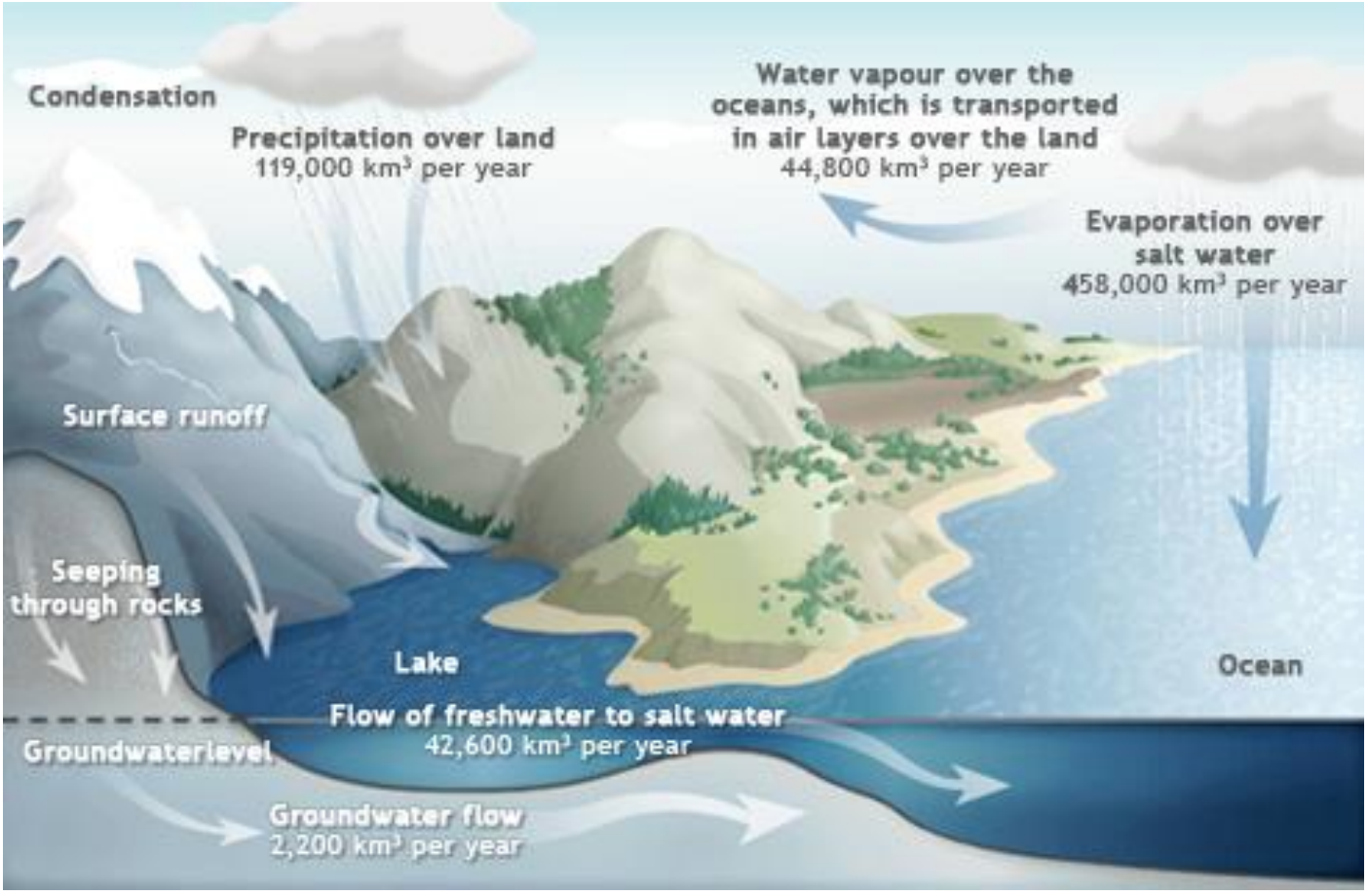
Edexcel Geography A-level

The Water Cycle and Water Insecurity Work booklet

KEQ 1: What are the processes operating within the hydrological cycle from global to local scale?



