

Class 11 · Geography (029) · Part A: Fundamentals of Physical Geography · Unit III: Landforms ·

Chapter 6 · CBSE 2026-27

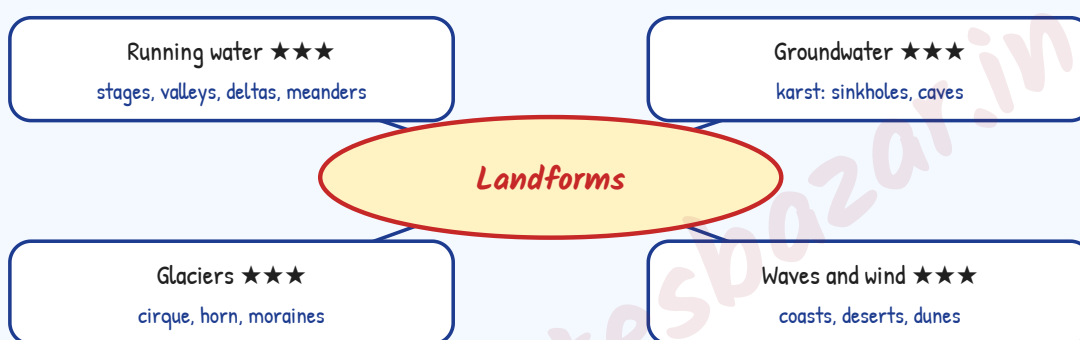
Chapter 6

Landforms and their Evolution



Landforms and landscapes · stages of evolution · running water: youth, mature, old; peneplain · valleys, gorges, canyons, potholes, plunge pools, incised meanders, terraces · alluvial fans, deltas, floodplains, levees, point bars, meanders, oxbow lakes · groundwater and karst · glaciers: cirques, horns, troughs, moraines, eskers, drumlins, outwash plains · waves and currents: rocky and sedimentary coasts · winds: pediments, playas, mushroom rocks, sand dunes

Chapter map (★ = most important for exams)



Syllabus and weightage

Unit III, Landforms — a high-scoring chapter for long answers and diagrams. Question types: MCQ (1), short answer (3), long answer (5), diagram/picture based. Important: erosional and depositional landforms of each agent, stages of a river, karst, glacial forms, coasts of India, desert landforms.

★ **Exam tip:** **Landforms** = small to medium tracts of the earth's surface, each with its own shape, size, material and making process; several related landforms make a **landscape**. Each landform has a history — evolution through stages like **youth, maturity and old age**, modified by changes in climate and crustal movements.

6.1 Running water ★★★

- Most important agent in **humid** regions. Two components: **overland flow** (sheet) and **linear flow** (streams, rivers).
- Erosional forms are linked with vigorous, youthful rivers on **steep** gradients; as gradients become gentle, rivers lose velocity and **deposition** increases; lateral erosion grows; hills and valleys are reduced to plains.
- Sheet erosion** → **rills** → **gullies** → network of **valleys**. Early: down-cutting removes waterfalls and cascades; middle: lateral erosion; finally divides are flattened → lowland of faint relief with resistant remnants called **monadnocks** – a **peneplain** ("almost plain").

Stage	Features
Youth	Few streams, poor integration; shallow V-shaped valleys; no or narrow floodplains; broad flat divides with marshes, swamps, lakes; waterfalls and rapids where hard rocks are exposed; down-cutting dominates
Mature	Plenty of well-integrated streams; deep V-shaped valleys; wider floodplains with meanders ; swamps disappear; sharp divides; waterfalls and rapids disappear
Old	Few tributaries, gentle gradients; streams meander freely over vast floodplains with natural levees, oxbow lakes ; broad flat divides with lakes and swamps; land near sea level

Erosional landforms ★★★

- Valleys**: from rills and gullies – V-shaped valley, gorge, canyon. **Gorge**: deep, very steep to straight sides; about equal width at top and bottom; in **hard rocks** (Kaveri near Hogenakkal). **Canyon**: steep **step-like** slopes, wider at top; in **horizontally bedded sedimentary rocks** (Colorado, USA) – a variant of a gorge.
- Potholes**: circular depressions on rocky beds of hill streams from erosion aided by **abrasion** of rotating pebbles and boulders. **Plunge pools**: large, deep potholes at the base of **waterfalls**.
- Incised/entrenched meanders**: deep, wide meanders cut in **hard rocks** (unlike ordinary meanders on gentle floodplains) – show renewed down-cutting after uplift.
- River terraces**: surfaces marking old valley-floor or floodplain levels – bedrock or alluvial; products of vertical erosion into the river's own floodplain; at the same height on both sides = **paired terraces**.

