Within ESSAY discuss factors
Political
Social
Economical
Environmental

Key for colors
Key Terms
Case Study

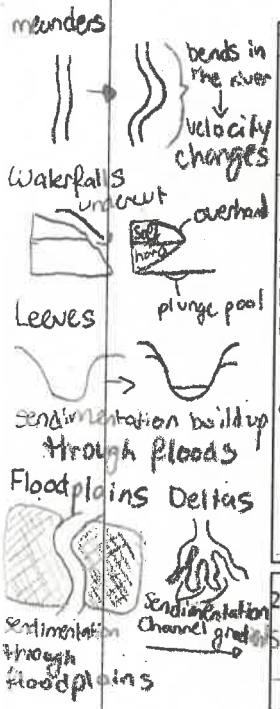
Option A: Freshwater

This optional theme encompasses the physical geography of freshwater in a systems framework, including core elements of hydrology (and the factors and processes that give rise to bank full discharge and flooding) and fluvial geomorphology (including river process and landform study).

It also covers the study of water on the land as a scarce resource requiring careful management, including freshwater bodies such as lakes and aquifers. This includes the ways in which humans respond to the challenges of managing the quantity and quality of freshwater, as well as the consequences (whether intended or unintended, positive or negative) of management within drainage basins.

The importance of integrated planning is emphasized, in addition to the geopolitical consequences of growing pressures on internationally shared water resources.

Through study of this optional theme, students will develop their understanding of processes, places, power and geographical possibilities. They will additionally gain understanding of other concepts including **systems** (the hydrological cycle), **flood mitigation** (attempts to tackle flooding) and **water security**.



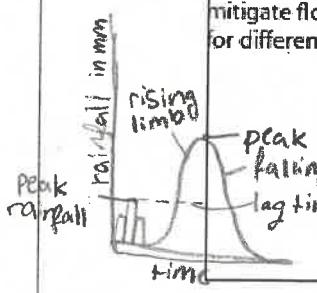
Geographic inquiry	Geographic knowledge and understanding
1. Drainage basin hydrology and geomorphology Suggested teaching time 6–8 hours	
How physical processes influence drainage basin systems and landforms	The drainage basin as an open system with inputs (precipitation of varying type and intensity), outputs (evaporation and transpiration), flows (infiltration, throughflow, overland flow and base flow) and stores (including vegetation, soil, aquifers and the cryosphere) River discharge and its relationship to stream flow, channel characteristics and hydraulic radius – Equation 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
2. Flooding and flood mitigation Suggested teaching time 6–8 hours	
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) • *Two contrasting detailed examples of flood mitigation of drainage basins*

Equation
discharge = distance (m) / time (sec)

Bradshaw Model
▷ decreases
▷ increases
Load particle size ▷
Channel bed/bank roughness ▷
Slope (angle) ▷
Discharge ▷
Velocity ▷
Cross-sectional area ▷
Erosion
H Hydraulic Action
A Abrasion
A Attrition
S Solution
Transportation
T Traction
S Saltation
S Suspension
S Solution
deposition
- build up of sedimentation

Influence the hydrograph
- steep rising limb, short falling limb

Urbanisation
- less absorption
- greater overland flow
- more impermeable surfaces (cement)



Pakistan

Hard engineering	Soft engineering
Dams	afforestation
Channel modification - straightening - embankment	Land use
PROS - effective	- less effective
CONS - more damage to environment - cost inefficient	- cost efficient

3. Water scarcity and water quality Suggested teaching time 6–8 hours	
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* Growing human pressures on lakes and aquifers, including economic growth and population migration Internationally shared water resources as a source of conflict • *Case study of one internationally shared water resource and the role of different stakeholders in attempting to find a resolution*

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* The growing importance of integrated drainage basin management (IDBM) plans, and the costs and benefits they bring • *Case study of one recent IDBM plan* 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*