Use the following link to review content from KEQ1 at the end: https://www.pearsonactivelearn.com/ebook.asp?id=OTg2OTkxfGJvb2t8MTUwfDA=

Lesson 1: The operation of the hydrological cycle at a global scale.

Videos to support - https://bit.ly/2LiDYGV, https://bit.ly/2Li77BS, https://bit.ly/3cjZeIh

Task 1: Read pages 24-25 in the textbook (link provided to Active Learn).

Task 2: Define the following terms:

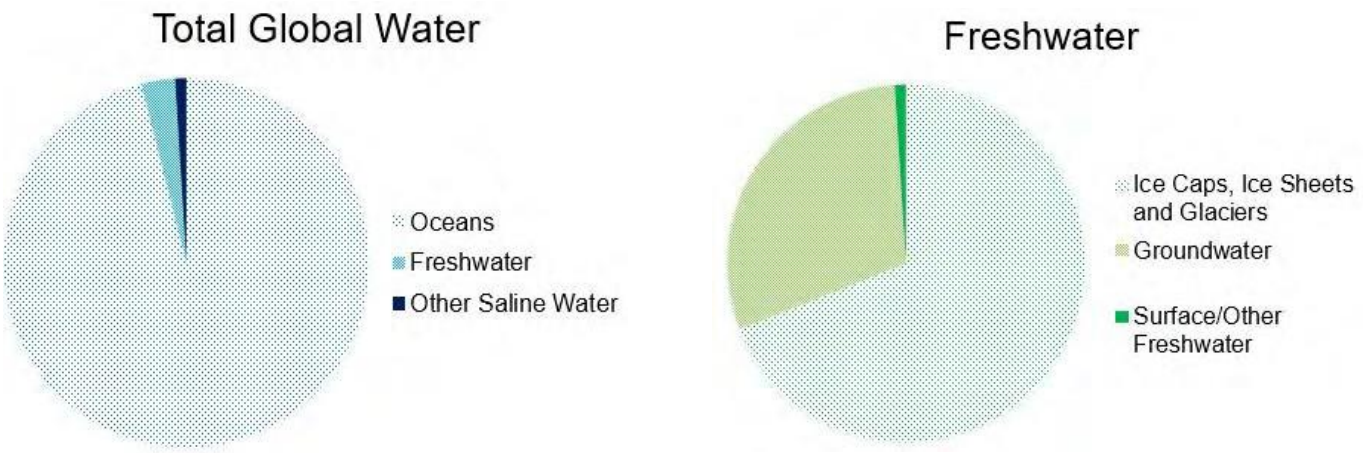
Stores _____

Fluxes _____

Processes _____

Global Water Budget

The global water cycle is comprised of many stores, the largest being oceans, which contain **97% of global water**. Only **2.5% of stores are freshwater** of which **69% is glaciers, ice caps and ice sheets** and **30% is groundwater.** Surface and other freshwater only accounts for around **1%** of global stores. Other surface and freshwater is made up of **permafrost, lakes, swamps, marshes, rivers and living organisms**.



Task 3: In the space below, draw the global hydrological cycle, including the key stores (including %s), fluxes (including amounts), and processes.

Task 4: Key Terms Match-Up – Match the key terms linked to main stores of water to their definitions below.

Blue water	Water frozen into ice and snow.
Green water	The average time a water molecule will spend in a store or reservoir.
Residence time	Freshwater stored in rivers, streams and lakes – the visible part of the hydrological cycle.
Fossil water	Freshwater stored in the soil and vegetation – the invisible part of the hydrological cycle.
Cryosphere	Ancient, deep groundwater from former pluvial (wetter) climatic periods.

Hydrology in Polar Regions

- 85% of solar radiation is reflected
- Permafrost creates impermeable surfaces
- Lakes and rivers freeze
- Rapid runoff in spring
- Seasonal release of biogenic gases into atmosphere
- Orographic and frontal precipitation

Hydrology in Tropical Rainforests

- Dense vegetation consuming 75% of precipitation
- There is limited infiltration
- Deforestation leads to less evapotranspiration and precipitation
- Very high temperatures
- Very humid
- Convectional rainfall

	% of total water	% of total freshwater	Residence time
Oceans	96.9	0	3600 years
Icecaps	1.9	68.7	15,000 years
Groundwater	1.1	30.1	10,00 years
Rivers and Lakes	0.01	1.2	2 weeks to 10 years
Soil moisture	0.01	0.05	2-50 weeks
Atmospheric Moisture	0.001	0.04	10 days

Task 5: Using your knowledge and the information above, EXPLAIN why only such a small percentage of freshwater is accessible for human use.

