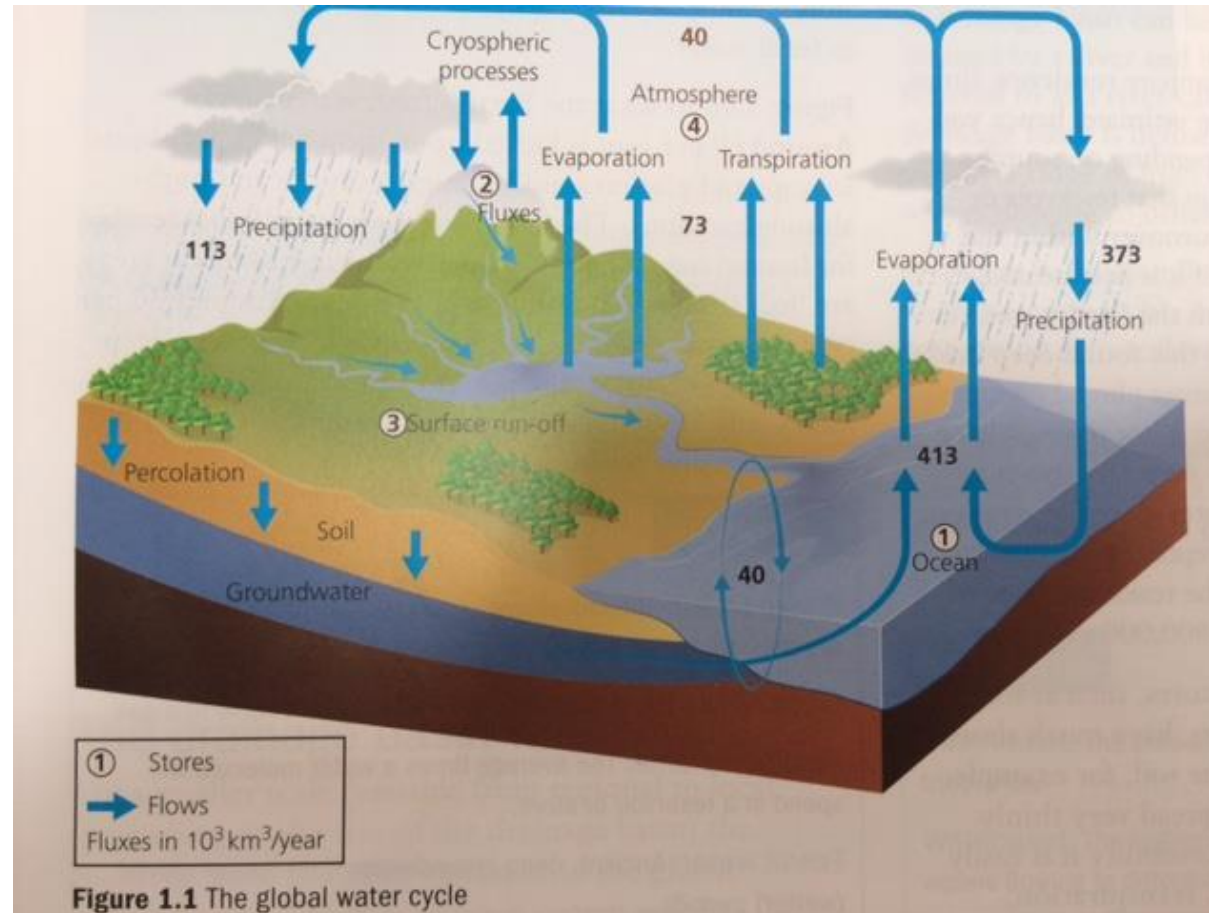


Water Cycle and Water Insecurity - Revision



Key term	Definition
Cryosphere	Describes the set of all locations on Earth where water is found in solid form, including areas of snow, sea ice, glaciers, permafrost, ice sheets and icebergs.
Flux	The flow or flowing of a liquid.
Orographic	Relating to mountains, orographic uplift is when the uplift of an air mass, because of an orographic obstruction, causes the cooling of the air mass. If enough cooling takes place, condensation can occur and form into orographic precipitation.
Evapotranspiration	Combined loss of water to the atmosphere via the processes of evaporation and transpiration.
Relief	The range of topographic elevation within a specific area.
Saturated overland flow	Occurs when the soil becomes saturated, and any additional precipitation causes runoff.
Runoff	Water (from rain, snowmelt or other sources) that flows over the land surface; can be due to soil saturation.
Percolation	A process similar to infiltration but travelling through rock surfaces towards the water table.
Porosity	A surface that allows water to pass through it, such as sand.
Permeability	A measure of the ability of soil, sediments and rock to transport water horizontally and vertically. It depends on the porosity of what the water is flowing through. Some rocks like granite have very poor permeability, while rocks like shale are actually quite pervious. As for soils, sand is the most pervious, while clay has the lowest permeability. Silt is usually somewhere in the middle.