Depositional landforms ★★★

Landform	Features
Alluvial fan	Where streams from higher levels reach low-gradient foot slopes; coarse load dumped as a cone ; streams shift and form distributaries ; low gentle cones in humid areas, high steep cones in arid areas (e.g. on the way to Amarnath, J&K)
Delta	Like a fan but at the sea ; load not carried far spreads as a low cone; well sorted and stratified – coarse settles first, silt and clay carried into the sea; distributaries lengthen as it builds seaward (Krishna delta)
Floodplain	Major depositional landform; coarse materials first, fine sand, silt and clay in gentle channels and over banks in floods; active (river bed) and inactive (above banks) floodplains; channel deposits (coarse, in cut-off courses) and flood deposits (fine); in deltas = delta plains
Natural levees	Low, linear, parallel ridges of coarse deposits along banks of large rivers, often cut into mounds
Point bars (meander bars)	Sediments deposited on the convex side of meanders (inside of the bend) in a linear fashion; uniform profile; mixed sizes

Meanders ★★★

- Loop-like channel **pattern** (not a landform) on flood and delta plains (Burhi Gandak near Muzaffarpur, Bihar).

- Causes: (i) water on very gentle gradients works **laterally**; (ii) **unconsolidated** alluvial banks with irregularities; (iii) **Coriolis force** deflects water.
- Deposition on the **convex** bank (slip-off, gentle); undercutting on the **concave** bank (cut-off/undercut bank, steep scarp). Deep loops cut off at inflection points → **oxbow lakes**.

Levee vs point bar: levees are along both banks of large rivers from overbank flood deposits (coarse, parallel ridges); point bars are inside meander bends (convex side) from lateral deposition (mixed sizes).

6.2 Groundwater ★★★

- Water percolates into permeable, thinly bedded, jointed rocks, then moves horizontally along bedding planes and joints, eroding rocks. Mechanical removal is insignificant; in **limestones and dolomites** (calcium carbonate), **solution and precipitation** create landforms.
- **Karst topography:** landforms from groundwater solution and deposition, named after the **Karst** region in the **Balkans** near the Adriatic Sea.

Erosional	Description
Swallow holes	Small to medium round shallow depressions formed by solution
Sinkholes	Circular at top, funnel-shaped below; a few sq m to a hectare, under 0.5 m to 30 m+ deep; solution sinks (more common) and collapse sinks (= dolines , when a cave roof collapses); soil-covered ones look like pools
Valley sinks / uvalas	Long, narrow to wide trenches formed when sinkholes and dolines join by slumping or cave-roof collapse
Lapies	Irregular surface with sharp pinnacles, grooves and ridges from differential solution along joints; may become smooth limestone pavements
Caves	Formed along bedding planes where limestone alternates with shales, sandstones, quartzites or is thick and massive; mazes at different levels; caves open at both ends = tunnels

Depositional (in caves)	Description
Stalactites	Hang like icicles from the roof; broad at base, tapering
Stalagmites	Rise from the floor from drips below stalactites; column, disc or crater shapes
Pillars/columns	Stalactites and stalagmites fuse

Calcium carbonate dissolves in carbonated water and is deposited when water evaporates or loses CO₂. Surface run-off often disappears down sinkholes as underground streams and re-emerges through caves.

6.3 Glaciers ★★★

- Masses of ice moving as sheets (**continental** glaciers; **piedmont** at mountain foot) or as linear flows in trough-like valleys (**mountain/valley** glaciers). Slow – cm to m a day; driven by **gravity**.
- India: Himalayas of Uttarakhand, Himachal, J&K. **Bhagirathi** rises from **Gaumukh**, snout of the **Gangotri** glacier; **Alkapuri** glacier feeds the **Alaknanda**; they join at **Devprayag** to form the Ganga.
- Erosion is tremendous through friction of heavy ice – **abrasion and plucking** of large angular blocks; can reduce high mountains to low hills and plains with outwash plains.