Synthesis (Sy), Evaluation (Ev) and Skills (Sk) opportunities	
These suggestions aim to synthesize the learning throughout the unit.	How natural processes or human interference in one part of a drainage basin may bring spatial interactions with other parts/places [Sy] How water management actions take place at personal to global scales [Sy/Ev] Different perspectives on the costs and benefits of water management strategies [Ev] How water cycling and water system flows can be represented graphically [Sk]

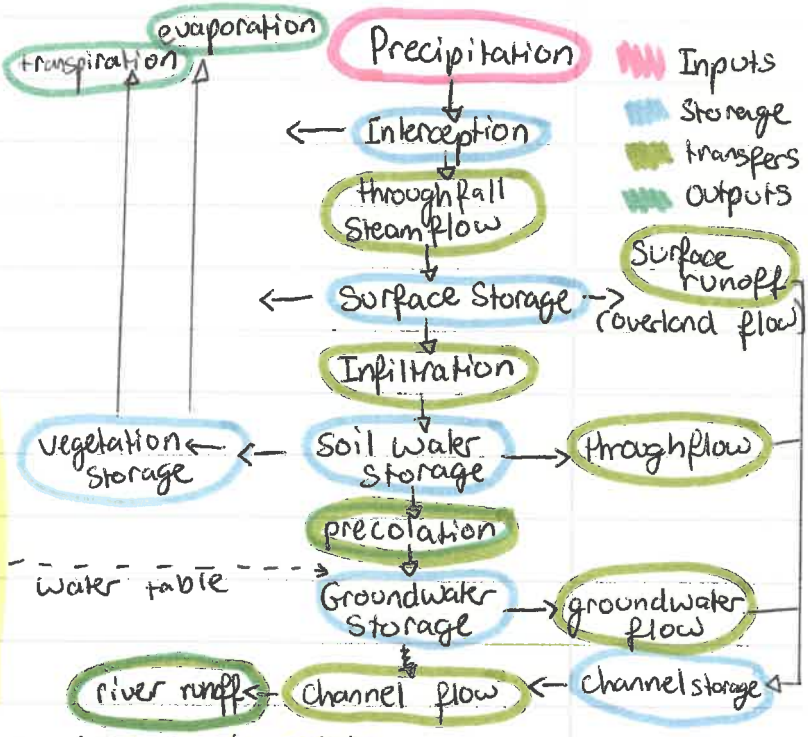
freshwater

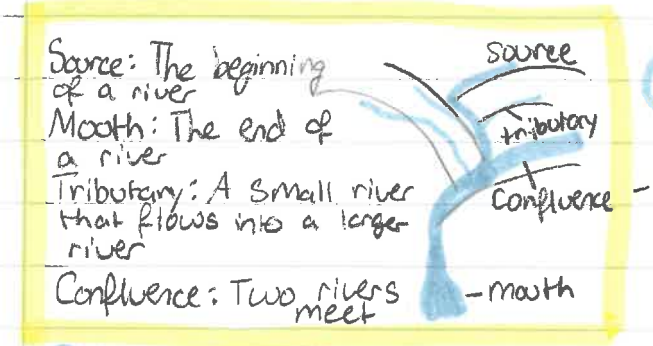
(1) Drainage basin Hydrology and Geomorphology

» The drainage basin is an Open System → Because the system is open to inputs from the outside

A drainage basin is an area of land where all flowing surface water converges to a single point

Watershed an area of land that drains into a particular river = drainage basin
Watersheds = the boarder between drainage basins



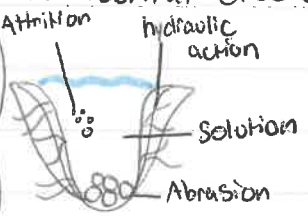


water table

PROCESSES – Erosion, transportation, deposition

(1) Erosion : Vertical + Horizontal erosion

H - hydraulic action
A - Abrasion
A - Attrition
S - Solution



Factors that effect rates of erosion
- Load Size - heavier/sharper bedload = ↑erosion
- Gradient - increased gradient = ↑ erosion
- Velocity - greater velocity = ↑ erosion
- PH value - more acidic = ↑ Solution erosion
- Human impact - Ex) deforestation, dams, bridges, interfer with natural flow
- Geology - soft, unconsolidated rocks (sand) = easily eroded