The Water Cycle and Water Insecurity

EQ1: What are the processes operating within the hydrological cycle from global to local scale?

6 & 8 markers = AO1. 12 & 20 markers = AO1 and AO2 larger weighting

[6] **Explain** why the global hydrological cycle is a closed system.

[8] **Explain** the impact climate type can have on soil water availability.

[12] **Assess** the role of physical and human factors in influencing the drainage basin cycle

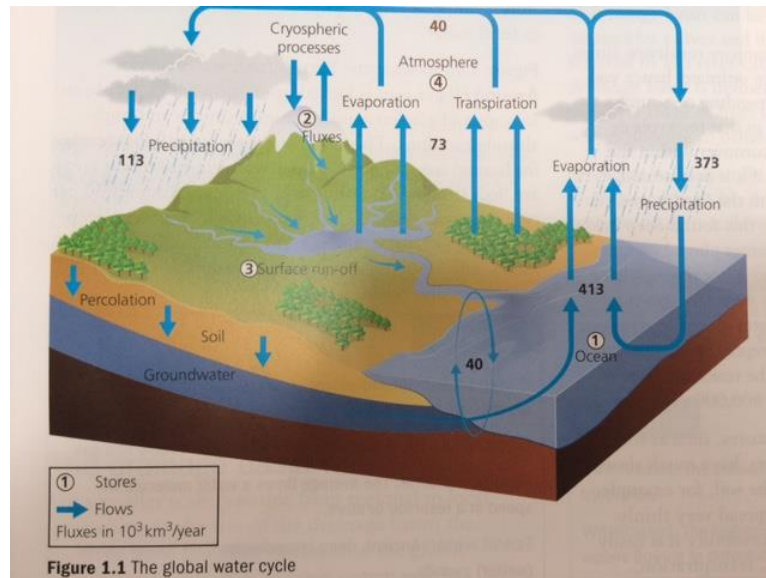
[20] **Evaluate** the contribution of human activity to the hydrological cycle at a local and global scale.

WATER EQ1: What are the processes operating within the hydrological cycle from global to local scale?

5.1 The global hydrological cycle is of enormous importance to life on earth

a. The global hydrological cycle's operation as a closed system (inputs, outputs, stores and flows) driven by solar energy and gravitational potential energy.

Annotate diagram, highlight fluxes



b. The relative importance and size (percentage contribution) of the water stores (oceans, atmosphere, biosphere, cryosphere, groundwater and surface water) and annual fluxes between atmosphere, ocean and land.

Store	Volume (10^3 km^3)	% total water	% total freshwater	Residence time	Notes

c. The global water budget limits water available for human use and water stores have different residence times; some stores are non-renewable (fossil water or cryosphere losses).

Total global water

Earth's freshwater supply

Surface water and other freshwater

Accessible freshwater

WATER EQ1: What are the processes operating within the hydrological cycle from global to local scale?

5.2 The drainage basin is an open system within the global hydrological cycle.

a. The hydrological cycle is a system of linked processes: inputs (precipitation patterns and types: orographic, frontal, convective) flows (interception, infiltration, direct runoff, saturated overland flow, throughflow, percolation, groundwater flow) and outputs (evaporation, transpiration and channel flow).

b. Physical factors within drainage basins determine the relative importance of inputs, flows and outputs (climate, soils, vegetation, geology, relief).

Climate

Soils

Vegetation

Geology

Relief

c. Humans disrupt the drainage basin cycle by accelerating processes (deforestation; changing land use) and creating new water storage reservoirs or by abstracting water. (Amazonia)

Human impact on precipitation:

Case study: Amazonia

Human impact on evaporation & evapotranspiration:

Human impact on interception:

Human impact on infiltration and soil water:

Human impact on groundwater:

INPUTS

FLOWS

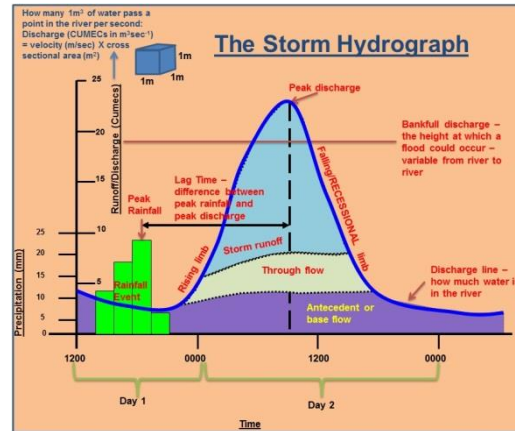
OUTPUTS

WATER EQ1: What are the processes operating within the hydrological cycle from global to local scale?