Erosional	Description
Cirque	Most common; at heads of glacial valleys; deep, long, wide trough with very steep concave walls; lake left = cirque/tarn lake ; may be stepped

Horns	Sharp pointed peaks from headward erosion of three or more radiating cirques – Matterhorn (Alps), Everest
Serrated ridges / arêtes	Narrow saw-toothed divides between cirques with zig-zag crests
Glacial valleys/troughs	U-shaped , broad floors, steep smooth sides; hanging valleys at height with truncated spurs (triangular facets); troughs filled by sea = fjords

Depositional	Description
Glacial till	Unassorted coarse and fine angular debris dropped by melting ice. Outwash (glacio-fluvial) deposits: roughly stratified, assorted, rounded
Moraines	Ridges of till: terminal (at the toe), lateral (along sides, may join terminal as a horseshoe), ground (irregular sheet on valley floor), medial (centre, between laterals)
Eskers	Sinuous ridges of coarse material deposited by meltwater streams flowing in ice channels beneath the glacier
Outwash plains	Broad flat glacio-fluvial fans joined at the foot of glacial mountains – gravel, silt, sand, clay
Drumlins	Smooth oval ridges of till (up to 1 km long, ~30 m high); long axis parallel to ice movement; blunt steep stoss end faces the glacier, gentler tail ; indicate direction of movement

6.4 Waves and currents ★★★

- Coastal processes are the most **dynamic** and destructive; mostly by breaking waves; storms and **tsunamis** cause rapid change.
- Coastal landforms depend on waves, the configuration of land and sea floor, and whether the coast is **emerging** or **submerging**.

High rocky coasts (submerged)	Low sedimentary coasts (emerged)
Rivers appear drowned; highly indented ; fjords; hill sides drop sharply into water	Rivers extend by building coastal plains and deltas; smooth coastline with lagoons and tidal creeks; gentle slope; marshes, swamps
Erosion dominates: cliffs, wave-cut platform/terrace; later wave-built terrace, beaches, bars, spits, lagoons → coastal plain	Deposition dominates: bars, barrier bars, spits, lagoons → swamps → coastal plains; deltas
India's west coast – high rocky retreating	India's east coast – low sedimentary

Erosional coastal forms ★★★

- Wave-cut cliffs** (a few m to 30 m+) and **wave-cut terraces** (platforms at the cliff foot above average wave height).
- Sea caves**: lashing waves and debris hollow the cliff base; roofs collapse, cliffs recede.
- Sea stacks**: isolated resistant rock remnants left offshore – temporary.

Depositional coastal forms ★★★

- Beaches**: deposits mostly of sand (from rivers and wave erosion) – temporary; **shingle beaches** of pebbles and cobbles. **Sand dunes** behind beaches, parallel to coast.
- Off-shore bar**: sand/shingle ridge parallel to coast; exposed = **barrier bar**; keyed to one end of a bay or headland = **spit** (Godavari delta); bars and spits closing a bay form a **lagoon** → filled → coastal plain.

- Off-shore bars, barriers, beaches, dunes and **mangroves** are buffers against storms and tsunamis — disturbing the **sediment budget** exposes habitations.

6.5 Winds ★★★

- Dominant in hot deserts: dry barren floors heat quickly → rising air, turbulence, eddies, whirlwinds, updrafts and downdrafts.
- Wind acts by **deflation** (lifting dust), **abrasion** (sand as a tool) and **impact** (like sand-blasting).
- Running water (torrential rain, **sheet floods/sheet wash**) and mass wasting also shape deserts — weathered debris moved by wind and sheet wash; stream channels broad and short-lived.

Erosional	Description
Pediments	Gently inclined rocky floors at mountain foot, by lateral stream erosion and sheet flooding; slopes retreat by parallel retreat (backwasting) ; mountain reduced to an inselberg ; ultimately a featureless plain = pediplain
Playas	Shallow temporary lakes in the centre of basins with inland drainage; salt deposits; salt-covered plain = alkali flats
Deflation hollows	Shallow depressions from persistent wind removal; blow-outs → caves
Mushroom, table, pedestal rocks	Resistant remnants polished by abrasion — slender stalk with broad cap; table tops; pedestals

Depositional: sand dunes ★★★

Wind **sorts** grains (rolling, saltation, suspension) and deposits them by critical velocity. Dunes need sand and **obstacles**.

Dune	Formation
Barchan	Crescent , wings pointing downwind; constant moderate wind, uniform surface
Parabolic	Reversed barchan; sandy surface partly covered with vegetation
Seif	Barchan with one wing — shift in wind; wing grows long and high
Longitudinal	Long low ridges; poor sand supply, constant wind
Transverse	Perpendicular to wind; constant wind, elongated sand source at right angles

With plenty of sand, dunes coalesce; most shift, some stabilise near habitations.

NCERT exercises, solved ★★★

1. MCQs: (i) stage where downward cutting dominates (ii) deep valley with steep step-like sides (iii) region where chemical weathering dominates (iv) best definition of lapies (v) deep trough with steep concave walls at head and sides. 5

Ans. (i) (a) Youth stage. (ii) (d) Canyon. (iii) (a) Humid region. (iv) (d) An irregular surface with sharp pinnacles, grooves and ridges. (v) (a) Cirque.