H) hydraulic action - force of water on the cracks of the river bed + bank
≈ as fluid accelerates, → air bubbles explode in river cavities

A) Abrasion - The bedload is rubbing against river bed/bank (Sandpaper Effect) causing the river to become wider + deeper

A) Attrition - Rocks (pebbles)/sedimentation carried by water knock against each other, causing them to break and become smaller →

S) Solution - when ph of water dissolves certain types of chemical ions from rock

(2) Transportation

T - Traction
S - Saltation
S - Suspension
S - Solution

T) Traction - transporting larger bedload (boulders, stones) by rolling them across the river bed - influenced by velocity
S) Saltation - transporting smaller rocks/pebbles through a bouncing movement along the river bed
S) Suspension - transporting fine sedimentation through water force
S) Solution - transporting dissolved chemicals through the water

(3) Deposition - depositing (laying down) sedimentation

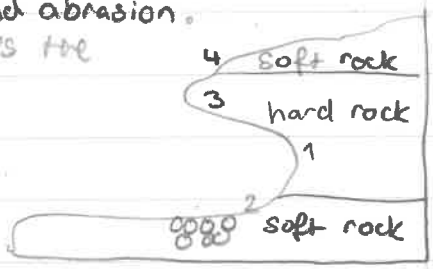
Causing
a) Shallowing of gradient which decreases velocity/energy
b) decrease in the volume of water in the channel
c) increase in the friction between water and channel

Note : Deposition can vary due to seasons and human activity

Landform formations

Waterfalls - The soft rock of the horizontally embedded rock is undercut by hydraulic action and abrasion. The weight of water and lack of support causes the overhang to collapse and retreat.

1. Hydraulic impact on soft rock
2. Abrasion of soft rock by hard fragments
3. Lack of support by soft rock = collapse
4. Creation of overhang and plunge pool



Floodplains - The area next to a river that floods during a storm. formed through erosion and deposition

1. Erosion through power of floods -> erods away any interlocking spurs
2. That material is then deposited on the banks of the river as it loses speed

Meanders - bends within a river

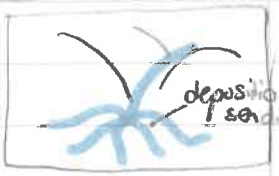
1. Erosion on the outer bends of the river due to placement of pressure on speed
2. Deposition of material on inside bends of the river as speed is less

Levees - Elevation of river bed/bank through deposition

1. eroded sendimentation from upstream gets transported downstream
2. When flooding occurs sendimentation spreads across floodplain
3. After many floods the sendimentation builds up

Deltas - landforms created by deposition of sendimentation -> found on lower course of river

The deposition of sendimentation occurs through Gradient becoming more shallow

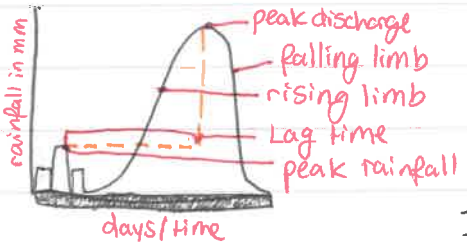


River discharge - volume of water passing a given point

Formula: Cross-sectional area x mean velocity of water

Catastrophes

higher magnitude
lower frequencies



Hydrograph

Factors that affect hydrograph
- o permeable/impermeable rocks
- o deforestation/deforestation
- o saturated/unsaturated soil
- o urbanisation
- o shape of drainage basin