5.3 The hydrological cycle influences water budgets and river systems at a local scale.

c. Storm hydrographs shape depends on physical features of drainage basins (size, shape, drainage density, rock type, soil, relief and vegetation) as well as human factors (land use and urbanisation)

Draw rough sketch of 'flashy' and 'flat' hydrograph



a. Water budgets show the annual balance between inputs (precipitation) and outputs (evapotranspiration) and their impact on soil water availability and are influenced by climate type (☑ tropical, temperate, polar examples).

Factor	'Flashy' river	'Flat' river
Weather / climate		
Rock, soils, relief		
Drainage basin characteristics		
Vegetation		
Antecedent conditions		
Human activity		

b. River regimes indicate the annual variation of discharge of a river and result from the impact of climate, geology and soils as shown in regimes from contrasting river basins. (☑ Yukon, Amazon, Indus)

Key term	Definition
Resilience	Ability to recover from or adjust easily to an event or change.
Deficit	Where a resource is less than the necessary amount.
Permafrost	Zone of permanently frozen water found in high latitude soils and sediments.
Hard engineering	Often hi-tech and high-cost engineering schemes such as dams or the Thames Barrier.
Monsoon	A seasonal prevailing wind.
ENSO	An irregularly periodical variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean, affecting much of the tropics and subtropics; may also have impacts elsewhere around the world.
Meteorological	The science that deals with the phenomena of the atmosphere, weather and weather conditions.
Aquifer	An underground layer of water-bearing rock or void.

The Water Cycle and Water Insecurity

EQ2: What factors influence the hydrological system over short- and long-term timescales?

6 & 8 markers = AO1. 12 & 20 markers = AO1 and AO2 larger weighting

[6] **Explain** the role that the ENSO cycle plays in causing a deficit in the hydrological cycle (drought).

[8] **Explain** how climate change might have significant impacts on the operation of the water cycle.

[12] For a named flood event, **assess** the factors that exacerbate the impacts of flooding for people and the environment.

[20] **Evaluate** the significance of climate change in causing concerns over the security of water supplies.

WATER EQ2: What factors influence the hydrological system over short- and long-term timescales?

5.4 Deficits within the hydrological cycle result from physical processes but can have significant impacts.

a. The causes of drought, both meteorological (short-term precipitation deficit, longer trends, ENSO cycles) and hydrological.

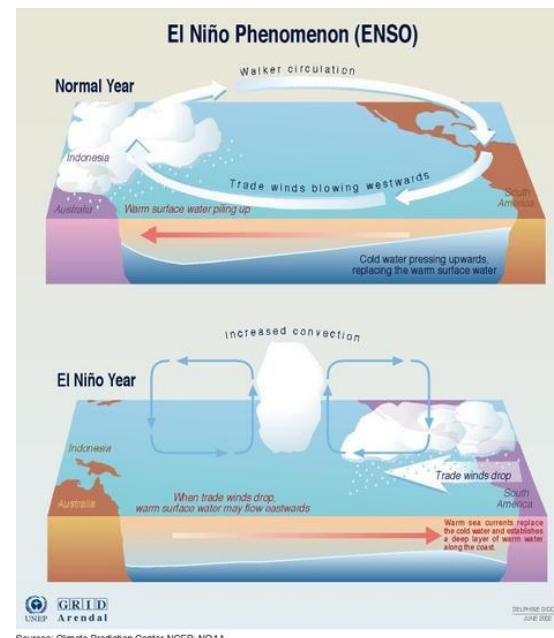
Meteorological drought

Agricultural drought

Hydrological drought

Famine drought

The El Nino-Southern Oscillation (ENSO)



b. The contribution human activity makes to the risk of drought: over-abstraction of surface water resources and ground water aquifers. (2 Sahelian drought; Australia)

Case study: The Sahel region of Africa

Case study: Australia

c. The impacts of drought on ecosystem functioning (wetlands, forest stress) and the resilience of these ecosystems

WATER EQ2: What factors influence the hydrological system over short- and long-term timescales?

5.5 Surpluses within the hydrological cycle can lead to flooding, with significant impacts for people.

a. Meteorological causes of flooding, including intense storms leading to flash flooding, unusually heavy or prolonged rainfall, extreme monsoonal rainfall and snowmelt.

b. Human actions that can exacerbate flood risk (changing land use within the river catchment, mismanagement of rivers using hard engineering systems.)

c. Damage from flooding has both environmental impacts (soils and ecosystems) and socio-economic impacts (economic activity, infrastructure and settlement). (☑ UK flood events 2007 or 2012)

Environmental impacts of England & Wales flood 2007

Socio-economic impacts of England & Wales flood 2007

WATER EQ2: What factors influence the hydrological system over short- and long-term timescales?