Lesson 2: The operation of the drainage basin as on open system.

Videos to support - https://bit.ly/35JR75g and https://bit.ly/3fAqF2r

Task 1: Read pages 26-30 in the textbook (link provided to Active Learn).

Task 2: Watch the first video on drainage basins and use it to define the following key terms.

Drainage basin _____

Watershed _____

Catchment _____

Task 3: Below, draw the drainage basin cycle. You must label and colour code all the aspects into stores, inputs, outputs and flows. Make sure you include a key.

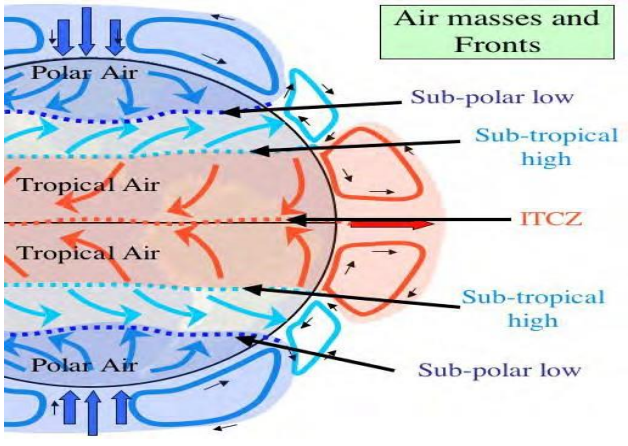
Drainage basins

A drainage basin is an **open subsystem** operating within the closed global hydrological cycle. It's defined as an area of **land drained by a river and its tributaries** with a boundary (known as the **watershed**), usually composing of hills and mountains.

Knowledge reminder:
ITCZ (Inter-tropical Continental Zone)

The Earth consist of **six cells of circulating air,** which form the globe's climate control. For the Northern Hemisphere

(the same is true for the south, just in opposite directions):



Hadley Cell - Air rises at The Doldrums, travels upwards, then sinks as it meets the cooler air of the Ferrel Cell. At this meeting point, precipitation tends to occur. The air then travels southwards, heating up as it does. It will then have heated sufficiently to rise up at the Doldrums, commencing the cycle again.

Polar Cell - Cold air sinks near the Arctic Circle, cooling and condensing to form precipitation over northern latitudes. The air then travels southwards, heating until it meets warm air from the Ferrel Cell. The air then rises, causing dry conditions for the land beneath, and then travels northwards, cooling as it does.

Ferrel Cell - The middle cell of the ITCZ (tends to be at a mid-latitude location). The air circulation is determined by the Hadley and Polar cells either side, similar to a cog system.

Task 4: Fill in the table to summarise how the drainage basin system works – include the details on inputs, fluxes, flows and transfers, and outputs.

Name – colour code into input, flux, flow/transfer, or output	What is it?	What influences it?

Task 5: Using your knowledge, EXPLAIN how through flow and groundwater flow are different.

Lesson 3: Physical and Human factors that influence the drainage basin cycle.

Videos to support - https://bit.ly/3fAqF2r (from 25.39) and https://bit.ly/2WJs1iB
Task 1: Read pages 30-32 in the textbook (link provided to Active Learn).

Task 2: Watch the first video and use your knowledge from the reading to fill in the table below to summarise how the following physical factors influence drainage basins.

Physical Factors	Description
Climate	
Soils	
Geology	
Relief	
Vegetation	

Task 3: Using your knowledge, EXPLAIN how physical factors have led to contrasts in the hydrological cycles shown in figures 1.9a and 1.9b.

