1.7 Factors affecting changes in the water cycle

In this section you will learn about the factors affecting changes in the water cycle

Natural (physical) variations affecting change

Extreme weather events such as severe storms or periods of drought can have significant impacts on the water cycle. They can affect both stores and transfers.

Californian drought (2012–16)

California suffered a severe drought between 2012 and 2016 (Figure **1**). Rivers and lakes dried up, agricultural productivity declined and fires raged across tinder-dry forests and grasslands.

- Drought causes reduction in water stores in rivers and lakes.
- Vegetation dies back or is destroyed by fire – it affects processes such as transpiration, interception and infiltration.
- Groundwater flow becomes more important – it is a long-term transfer and not affected by short-term weather extremes.

- Heat and dry air causes initial high rates of evapotranspiration. This declines as water on the ground dries up (less water available to be evaporated) and trees transpire less.
- Soils dry out – the soil water store is reduced and throughflow ceases.

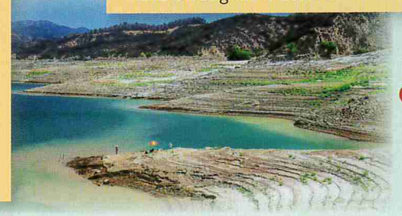

Figure 1 *Castiac Lake, California at half its usual capacity, 2014*

Seasonal changes are quite marked in mid- to high-latitude countries.

Figure 2 *Some of the effects of summer and winter variations on the UK water cycle*

Water cycle component	Summer	Winter
Precipitation	Total rainfall may be less but storms are more frequent.	Greater quantities of rainfall with a likelihood of snow.
Vegetation – interception, transpiration, etc	Vegetation grows rapidly increasing interception and transpiration.	Vegetation dies back reducing interception and transpiration.
Evaporation	Higher temperatures encourage rapid evaporation (warm air can hold more moisture).	Lower temperatures reduce rates of evaporation.
Soil water	Dry soils encourage infiltration. But hard, baked soils encourage overland flow.	Soils may become saturated, leading to overland flow.
River channel flow	Low flow conditions are more likely.	High flow conditions are more likely.

Human activities affecting change

Land-use change

The land-use changes that impact the most on the water cycle are urbanisation and deforestation.

- Urbanisation is the replacement of vegetated ground with impermeable concrete and tarmac. Water cannot infiltrate the soil, which increases overland flow and makes flooding more likely. Soil water and groundwater stores are reduced.
- Deforestation is the removal of trees, leading to surface runoff and soil erosion and reducing soil water stores.

Farming practices

Farmers are able to control the local water cycle through irrigation or land drainage. Soils covered with plants have higher infiltration and soil water rates, and, therefore, reduced runoff.

If **desertification** occurs (see 2.13), the capacity to retain water is much lower. This capacity is lost completely once the soil is sealed.

Water abstraction

The extraction of water from rivers or groundwater aquifers is referred to as *water abstraction*. Water that is abstracted for irrigation, industry and domestic purposes can have significant effects on the local water cycle.

Aquifers can become depleted. They can also become contaminated by inflowing saltwater if the water table drops below sea level – this has become an issue with the chalk aquifer beneath London. Abstraction can result in low flow conditions in rivers, which can have harmful impacts on ecosystems.

Irrigation in the Middle East

Irrigation has a significant impact on water stores (aquifers and rivers) and transfer processes (evaporation and infiltration). In parts of the Middle East, water is being abstracted from underground aquifers that were formed thousands of years ago. They are in serious danger of becoming depleted as the rate of recharge is far slower than the rate of use. Figure **3** shows how technology can be used to reduce evaporation in hot environments.

Figure 3 *Netting of a banana plantation, the Jordan Valley, Israel*

Land drainage in the UK

The low-lying land of the East Anglian Fens and the Somerset Levels were once submerged. Through the construction of deep drains and a network of ditches, which move water quickly through the system, this land is now highly productive farmland, although still vulnerable to occasional floods (Somerset in 2014). Moorland drainage ditches have been held partly responsible for increasing the flood risk in the city of York.

The drainage of peatlands can have significant impacts on both the water cycle and the carbon cycle – the water table is lowered, changing rates of infiltration and evaporation. Dry peat is friable and vulnerable to erosion. In the past, excessive drainage in the Fens led to clouds of peat being formed – during the infamous 'Fen Blows' peat would be whisked up into the air to create huge black clouds.

Peatlands are essentially thick deposits of partly decomposed vegetation and, as such they act as important carbon stores. English peatlands alone are thought to store some 584 million tonnes of carbon. Vegetation on top of the peat also absorbs carbon dioxide from the atmosphere. As the peatlands are drained, air penetrates deeper, enabling decomposition of the carbon, releasing carbon dioxide. Dry peat can also ignite releasing carbon. It has been estimated that if all the peat in England were to be destroyed, the amount of carbon released to the atmosphere would be equivalent to about five years of England's current carbon dioxide emissions!

ACTIVITIES

1 Study Figure **1**.
   - **a** Draw a simple diagram to show the water cycle. Add annotations to show how a drought can impact on its stores and transfers.
   - **b** Work in pairs to attempt a similar diagram to show the impacts of a severe storm event.
2 Figure **2** describes the influence of seasonal changes on selected components of the water cycle. Suggest impacts for stores and transfers that are not listed in the table.
3 Outline ways in which human activities can lead to changes in the stores and transfers in the water cycle.

STRETCH YOURSELF

In 2015 floods in South America, drought in East Africa and even the warmest and wettest December on record in the UK, have all been linked to the cyclical phenomenon, *El Niño*. Every six years or so, warmer water replaces the cold water in the Eastern Pacific off the coast of South America. This has direct consequences for the local weather patterns and also global weather conditions. These short-term cycles have implications for the water cycle – rainfall patterns become distorted which, in turn, affect other stores and transfers.

Find out more about the 2015/16 El Niño event. Describe the effects that it had on the world's weather and consider the implications of these effects on stores and transfers within the water cycle. Is there any connection between El Niño and climate change?