Focus	Geographical content
3.1.1 The concepts of system and mass balance	• Inputs, outputs, stores and flows in the water cycle, including the concept of mass balance • Distribution, size and characteristics of major stores of water including lakes, oceans, atmosphere and cryosphere, vegetation, soil and groundwater stores • Change in size of stores over space and time including , sea-level change and cryospheric processes (ice accumulation and ablation) • Processes which control transfers within and between land, ocean, atmosphere and cryosphere at a range of time (minutes to millennia) and space (hillslope to global) scales
3.1.2 Catchment hydrology – the drainage basin as a system	Example(s) from Wales should be used to illustrate the following: • Input: precipitation type, amount, duration and intensity • Flows: throughfall and stemflow, infiltration, overland (saturation and infiltration excess) flow, throughflow, percolation, groundwater flow and channel flow • Stores: interception store, vegetation store, surface store, soil moisture store, channel store, groundwater store • Outputs: evaporation, transpiration and channel discharge to oceans
3.1.3 Temporal variations in river discharge	• Characteristics of river regimes including simple and complex regimes • Factors influencing river regime characteristics including climate, season, geology, vegetation and land use • The components and shape of storm hydrographs • Climatic factors influencing storm hydrographs including precipitation type, amount, duration and intensity, temperature, evaporation, transpiration and antecedent conditions • River catchment characteristics influencing storm hydrographs including size and shape, drainage density, porosity and permeability of soils and rock types, slopes, vegetation and land use

Key Definitions (useful for introductions to link to A02 and key concepts)

The hydrological cycle is open and closed operating in Mass balance causing fluctuations upon local and global scales creating a dynamic equilibrium. Discharge is the amount of water at one point in the river (Channel store) at one point in time measured in cumecs (cubic metres per second). Annual variations in discharge and flow etc is referred to as a river regime can be simple and complex. Lag time is the time between peak rainfall and peak discharge. Therefore, short lag times can result in higher peak discharge as there is little delay between precipitation landing and entering river as it ends up as surface run off for a plethora of reasons:

What physical factors influence discharge?

- **Shape** circular (by mouth especially) basins have a shorter lag time
- **Steep sided** mean that less infiltration and shorter lag time as gravity moves surface water faster as less distance from watershed
- **Size**- smaller basins can mean that discharge can reach higher peaks due to shorter lag, as it takes less time to enter river
- **Geology – soils**, sandy soils with larger pores allow for more infiltration and thus a shorter lag time as water has to travel more slowly via throughflow, whereas clays with small pores limit infiltration leading to excess run-off. If any soils become saturated when they reach field capacity they no longer allow infiltration thus more surface run off and shorter lag times aka saturation-excess. However, infiltration-excess is when infiltration cannot happen due to rainfall intensity no matter how dry the soil is.
- **Geology- rock**, granite is impermeable and sandstone and chalk are permeable, so is carb limestone in bedding planes and joints due to porous characteristics
- **Drainage density** – higher densities of surface flows are found where there are impermeable rock leading to shorter lag times and more flashy conditions
- **Deforestation/ vegetation**- where there is natural cover 50% of rainfall infiltrates, 40% is intercepted and only 10% runs off. 80% of forests in Uk which protected are now removed, reducing resilience and making it harder to deal with any increased risk.
- **Cold temperatures** reducing evapotranspiration and reducing vegetation growth
- **Intense and long duration rainfall** will cause ground to reach field capacity quicker and cause infiltration-excess **(most significant causes of RO)**
- **Antecedent conditions**- when rainfall prior to an event creates wet conditions leading to increased ground saturation leading to shorter lag and higher PD
- **Glaciers**- in winter will hold back water leading too large discharges in winter e.g. Mohawk and then meltwater in summer plus permafrost reduces infiltration
- **Soil Depth** – deeper soil holds more water and has higher field capacity causing less run off

Essay Plan- examine the significance of physical and human causes causing water cycle deficits? (Make sure linked back to deficit in cycle, e.g. stores)