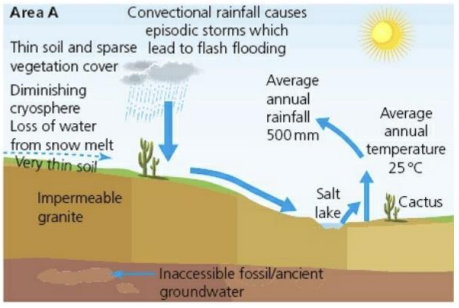


Figure 1.9a The impact of physical factors on two contrasting hydrological cycles (Area A)

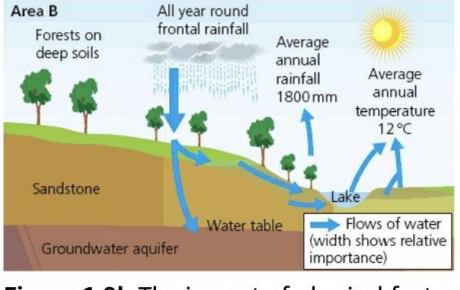


Figure 1.9b The impact of physical factors on two contrasting hydrological cycles (Area B)

Task 4: Watch the second video and using it, along with your knowledge from your reading, fill in the table below with detail on human influences including type, description, what it affects (input/processes/outputs), named example with place based detail, and judgement of severity of impact.

Human factor	Description	Influence on processes	Place Based Detail	Overall judgement on impact
Cloud seeding				
Deforestation				
Afforestation				
Reservoir building				
Land use changes				
Irrigation				

Task 5: SUGGEST what the effects of afforestation would be on drainage basin flows.

Lesson 4: The operation of the hydrological cycle at the local level.

Videos to support - https://bit.ly/2yxSisp, https://bit.ly/3dDtSg1, and https://bit.ly/2Wixfmr
Task 1: Read pages 33-37 in the textbook (link provided to Active Learn).

Task 2: Watch the first video and use your knowledge from the reading to define the key terms below.

Water budgets _____
River regimes _____
Storm hydrographs _____

Task 3: Using your knowledge, complete the formula below and annotate off what each symbol means:

$$= Q + \quad \pm S$$

Answer the following: Who would this formula be useful for? Why?

Task 4: Look at Figure 1.12 below. Annotate around the diagram what you notice about the global water budgets. Need help? Match the budget up to a map of the world and see where is in surplus and where is in deficit.

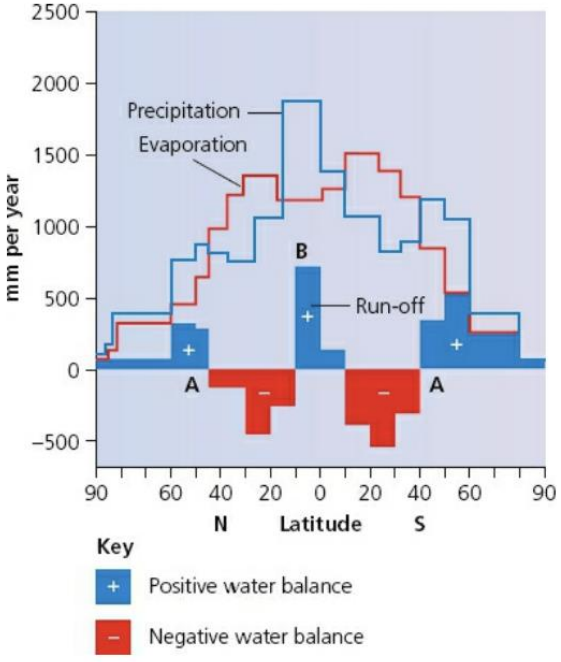
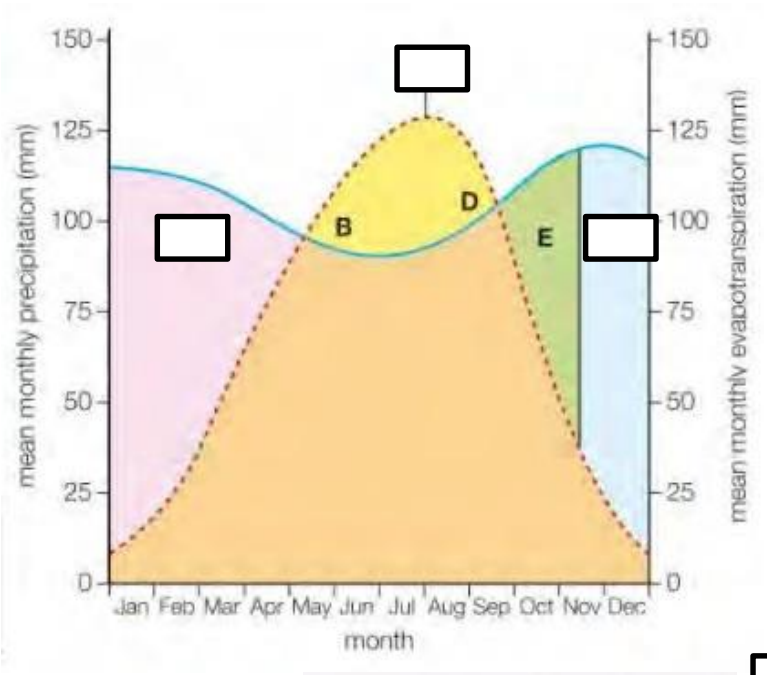


