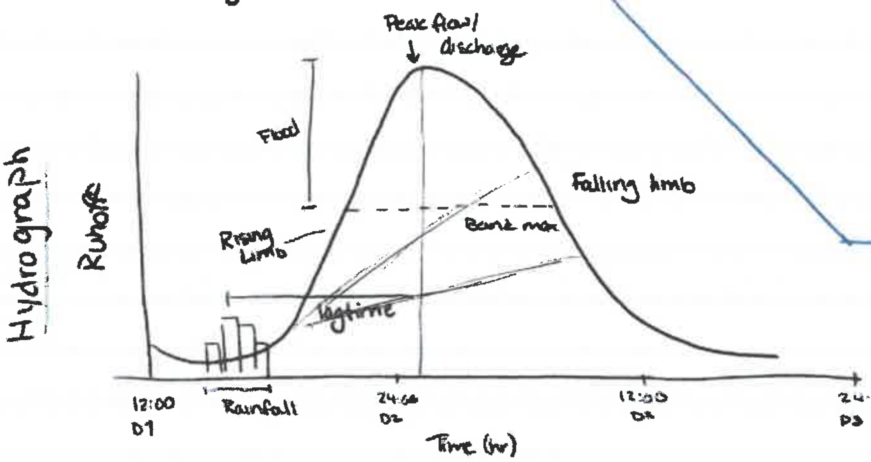
- Hydrological Cycle
  - * Inputs — precipitation
  - * Outputs - evaporation + transpiration
  - * Flows - infiltration + throughflow + overland flow + base flow
  - * Stores - vegetation + soil + aquifers + cryosphere
- Bradshaw Model
- Processes:
  - Erosion { Hydraulic Action, Attrition, Abrasion, Solution
  - Deposition
  - Transportation { Traction, Solution, Saltation, Suspension

- Landforms



meanders (lateral erosion) cut into sides of valley.

1.2 - Flooding



- Weather Prediction
  ↳ temp + humidity + wind
- Climate prediction
  ↳ stacked cubes global
  ↳ doesn't account for
  - humans, cities + population
  - microclimates

- Land use
  - * urbanisation
    ↳ more runoff (less absorption)
    ↳ shorter lag time + steep rising limb
    ↳ high peak discharge
  - * deforestation
    ↳ less interception
    ↳ shorter lag
- Soil
  - * thick permeable soil
    ↳ ↑ infiltration → long
    ↳ high lag time + shallow rising
  - * non-porous / impermeable
    ↳ more runoff
    ↳ short lag + steep rising
- Precipitation / Temperature
  - * Short intense rainfall
    ↳ rapid overland flow
    ↳ short lag time + steep
  - * Extreme temp (hot or cold → dry/frozen)
    ↳ rapid surface runoff —//—
  - * Snow
    ↳ Store
    ↳ long lag, shallow rising
- Drainage
  - * High density
    ↳ rapid overland flow
    ↳ short lag

- Hard engineering
  - Dams
  - Channelization
  - Straightening
  - levees
  - dredging
  - artificial stores
- Soft engineering
  - Afforestation
  - Controlled flooding
  - restoration } river
  - conservation
  - Land use planning } prep
  - insurance
  - flood proofing

1.3 Water Quality & Scarcity

Physical water scarcity - when water consumption exceeds 60% of the usable supply

Economic water scarcity - where a country physically has sufficient water to meet its needs, but requires additional storage and transport facilities.

Droughts - extended period of dry weather leading to conditions of extreme dryness.

Absolute → 15 consecutive days with < 0.2mm rainfall

Partial → 29 consecutive days with average daily rainfall < 0.2mm

Freshwater 2.5% (oceans)
1% available to humans (glaciers)
6,400m³ per person per year (6mil litres)

Severity - length of drought + severity of water shortage

Impact - reduced crop yields, increased animal mortality + illness in humans (dehydration), forest fires, water usage bans

Water quantity & quality - Quantity → rainfall, evaporation, transpiration (use of water by plants), river + groundwater flows

water use - world pop x3, water use x6 | loss of wetlands, freshwater species, water table, aquifers