rural area > overland flow
urban area < flow

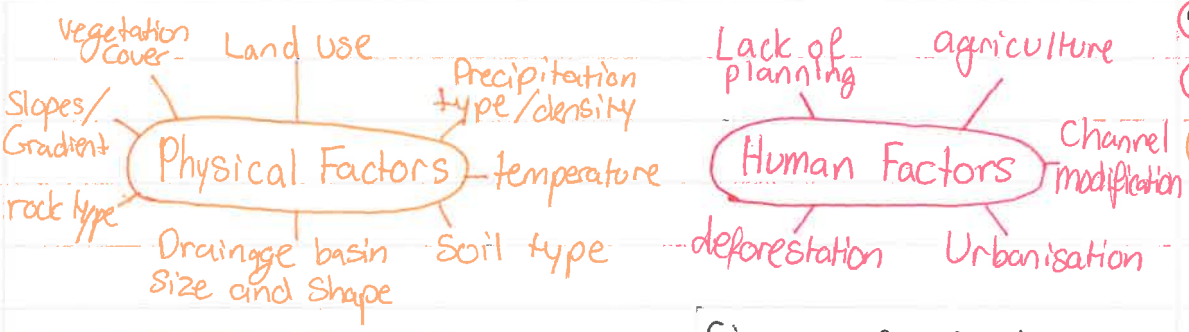
Influence of seasonality
- >> maximum flow in spring (ice melts)
- >> monsoonal rivers = maximum flow in summer
- o amount and nature of precipitation
- o seasonal variation in temperature and evotranspiration
- o changes in vegetation cover
- o variation in rock + soil types -> shape and size of drainage basin

Urbanisation

Shorter lag time
steeper rising limb
higher peak flow
steeper falling limb

- Creation of impermeable surfaces
- Creation of smooth surfaces (-> increase drainage density)
- natural river channel are often constructed by bridges

Factors that influence flood risk



Consequences of floods

- Economical
- Social
- Political
- Environmental

Economical Consequences

- Farming land/crop loss → loss of income
- Damaging (BD of the city → important source of economical income
central business district

Social Consequences

- increases poverty
- Spread of diseases
- loss of property (Ex. schools)
- Lack of resources (food, water)
- Death rates (larger = better case study)

Political Consequences

- criticism to government → bad rep

Ex) Pakistan, Taliban = increase in size

Environmental Consequeses

- destruction of ecosystem/Biodiversity threats
- Damage to drainage basin

Strategies for flood mitigation

Hard engineering - make greater impact

	disadvantages
Dams ① holds back water during times of flooding ② Benifits agriculture, tourism hydroelectricity	- greater cost - more destructive - increases loss of water through evaporation
Channel modification types of ↑ ↳ embankment ↳ straightening ↳ Channelization - reduces overland flow - removes water from area	- flooding may occur downstream through straightening - cost inefficient

Soft engineering - cost friendly

Afforestation - planting more trees ① increases interception, infiltration - reduces flood size = flood control	- only makes slight improvement - It takes more time for plants to grow

Deforestation

higher magnitude

- vegetation cover ↓ → overland flow
  - ↳ reduces interception
  - ↳ reduces evapotranspiration
  - ↳ causes flood runoff

Channel modifications

- increase velocity of water
- cause meandering rivers ✗ to form naturally

WATER SCarcity and Water Quality

Physical Water Scarcity - population demand exceeds water availability

Economical water scarcity - lack or poor management of Infrastructure

Eutriphication - Occurs when nitrogen/phosphorus molecules get carried in larger Quantities in the river

→ Result: Nutrient enrichment for alga = algae growth

→ cuts submerged plants below off from light supply (Anoxic environment)

Dealing with Eutriphication

① Altering human activities which produce pollution
② regulating pollutants at point of emission
③ restoring water quality by pumping mud for eutriphication

③ main reasons for eutriphication causing problems

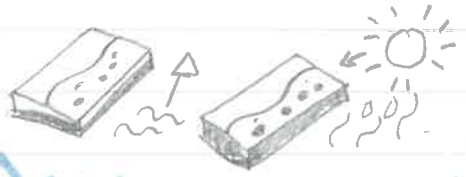
① loss of fertilizer found underwater → economical loss
② nitrate concentration in drinking water is bad
③ Damaging environment for other submerged organisms

Examples: - Indigenous people - governments
- residence - fishers

Stakeholders - individuals that both rely directly or indirectly on or deal with the source of water from a river

Salinization - Irrigation leads to Salinization (increase salt concentration)

Occurance: Groundwater levels are close to surface
→ water then evaporates
→ leaves behind salt



④ Water management futurs

Wetlands → Kissimmee river Case Study →

Definition

Wetlands are areas of land that are frequently saturated with water. They are home to several different varieties of land and see/aquatic organisms.