5.6 Climate change may have significant impacts on the hydrological cycle globally and locally.

a. Climate change affects inputs and outputs within the hydrological cycle: trends in precipitation and evaporation.

Precipitation

Evaporation

b. Climate change affects stores and flows, size of snow and glacier mass, reservoirs, lakes, amount of permafrost, soil moisture levels as well as rates of runoff and stream flow.

STORAGE

Soil moisture

Reservoir, lake and wetland storage

Snow and ice storage

Permafrost

FLOWS

Runoff and stream flow

Groundwater flow

c. Climate change resulting from short-term oscillations (ENSO cycles) and global warming increase the uncertainty in the system; this causes concerns over the security of water supplies.

Floods and the future

Low flows and drought in the future

Key vocabulary for EQ3

Key term	Definition
Water stress	When the demand for water exceeds the available amount during a certain period.
Salt water encroachment	Where saline water begins to find its way into freshwater aquifers, especially near coastal aquifers which run low, allowing salt water to seep back in and cause contamination.
Physical water scarcity	Where water availability does not meet water demand in a particular area. Arid regions often face this, such as southern Spain.
Economic scarcity	Occurs due to lack of investment in infrastructure so people cannot get access to water, or the price of it is at a point where the population cannot afford the amount they need.
Hydropolitics	Politics that surrounds the use of water between nations who share the same supply.
Trans-boundary water source	A water source that passes through more than one country, such as the Nile.
Territorial sovereignty	In terms of water supply it is where a country claims ownership and rights over the water when the source of it begins in their country, such as Ethiopia and the Nile.
Territorial integrity	Where a country claims that they should continue to get the same amount of water as they always have from a shared water source that doesn't begin in their country.

The Water Cycle and Water Insecurity

EQ3: How does water insecurity occur and why is it becoming such a global issue for the 21st century?

6 & 8 markers = AO1. 12 & 20 markers = AO1 and AO2 larger weighting

[6] **Explain** the global pattern of water stress and water scarcity.

[8] **Explain** the physical and human causes of water insecurity.

[12] **Assess** the extent to which some approaches to future water supply management are more sustainable than others.

[20] **Evaluate** the extent to which conflicts might occur between users within a country, and internationally, over the use of water and energy.

WATER EQ3: How does water insecurity occur and why is it becoming such a global issue for the 21st century?

5.7 There are physical causes and human causes of water insecurity.

b. The causes of water insecurity are physical (☒ climate variability, salt water encroachment at coast) as well as human (☒ over abstraction from rivers, lakes and groundwater aquifers, water contamination from agriculture, industrial water pollution).

Physical causes of water insecurity

Human causes of water insecurity

a. The growing mismatch between water supply and demand has led to a global pattern of water stress (below 1,700 m³ per person) and water scarcity (below 1000 m³ per person).

c. The finite water resource faces pressure from rising demand (increasing population, improving living standards, industrialisation and agriculture), which is increasingly serious in some locations and is leading to increasing risk of water insecurity

Physical distribution

Gap between rising demand and diminishing supplies

Dwindling supplies

Water availability gap

WATER EQ3: How does water insecurity occur and why is it becoming such a global issue for the 21st century?

5.8 There are consequences and risks associated with water insecurity

a. The causes of and global pattern of physical water scarcity and economic scarcity and why the price of water varies globally.

Physical water scarcity

Economic water scarcity

The price of water

b. The importance of water supply for economic development (industry, energy supply, agriculture) and human wellbeing (sanitation, health and food preparation); the environmental and economic problems resulting from inadequate water.

Economic development

Human wellbeing

c. The potential for conflicts to occur between users within a country, and internationally over local and trans-boundary water sources (e.g. Nile, Mekong)

WATER EQ3: How does water insecurity occur and why is it becoming such a global issue for the 21st century?

5.9 There are different approaches to managing water supply, some more sustainable than others

a. The pros and cons of the techno-fix of hard engineering schemes to include water transfers, mega dams and desalination plants (Water transfers in China).

Water transfers

Mega dams

Desalination plants

b. The value of more sustainable schemes of restoration of water supplies and water conservation (smart irrigation, recycling of water) (Singapore).

c. Integrated drainage basin management for large rivers (Nile, Colorado)

and water sharing treaties and frameworks (United Nations Economic Commission for Europe (UNECE) Water Convention, Helsinki and the Water Framework Directive and Hydropower, Berlin)