	A01	A02
Intro	Hyd Cycle def works in MB varies globally forming dynamic equilibrium, drought def, lack in local scale open system, diff drought conditions, diff types of droughts (above), 0.003% (closed)	No. significant causes, introduce some of both human and physical causes begin examining
Physical (link in climate change but note its anthropogenic otherwise the 'blob' most sig in Cali)	Meteorological and agricultural D Lack of precipitation- less snow and higher temperatures from EN 28 inches to 1.5 less water in rivers etc in summer less water when warmer, la Nina initiated warm air mass blob 4 years as well as extreme drought and HP conditions and changing wind flow and storm tracks leading to further decrease and deficit. Reservoir deficit to 41% of capacity forced to use ground water. Orographic Sierra Nevada and Coastal Ranges rain shadow.	Larger scale climate change contributed 8-27% would still have happened but would've been 15-20% less severe. La nina most significant enabled the 4 year 'blob' and other drought causing conditions and orographic shadow (depletes rain moisture no rain) often occurs so wouldn't explain the record-breaking drought disrupt MB// DE.
Human (Agriculture (ag) most substantial cause- 80% use, only 2% economy)	Hydraulic D, over extraction of groundwater e.g.Cali 30%-> 75% usage of Ground Water in 2012-2016, 5.5 trillion gallons, domestic 39million depletion of aquifers, pop & wealth growth, agriculture 7.6 trillion gallons per year, wasteful irrigation of ½ million acres avoid surplus, provide 80% global almons which use 1 gallon each to grow this industry uses 80% water but only 2% of economy (disproportionate)	Significant causes of lack of water leading to strict measures on domestic use, but not agriculture due to political influence. Thus agriculture far more impactful and wasteful especially considering its lack of economic importance. But previous over-extraction from all areas worsened a lot. Low resilience.
Conc	Both very significant but physical factors were the principal cause but worsened substantially by human activity. This is because physical factors resulted in the	

This will perhaps most notably (concerning water cycle) will create water security problems big time China + India Rapid pop growth +glob as Cryosphere melting is unstainable as it is not being replenished causing potential water shortage.

Huge difference of we exceed threshold (see graph on book) where our lowest possible scenario vs worst possible scenario.

Essay Time

Asses the impact of increasing atmospheric carbon on aspects of the water cycle

Intro	Due to pop growth of from 1bn in 1750 to 7.9 billion now as well as globalisation and consequent growing consumption nof energy and other resources atmospheric carbon has significantly inc4eased in recent decades. For instance, 206 (1750)-410 ppm which without global governance/ action will breach threshold and is already being witnessed by a number of substantial impacts on water cycle influencing its flows, inputs, outputs and stores across a variety of scales disrupting the dynamic equilibrium.
1st River Discharge (Local)	Significant increase in overland excess flow e.g. Storm Desmond in Cumbria made 40 % more likely due to climate change 341mm of rain 24 hours as Increased seasonality may create more flashy conditions as ground hard in summer thus lack of infiltration and lots of run off, although precipitation amount won't change (closed system) its increased seasonality has seen an increase in annual run off exaggeration of pattern e.g Avon and Mohawk Only local impact on river discharge whilst flooding could be serious impact will depend on other factors like resliance, topography for orthographic etc thus precipitation patterns more sig
2nd Storms/ precipitation patterns (Regional)	As an open system regionally/ locally increased seasonality e.g. UK warmer air from oceans will carry more moisture making it harder to condense and reach dew point in summer but this increased energy (as more water vapour in atmosphere is storm fuel) will ultimately increase the turbulence and storms of our metrological system which will in turn affect the water cycle. Therefore, in UK we would expect more seasonal rainfall with more in winter due to increased frontal rain and less in summer due to less frontal rain since temperatures warmer. Can cause significant consequences but is arguably worse elshwere e.g. Scandanaia as tehres a change in amount and type but not in UK and in Sunderbans less resilient etc Strom Aila Bangladesh 2009, Cat 1 aprox 74 mph winds – not powerful but hit very poor area- Sundarbans where majority are on les sthan $1 per day thus 330 killed 500k