Figure 1.12 The variation of global water budgets with latitude

Task 5: Look at the second video provided and use it, along with your knowledge from the reading, to complete the missing detail from the soil moisture budget graph below.



A Precipitation is greater than potential evapotranspiration. The soil water store is full and there is a soil moisture surplus for plant use, runoff and ground water recharge.

B Potential evapotranspiration is greater than precipitation. The water store is being used up by plants or lost by evaporation (soil moisture utilisation).

☐ The soil moisture store is now used up. Any precipitation is likely to be absorbed by the soil rather than produce runoff. River levels will fall or may dry up completely.

☐ There is a deficiency of soil water as the store is used up and potential evapotranspiration is greater than precipitation. Plants must have adaptations to survive and crops must be irrigated.

E Precipitation is greater than potential evapotranspiration. The soil water store will start to fill again (soil moisture recharge).

☐ The soil water store is full. Field capacity has been reached. Additional rainfall will percolate down to the water table, and groundwater stores will be recharged.

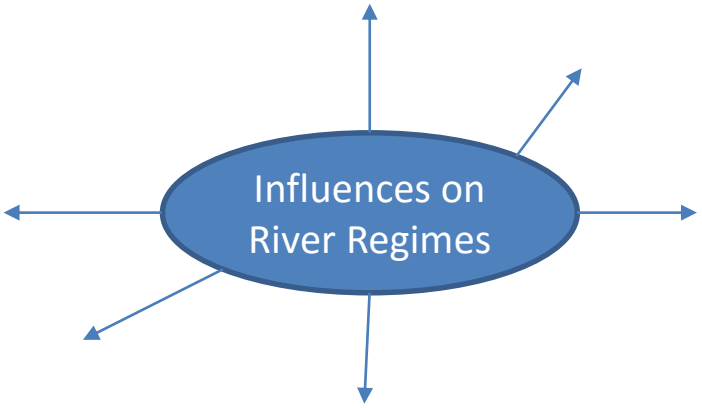
Answer the following: Who would this graph be useful for? Why?

River Regimes

A regime is the **annual variation in discharge** of a river at a particular location. Most of this river flow isn't from immediate precipitation, but is supplied from **groundwater** between periods of rain, which slowly feeds water into the river system.

There can be **seasonal** variations in the regime - periods of high discharge followed by low discharge which are due to **glacial meltwater, snowmelt** or **monsoons** which cause sudden fluctuations in river input. **Complex regimes** tend to occur for larger rivers, that cross different reliefs and climatic zones (e.g. The Ganges, Mississippi).

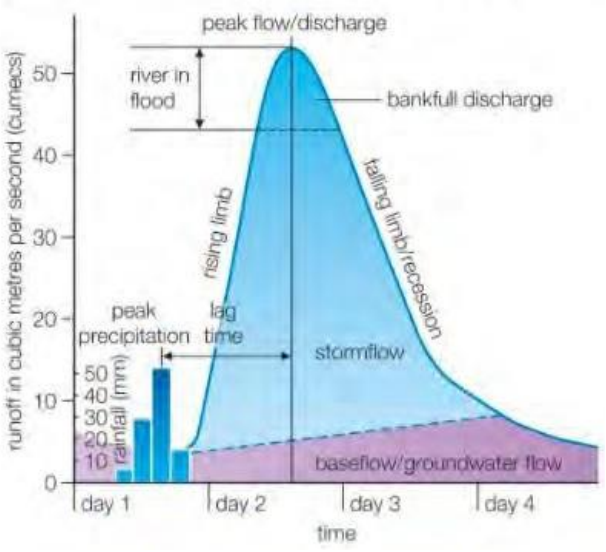
Task 6: Using your knowledge from reading, create a mind map below to identify what factors can affect river regimes.