Quality → adequate for consumption 8 water, availability, infrastructure, cost

4mil deaths from water-related disease | Urban > rural

Environmental consequences of agriculture activities on quality

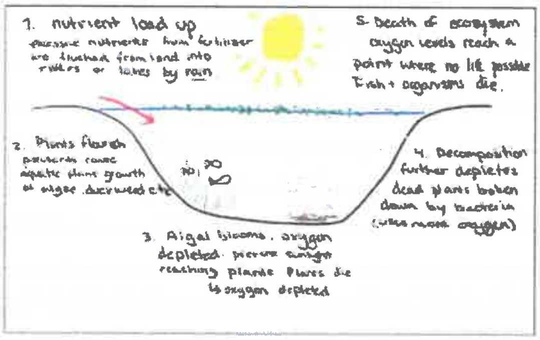
* Eutrophication → increased amounts of nitrogen / phosphorous carried in - streams = groundwater → contaminant

↳ algal blooms | shade water below light → anoxia (dead zones)

- High concentrations of nitrogen problem
  1. [illegible] water effects health
  2. loss of fertilizer (econ. loss for farmer)

3 ways to deal with eutro...

1. alter human activities causing pollution (eg alternative fertilizer)
2. Regulating/reducing pollutants at emission point (eg sewage treatment remove nitrates)
3. Restore water quality - pump mud out of eutrophic lakes)



Stakeholders -
- farmers - applying fertilizer → increase farm yields
- chemical companies - profit from sale of fertilizer
- government - achieve food security
- customers - recieve reliable food supplies + lower prices
- water companies - provide water to consumers

* Irrigation

- using aquifers faster than they can regenerate → lowered water table → loss of aquifer capacity + water quality
- raised water table → salinization
- reduce albedo (Earth reflectivity)
- Precipitation change → semi-arid places (typically dry in summer) higher rainfall (vegetation + moist soil ↳ evapotranspiration) (hailstorm/tornado increase in irrigated areas)

Salinization - increase in amount of salt in soil when groundwater is too close to surface

- capillary forces bring water to surface - water evaporates & leaves salt at surface

Pakistani Floods

Background	August 2010 - River Indus Highest water levels in past 110 years Pakistan is in north west of india + bordering india and is approx 800,000 sq km Indus river is 3000 km long Seasonal reversal of winds - Monsoons - rain season from june to october, october to River flow peaked at 32,000 cubic meters per second
Causes	Physical - Heavy rainfall late july, 5 days, 60 straight hours - 30% over 3 month total Once in a century level rainfall Tsunami like wave of water down mountain valleys feeding the indus Monsoon rains continued as normal afterwards + additional storms → flooding waves Abnormal storms (weather patterns) Climate change → warmer weather → increase in heavy rainfall events Human - Levees raised river beds, let any overflow into vulnerable areas River management repairs delay Deforestation (caused by taliban) limited the interception
Effects	Direct effect on one 9th of the population (20 mil/180 mil) (6mil in first week) 1,700 person death toll (effects on poor in long term) 11,000 villages overrun - mostly poor, their assets (house, crops, livestock) damaged 8 million displaced Sindh province most affected by this event; 7.3/20 million Billions of dollars - damages to infrastructure, housing, agriculture, livestock, *roads 1.2 million houses damaged or destroyed 7 million hectares of fertile land damaged Food prices double or triple (bread making part of pakistan flooded and crops gone) Environmental - 20 percent of land area covered (1/5) Lower parts, the river was 24 km across (25time normal) Tsunami like water waves from mountains → floods to affect all of downstream River flow peaked at 32,000 cubic meters per second Countryside → swamps Try to relieve pressure on dams, dykes were broken and let water into farmlands Political - government ineffective & slow Image issue Loss of trust in gov
Response	Short term - Government useless? - military help - helicopter and boats (first week save 100,000) 30,000 soldiers aid, food, rebuilding, camps for refugees Gov not declare emergency, no aid (food, shelter, medicine) Most of military fighting taliban and can't assist flood relief Long term - India+china+saudi arabia+EU+US- give funds, but slowed and only half UN funds met UN request donation for 460 mil USD for first 3 months, (not met)