The 3 Gorge Dam is a good example for this

Dams

Benifits	Drawbacks
① Hydroelectricity (power)	1) loss of water
② flood control	② Hard engineering strategies (takes longer time / cost)
3) Creation of water reservoirs	③ change in habitat
④ Water Supply	4) Species interference → fish swimming upwards
5) Sight seeing (tourism)	5) international water conflict
6) Political power	⑥ loss of land / agricultural land and or settlements
7) Employment	⑦ causes/forces migration
8) Industry	⑧ Eutrophication
a) Clean Green energy	⑨ maintanence (high cost)

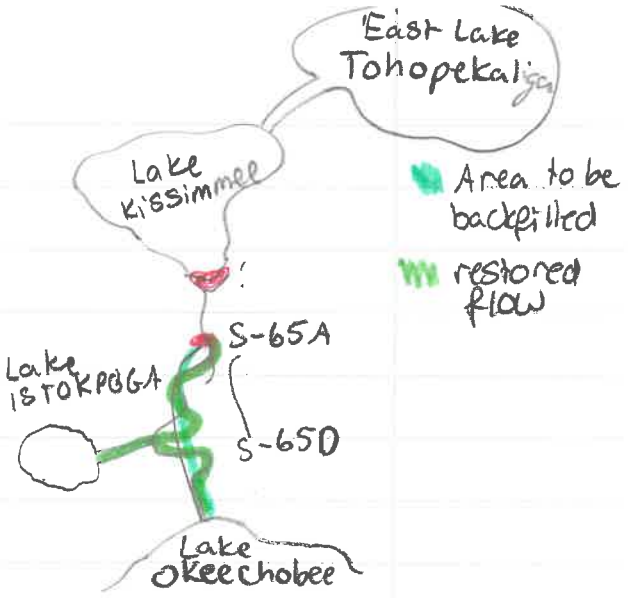
Colorado River Source: Rocky Mountains Mouth: Gulf of Mexico

International water conflict: between Mexico and Colorado
↳ only 1% of the Colorado river water reaches mexico
Effect
- loss of biodiversity → plants + animals
- dried up floodplains → migration, jobs (fishers) lost

What measures have occured in the past? - Opening Hoover dam more than 1 time

Kissimmee River Restoration

Source: East Lake Tohopekaliga
Mouth: Lake Okeechobee



Original issive

3 million invested for Channelization by cutting and dredging a 30-feet deep straightaway through the rivers meander the C-38 canal
↳ Social critik about decision

Problem: Caused by river management

- floodplain dried up reducing waterflow by 90%
- biodiversity declined by 2/3
- eutriphication

Restoration Process

Dam Removal 2/6
→ natural flow
↳ meander
↳ transports silt/ sedimentation
Biodiversity ↑
removed pressures on wetland

Channelization removal
↳ meander
↳ natural flow
Erosion, transportation, deposition
↳ vegetation
return of water bug
water scorpion

Dredging
reduced friction in the channel
→ increased velocity
Con: Loss of Biodiversity

Backfilling of C38
opening up dam gate, allows for water to enter river
restored water quality

IDBM System - Colorado River / Kissimme River ↕ 2 possibilities

Source: Rocky Mountain } 15 dams on main stream
Mouth: Gulf of Mexico }

Stakeholder issives

Upstream → recieves more water than downstream
Issue: Mexico losses Biodiversity

Several industries are responsible for the management disadvantages

IDBM plan - WaterSmart

advantages
Sustainability
long-term vision
reliable research based info
holistic approach
employment
reduces flood risk
economical benifits
better water quality

Cost inefficient
A lot of time management
to all Stakeholders are involved
- remove dams = less energy
- hidden costs (unexpected need)
- ethic consideration