Teacher guidance

1 Changing river environments

**1.1 The main hydrological characteristics and processes that operate in rivers and drainage basins**

1.1 Topic summary

This first unit will explain the characteristic features of a river and its drainage basin. It will explore how a drainage basin operates within the water cycle. It will look at the processes that operate in a drainage basin and also within a river.

**Prior learning**

It would be useful for students to have previously studied rivers and the water cycle.

**Key terms**

**Abrasion/corrasion** The wearing away of the river bed and banks by the river’s load hitting them repeatedly.

**Aquifer** A rock that allows water to move through it, such as a layer of sandstone.

**Attrition** The process by which particles of rock being transported by a river are rounded and become smaller in size by being struck against one another. Particles near the shoreline become smaller and more rounded due to more frequent attrition.

**Bedload** Material rolled along the river bed.

**Bradshaw model** A geographical model that suggests how a river’s characteristics change from the source to the mouth of the river.

**Channel flow** The movement of water within the river channel.

**Channel network** The pattern of a main river and its tributaries within a drainage basin.

**Channel roughness** The frictional force of a river bed. A rough bed (with boulders, pebbles, potholes) exerts more friction than a smooth channel.

**Closed system** A system unconnected to other entities. It has no inputs from, or outputs to, elsewhere.

**Condensation** The process by which water vapour changes into water droplets.

**Confluence** The point where a tributary stream/river joins a main river.

**Deposition** The laying down of material carried by rivers or the sea because of a reduction of velocity or discharge (both causing a loss of energy), often caused by increased friction with vegetation or coarse particles.

**Desert** A dry area with limited vegetation. Deserts can be either hot or cold. Characteristics common to all deserts include irregular rainfall of less than 250 mm per year.

**Direct channel precipitation** Rainfall and snow falling directly into a river or stream.

**Discharge** The amount of water passing a specific point at a given time (the volume times the velocity). It is measured in cubic metres per second.

**Drainage basin (or catchment area)** The area of land drained by a river system.

**Drainage density** The total length of all the streams and rivers in a drainage basin divided by the total area of the drainage basin.

**Erosion** The wearing away of the Earth’s surface by a moving agent, such as a river, glacier or the sea. In a river, there are several processes of erosion, including hydraulic action, abrasion, attrition and solution. In coastal areas, hydraulic action is the most potent form of erosion.

**Evaporation** The process in which a liquid turns to a vapour.

**Evapotranspiration** A combination of the processes of evaporation and transpiration. Vegetation takes in moisture through its root system. It loses some of this into the air by transpiration. Surface water is also lost by evaporation.

**Flood** A discharge great enough to cause a body of water to overflow its channel and submerge (flood) the surrounding area.

**Friction** The resistance encountered when one body moves relative to another body with which it is in contact.

**Groundwater** Water stored underground in a permeable rock, e.g. chalk or sandstone.

**Groundwater flow** The flow of water through permeable rock.

**Hydraulic action** The erosive force exerted by water alone, such as the sheer force of river water removing loose material from the bed and banks of the river. It is particularly effective on jointed rocks, especially during storm conditions.

**Hydraulic radius** A measure of the efficiency of a stream’s shape – that is, the cross-sectional area divided by the wetted perimeter. The higher the ratio, the more efficient the stream and the smaller the frictional loss. The ideal form is semi-circular.

**Hydrological cycle** The movement of water between air, land and sea.

**Impermeable** Rocks that do not allow water to pass through.

**Infiltration** The initial movement of water from the surface into the upper level of the soil.

**Interception** The precipitation that is collected and stored by vegetation.

**Lateral erosion** Sideways erosion of a river bank that results in its valley getting wider.

**Load** The particles of sediment and dissolved matter carried along by a river.

**Long profile of a river** A longitudinal section of the course of the river, drawn along the river from source to mouth.

**Mouth** The point at which a river flows into a much larger body of water – an ocean, sea or lake.

**Overland flow** Water flowing over the surface under the influence of gravity. It occurs when the soil is saturated.

**Percolation** The downward, vertical movement of water within soil or rock.

**Permeable** Rocks that allow water to pass through, either due to porosity (large volume of pore spaces) or due to being pervious (having joints and cracks/fissures).

**Precipitation** Water that falls to the Earth from the atmosphere. It is part of the hydrological cycle. Forms of precipitation include rain, snow, sleet, hail, dew and frost.