Western European Floods

Background	July 2021 western Europe (belgium, luxembourg, netherlands and Germany) Main flooding from 12th to 15th Most severe natural catastrophe in past half century for europe North Rhine-Westphalia (NRW) and Rhineland-Palatinate (RP) - 2470 km2 rivers Ahr/Erft (rhine) and the Meuse Flow peak on meuse 3179m3/s European Flood Aware System → flood notification (extreme rain and floods risk) germ. evac late (euro warning, but countries individ warn, why isn't there overall) Winter is usual flood season (highest discharge - high precip + low evaporation) Dykes and intentional flooding of wetlands (water management)
Causes	Physical - Extreme rainfall (150 mm over large area 15-18 hours prior) Drainage basin, narrow valley + steep slope (funnel-like) - Oversaturated soil Climate change increased intensity max 1 day rainfall by 3-19% compare 1.2°C cooler River management Land use Lack of planning for summer floods Delay between meteorologists and the public
Effects (short + long term)	Social - Over 200 deaths (extreme) Villages closed off (roads) no evac Medical care under strain, multiple hospitals evac, supplies limited (damaged clinics) Economic - Damage to infrastructure → houses, highways, railways, bridges, key income sources Water and electricity supply disrupted, extreme power loss Total losses EUR 46 billion Property damage EUR 10 billion Environmental - 57% of inundated land was agricultural River Kyll rose from normal 1m to 7.8m
Response	Short term - Dykes and intentional flooding of wetlands Early warning Financial aid from countries, emergency response teams, 15000 in germany Rebuilding Scientists investigate impact of climate change, intensity of rainfall → severe flooding Limited data because of damage to hydrological monitoring systems Examine how to reduce vulnerability and exposure and become critical to reducing future impacts Flood prediction + flood protection acts (limit increase in flood risk) Dike relocations, polders, flood buffer zones, lowered floodplains, in channel dredging and widening, zoning laws

Stakeholders + internationally shared water sources: Colorado

Link

Stakeholders	Use (quantification as evidence)	Effects of the use (SEEP)	Influence/ most powerful (6)- least powerful (1)
1. The States[1,2,3] Colorado, New Mexico, Utah, and Wyoming, Arizona, California, Nevada + Mexico 40 million people rely on its resources	Supplies water to states.  Distribution of 16.5 maf (also incl. agriculture, electric, industry, culture, tourism	S - E + E - economic + physical water scarcity - states use majority of water, and at same time they have caused a decrease in supply *see sections for other effects  P - colorado compact, distribution of water Each state is so reliant on river as a water source, they will argue against anything that tries to limit their use	California uses highest % water Arizona has the two largest dams (hoover + glen canyon) States themselves, rely on water, fight for most water usage, even if it damages environment — Nevada only 2%, but vegas needs more (built after 1922) Environment disadvantage, states power
2. Agriculture Takes up 80% of the rivers water	Irrigates 15% of the nations farmlands Produces 90% of winter vegetables	S - farmers, people relying on the agriculture for a living E - causing water scarcity + deficit Eutrophication E - supplies 15% of farmlands + makes most winter veggies P - selling crops..? Govt subsidising crops	Water isn't being returned to basin, exported (food+animals) Taking away water Biggest export of water
3. Hydroelectric Dams[1 2]	Doesn't 'use' water, rather limits how much flows further downstream. Provides energy for Ca. 782,000 U.S. households	S - 100 workers died while building hoover dam Env - clean, renewable source of energy. Doesn't release fossil fuels Changed rivers course Eco - provides cheap electricity which is good for industry & business P - large investment to build	
4. Industry	Fishing, winter vegetables, cotton, cattle, dairy, P2: energy development, snowmaking, thermo-electric power, food processing and large industries, eg breweries, farming	S- drinking water to 36 million people Eco- $1.4 trillion impact Env- P- Water can be used by industries (part 2_	
5. Culture (native)	Indigenous people use it for agriculture	S- Eco- Env- P-	
6. Tourism			

Dams: 3 Gorges Dam

Link, Link

Case Study name:	Three Gorges Dam	**Section of specification:**	Option A - Freshwater - Issues and conflicts
Location:	**City/Region:** Yangtze River	**Country:** China	**Continent:** Asia

What:

A multi-purpose dam in central China and the world's largest dam. Controversial due to several negative impacts.

