# Drainage Basin Systems *Pt. 2/2*

| What you need to know |
|---|
| How runoff varies within the water cycle. |
| How to analyse a flood hydrograph |
| How the water cycle changes over time |

**Introduction:**

Runoff (the flow of water over the Earth's surface) can vary depending upon a range of physical and human factors.

**Physical factors affecting runoff:**

***Time of year:*** *In temperate climates, where seasonal change is evident, runoff levels can vary greatly throughout the year.*

*In summer, runoff levels can be low due to a reduction in rainfall. Soil saturation levels will be low and therefore any rainfall at this point can easily infiltrate into the ground. However, intense baking of the soil by the sun can lead to the soil becoming effectively impermeable and summer storms can lead to high levels of runoff as the rain is unable to soak in. This can lead to flash floods.*

*In winter, precipitation may be in the form of snow and the water may be stored on the ground due to low temperatures. Warmer temperatures in spring may lead to snowmelt and this can lead to the soil reaching field capacity quickly. Further meltwater will therefore run over the surface.*

***Storm conditions:*** *Intense storms with heavy rainfall can lead to soils quickly becoming saturated. This can happen in two ways:*

- *Prolonged rainfall – moderate to high volumes of rainfall over a sustained period can eventually saturate the soil leading to runoff.*
- *Intense rainfall – heavy rain in a short period can bounce and then flow over the Earth's surface as runoff.*

***Vegetation cover:*** *Vegetation can intercept precipitation and reduce runoff. Leaves and stems can capture rain and prevent it from reaching the ground. It will eventually reach the ground but the process will have been slowed by the vegetation and therefore water will infiltrate into the ground rather than runoff.*
*Dense vegetation can absorb large volumes of water even in storm conditions, which will prevent runoff.*

***Soil saturation levels:*** *Where field capacity is reached in the soil, no more infiltration can take place and therefore runoff will occur.*

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***Topography & relief:*** *In "v" shaped valleys on steep slopes, runoff will increase due to gravity. On flatter surfaces runoff is less likely to happen as water will be able to infiltrate into the soil more easily. Equally, an undulating relief can allow water to collect and reduce runoff.*

## Human factors affecting runoff:

***Agricultural land use:*** *Initially, agricultural land use can have the same impact as vegetation cover, in that crops can intercept precipitation and reduce runoff. However, intensive agriculture where irrigation may be used, can cause waterlogged soils and therefore lead to runoff. Heavy use of agricultural machinery can compact the soil and reduce its infiltration capacity, making runoff more likely.*

***Urban land use:*** *Changing greenfield surfaces to impermeable concrete and tarmac as construction takes place can increase the level of runoff in an area.*

**Flood Hydrographs** are graphs that show how a drainage basin responds to a period of rainfall. They are used to plan for flood situations and times of drought. They show the river discharge that occurs as a result of precipitation from an earlier storm.

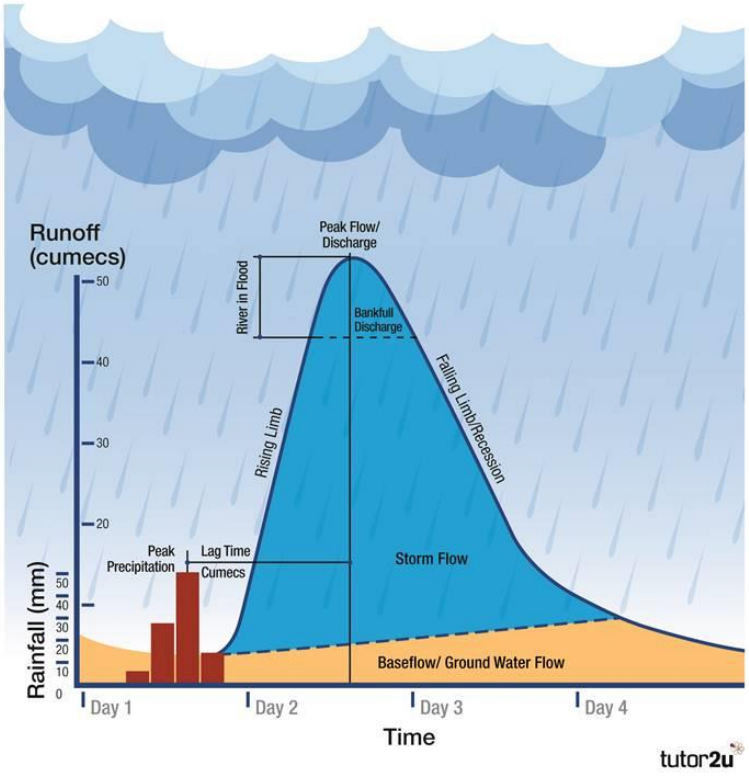
## Physical factors affecting flood hydrograph dynamics:

Drainage basins all have a variety of characteristics. The range of characteristics can affect how likely a river within the basin will flood.

***Size****: the smaller the drainage basin the less time it takes for water to reach the river, resulting in a shorter lag time and vice versa.*

***Topography & relief****: the steeper the basin the more quickly it drains. Indented landscapes will collect water and reduce runoff rates.*

***Heavy Storms****: runoff will increase after soil field capacity is met which means water will reach the channel quicker.*



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***Snowfall**: until the snow melts, the water is held in storage but when the snow melts this can lead to flooding.*

***Vegetation**: this can reduce discharge as it intercepts precipitation. Roots of plants can also take up water that goes into the soil.*

***Rock type:** the underlying geology varies within drainage basins and can be permeable (allowing water through) or impermeable (not allowing water through). Impermeable rocks encourage greater amounts of surface run-off and a more rapid increase in discharge than permeable rocks.*

## Natural changes over time affecting water cycles:

- ***Storm events:** these lead to an increase in both channel flow and surface runoff. Depending upon the drainage basin, flood events can occur.*
- ***Seasonal changes:** seasons with high levels of precipitation lead to increased surface runoff and channel flow. In contrast, drier seasons will lead to reduced river discharge and no runoff. In mountainous regions, increased channel flow and run off can occur due to ice melt. Countries to the south of the Himalayas will face flooding during this time but also will utilise the extra water for agricultural and domestic use.*
- ***Ecosystem changes:** plant successions may change the dominant type of vegetation in an area. If vegetation dies off due to natural events there will be less absorption of water by plant roots, and less transpiration – which may reduce precipitation.*

## Human changes over time affecting water cycles:

- ***Climate change**: increasing global temperature is leading to a reduction in size of mountain glaciers and therefore future dependency on this water will become more of an issue as this input declines after a period of increased discharge. Potential drought conditions and associated economic and social impacts will be likely consequences.*
- ***Farming practices:** particularly in hotter climates, farming can have a significant effect on the water cycle. Irrigation for plants can lower channel levels in rivers together with groundwater levels if wells are the source for the irrigation.*
- ***Deforestation:** removing vegetation for agriculture, urbanisation or – most frequently in many rural developing countries – for fuel supply, an important water store and water-transfer capacity is lost. Soil moisture reduces, transpiration*

*declines and micro-climates give less precipitation, leading to local river systems drying up.*

- ***Land use change:*** *change from natural landscape to urbanised landscape increases impermeable surfaces. This leads to an increase in runoff and a reduction in infiltration. Cities create drainage systems to take water quickly away from the urban environment. However, this can lead to flooding as river levels then receive this water too quickly in a large amount.*

- ***Water abstraction:*** *growth of global population and in particular in countries where climates are drier has resulted in increased water demand. Where precipitation levels are low, an alternative supply is ground water. This supply of water in porous rocks underground is known as an aquifer. Excessive abstraction of this water, where it is taken too quickly and does not recharge naturally, is unsustainable and can lead to groundwater stores being depleted.*

  *River water is also used for water supplies for both domestic and industrial uses and that can affect river levels. In conjunction with limited groundwater reaching the river, the river can ultimately dry up.*

Make sure you learn about this – a very key concept which has been increasing for many years and is posing a problem in many areas of the world, notably Cape Town. Link to PowerPoint here!