Storm Hydrographs

Storm hydrographs represent the variation in discharge within a short period of time (**days**, rather than years). Before a storm begins, the main supply of water to the river is through groundwater or base flow. However, as a storm develops, infiltration and surface runoff will increase which causes a greater **throughflow**.

Task 7: Using the third video and your knowledge from reading, fill in the blanks with definitions for features of a storm hydrograph.



Features of storm hydrographs include:

- **Rising limb** –

  _____

  _____

- **Peak flow -** The maximum discharge, delayed after maximum precipitation has occurred.
- **Lag time** –

  _____

  _____

- **Falling limb** – As the storm precipitation levels decrease, discharge will in turn decrease over time.
- **Base flow** –

  _____

  _____

Task 8: Now, fill in the missing details to illustrate your knowledge of the differences between flashy and subdued hydrographs.

	Flashy Storm Hydrograph	Subdued Storm Hydrograph
Description of hydrograph	Short lag time High peak Steep rising limb	
Weather/Climate		Steady rainfall which is less than the infiltration capacity of soil Slow snow melt as temperatures rise very slowly High evaporation rates due to high temperatures
Rock type	Impermeable rocks like granite which encourage rapid surface runoff	
Soil		High infiltration rate
Relief		Low and gentle slopes → Less runoff
Basin size	Usually small basin	Usually large basin
Vegetation		High density vegetation, more interception, more evapotranspiration
Pre-existing conditions (Antecedent conditions)	Basin already wet from previous rainfall High water table Soil saturated, less infiltration	
Human activity		Afforestation

Lesson 5: The impact of urbanisation on hydrological processes.

Videos to support – https://bit.ly/3dt3Ewk (both problems and solutions included)
Task 1: Read pages 32 in the textbook (link provided to Active Learn).

Task 2: Watch the video and use your knowledge from the reading to annotate around each of the images in Figure 1.17 how aspects from the diagrams lead to an impact on the hydrological cycle.

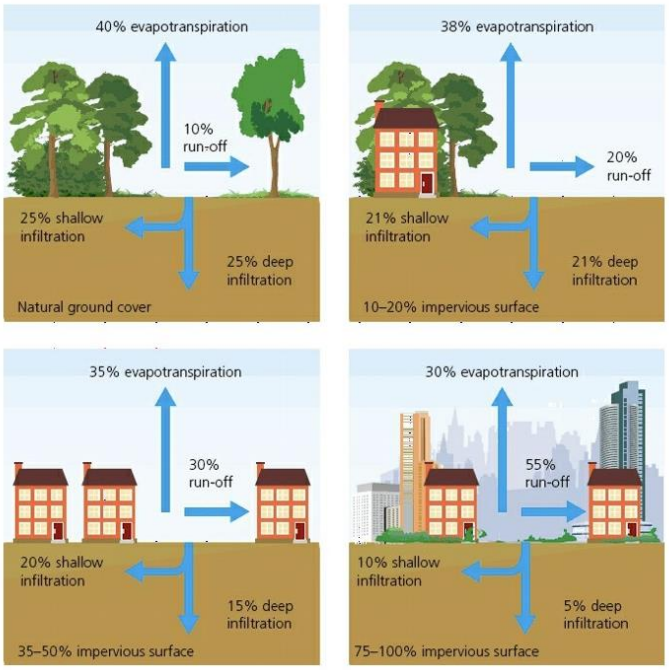


Figure 1.17 The impact of the spread of urbanisation on hydrological processes (Source: US Department of Agriculture)

Task 3: EXPLAIN what influence decision makers and planners have to manage a catchment area as a whole.

Task 4: EXPLAIN how urbanisation increases runoff and the risk of flooding. Need help – see the HINT on the website to see if you are on the right track.

KEQ 1 Completed – on the website, complete the Google Quiz for KEQ 1.