When:

Completed 2015

Causes/Theory:

- China is looking for renewable sources of energy due to increased air pollution and high projected increases in energy demand.

- It creates employment and accelerates economic growth and development through electricity supply.
- Beneficial for flood control

Facts and Figures

- 10% of China's energy supply through HEP
- Protects 10 million from flooding downstream
- Resettlement of 1.3 million people
- Cost $27 billion

Political Effects:	**Economic Effects:**	**Environmental Effects:**	**Social Effects:**
	- High cost to build ($27 billion)	- Pollution problems remain due to sewage, industry and chemicals released from the flooding of factories. - Threat to wildlife: Increased river traffic and ecosystem changes	- Resettled populations face problems finding adequate housing and employment as previous income sources have been eradicated. - Flood control benefits 10 million

Solutions:

Governmental effort and extensive planing could implement water-cleaning strategies or improved conditions for endangered species.

Possible Exam Question:

„Dams and reservoirs create as many problems as they solve."
Discuss this statement with reference to multi-purpose schemes.

Wetlands: Kissimmee River

- Kissimmee used to go 103 miles, central florida 2 miles across
- Prolonged flooding significant impacts, between 1962-1971, florida installed the C-38, cut and dredged the Kissimmee River into a 30-foot deep straightaway
- Helped with flood mitigation
- Many negative impacts on river-floodplain ecosystem
    - Restore flora + fauna
- Restoration began 1999 with 4 phases
    - Refilling (basin - meanders, floodplains, wetlands)
    - Backfilling (C38)
    - Dam removal
    - Removal of channels
    - Dredging
    - Strict usage rules
- Acquired 100,000 acres of land to complete the Kissimmee River Restoration project
- Negative effects
    - Fish () cant migrate up and down stream, if some areas dont have fish, then the birds who catch them move away, same goes for small plants/insects, fish dont stay is they are not there
    - Silt/sediment cannot pass dams, bring nutrients downstream to floodplains, farms, wetlands etc
        - Sandbars for aquatic birds and insects
- Improvements since
    - Oxygen (dissolved) levels have gone up - fish/plants
    - Floodplains - wetlands, plants are thriving
    - Long legged wading bird populations increase (great egret)
    - 8 birds species (previously absent) have returned to riverside

Essay:

➢ Define wetland - a wetland is an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be partially or completely covered by small pools of water

➢ Place - Kissimmee River, central/south Florida (103 miles → 56 + 6 dams)

➢ Additional info (growing pressures, negative effects)

➢ Thesis - identify main points

Body:

➢ Dam removal

➢ Refilling (basin)

➢ Backfilling (c38)

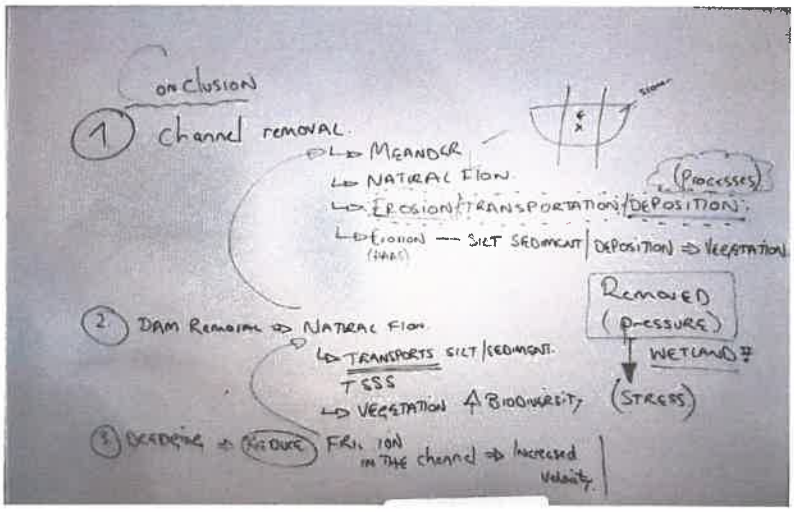
➢ Channel removal

➢ Dredging

➢ Usage rules

Conclusion:

➢ Most → least effective strategies + WHY



Insects -

Giant water bug / fly

- live in water
- shorelines ← shelter during flood