**River velocity** The speed at which water is flowing, in metres per second (m/s).

**Saltation** When larger particles of a river’s load (sands, gravels, very small stones) are transported in a series of ‘hops’ or bounces along the river bed. It is the means by which bedload (material that is too heavy to be carried in suspension) is transported downstream.

**Saturated** When the soil is so full of water that it cannot absorb any more.

**Solution** The process by which the minerals in a rock, notably calcium ions, are dissolved in acid water. Solution is one of the processes of erosion.

**Source** The origin or starting point of a river.

**Stemflow** Water that trickles down plant stems and tree trunks.

**Store (of water)** A body of water that receives, holds and releases volumes of water. On land, these include rivers, lakes, reservoirs and aquifers.

**Surface runoff** The unconfined flow of water over the ground surface. It occurs when excess precipitation can no longer infiltrate into the soil.

**Suspension** When the smallest and lightest particles of a river’s load (silts and clays) are carried in suspension by the moving water.

**Throughflow** The flow of water through the soil under gravity.

**Traction** The sliding or rolling of sediment along the river bed or sea floor.

**Transfer (of water)** The movement of water between stores in the hydrological cycle.

**Transpiration** The loss of moisture from vegetation into the atmosphere.

**Transportation** The movement of a river’s load by the processes of traction, saltation, suspension and solution.

**Velocity** The speed of a river’s water, measured in metres per second.

**Vertical erosion** Downward erosion occurring in the upper course of the river, where the river cuts down into its bed, deepening the valley.

**Water table** The upper level of groundwater saturation in permeable rocks.

**Watershed** A ridge of high land that forms the boundary between two drainage basins.

**Wetted perimeter** The total length of the cross-section at the interface between a channel bed and the stream water that occupies it.

**Techniques for fostering geographic skills**

* Drawing cross-sections and long profiles
* Cross-sectional area and wetted perimeter
* Interpreting Bradshaw’s model
* Interpreting the water cycle model

**Incorporating technology**

**For students:**

* Consider using digital tools like Google Earth, GIS software and online simulations:
  + Online simulation – The Cycling of Water | PBS LearningMedia (<https://www.pbslearningmedia.org/resource/buac20-68-sci-ess-cyclingofwater/the-cycling-of-water/>)
  + Earth’s Water Cycle | NASA Goddard (<https://youtu.be/oaDkph9yQBs>)
  + Hydrologic and carbon cycles |CrashCourse (<https://youtu.be/2D7hZpIYlCA>)
  + Understanding Rivers | National Geographic (<https://education.nationalgeographic.org/resource/understanding-rivers/>)

**For teachers**

* Unit of work from RGS – Rivers |RGS (<https://www.rgs.org/schools/resources-for-schools/rivers>)
* ‘Rivers of life’ Search Results | PBS – Rivers of life PBS (<https://www.pbs.org/search/?q=rivers%20of%20life>)

**Hands on activities to encourage:**

* Sketching – practise drawing diagrams like cross-sections of a river (upper, middle, and lower courses) with labelled features.
* Create a simple river model using sand, water and a slope to demonstrate erosion and deposition.

**Fieldwork opportunities**

* Investigate infiltration rates – measure how different surfaces absorb water using an infiltration ring.
* Assess how erosion affects river banks at different locations using a tape measure to record the width of the river at various points and then comparing the steepness of river banks using a clinometer or ranging poles. Note signs of undercutting, collapsing banks or vegetation coverage.

**Case Studies**

Encourage learning real-world examples:

* River Severn (UK): Longest river in the UK, showcasing features like estuaries.
* Amazon River (South America): Focus on scale, biodiversity, and human use.
* River Nile (Africa): Example of a river's importance for civilisations.

**Links to other topics**

Erosion, transportation and deposition are covered within Topic 2, Changing coastal environments.

**Climate education**

* **Impact on water cycle:**Climate change affects the water cycle, including changes in precipitation patterns, increased evaporation rates and altered river flows. Relate this to the processes of evaporation, condensation and precipitation.
* **Glacial melt:**Melting glaciers in river source regions have implications for river flow and downstream water availability. Connect this to the sources of rivers, such as the Gangotri Glacier for the River Ganges.
* **Extreme weather events:**Climate change increases the frequency and intensity of extreme weather events, such as floods and droughts, and their impact on river systems. Link this to river hazards and management strategies.
* **Online resources:** NASA Earth’s ‘Water Cycle’ and National Geographic's ‘Understanding Rivers’ help to visualise climate impacts on rivers.