2(i). What do incised meanders in rocks and meanders in alluvial plains indicate? 3

Ans. Meanders in alluvium indicate very gentle gradients where lateral erosion and deposition dominate (old stage). Incised meanders cut deep into hard rock indicate that an earlier meandering river began down-cutting vigorously — usually after uplift of the land (rejuvenation), retaining its meandering course.

2(ii). Evolution of valley sinks or uvalas.

3

Ans. In limestone areas, solution forms swallow holes and sinkholes; when sinkholes and dolines merge through slumping of their margins or collapse of underground cave roofs, long, narrow to wide trenches called valley sinks or uvalas form.

2(iii). Why is underground flow more common than surface run-off in limestone areas?

3

Ans. Limestone is soluble and highly jointed; water dissolves and widens joints, bedding planes, sinkholes and caves, so surface water quickly sinks through swallow holes and flows as underground streams, re-emerging through caves downstream.

2(iv). Linear depositional forms in glacial valleys — names and locations.

3

Ans. Moraines — **terminal** (at the toe/end of the glacier), **lateral** (along the sides of the valley), **medial** (in the centre, between lateral moraines) and ground moraine (on the floor); **eskers** (sinuous ridges on the valley floor beneath former ice channels); **drumlins** (oval ridges parallel to ice movement).

2(v). How does wind work in deserts? Is it the only agent?

3

Ans. Wind erodes by deflation, abrasion and impact, forming deflation hollows, blow-outs, mushroom and pedestal rocks, and deposits sorted sand as dunes. It is not the only agent — torrential rains cause sheet floods and stream erosion that form pediments, pediplains and playas, and mass wasting also contributes.

3(i). Running water is the most dominant agent in humid as well as arid climates. Explain.

5

Ans. In **humid** regions heavy rainfall produces overland flow and rivers that carve rills, gullies and valleys (V-shaped valleys, gorges, canyons, potholes, plunge pools, waterfalls, terraces, incised meanders) and deposit alluvial fans, floodplains, levees, point bars, meanders, oxbow lakes and deltas, eventually forming peneplains. In **arid** regions rain is scarce but torrential; bare rocks weathered by temperature changes are easily removed by **sheet floods and sheet wash**; streams cause lateral erosion forming **pediments** and **pediplains**, and inland drainage forms **playas** and alkali flats; wind mostly moves fine material. Thus running water does most of the work of erosion and deposition in both climates.

3(ii). Why do limestones behave differently in humid and arid climates? Dominant process and results.

5

Ans. Limestone dissolves easily in water containing carbon dioxide. In **humid** climates with plenty of water, **solution** is intense, producing karst; in **arid** climates there is little water, so solution is weak and limestone behaves like a resistant rock, forming ridges and cliffs through mechanical weathering. The dominant, almost exclusive process is **solution (chemical weathering) and precipitation** by surface and groundwater. Results: erosional — swallow holes, sinkholes (solution and collapse sinks/dolines), uvalas, lapies, limestone pavements, caves, tunnels; depositional — stalactites, stalagmites, pillars; disappearing streams.

3(iii). How do glaciers reduce high mountains into low hills and plains?

5

Ans. Heavy moving ice erodes by friction, **plucking** large angular blocks and **abrading** floors and sides with debris dragged along. Accumulated ice cuts **cirques** at mountain tops; headward erosion of radiating cirques forms **horns** and narrows divides into **arêtes**; valleys deepen and widen into **U-shaped troughs** with hanging valleys. Debris is removed and divides are lowered until slopes become so gentle that

glaciers stop moving, leaving low hills, **moraines, eskers, drumlins** and vast **outwash plains** of glacio-fluvial deposits. Glaciers can thus damage even unweathered rock and level high mountains.

Practice: 1. What is a peneplain? 2. Gorge vs canyon. 3. What is a plunge pool? 4. What is karst topography named after? 5. What is a fjord? 6. Till vs outwash. 7. Spit vs barrier bar. 8. What is an inselberg? **Answers:** 1. An almost-plain formed by stream erosion with monadnocks. 2. Gorge — steep straight sides, equal width, hard rock; canyon — step-like sides, wider at top, sedimentary rock. 3. A large deep pothole at the base of a waterfall. 4. The Karst region in the Balkans. 5. A deep glacial trough filled by the sea. 6. Till — unsorted angular glacial debris; outwash — stratified, sorted, rounded meltwater deposits. 7. Barrier bar — exposed off-shore bar; spit — bar attached to one end of a bay or headland. 8. A residual hill left after pediment formation.

Multiple choice: 20 MCQs

1. Low resistant remnants on a peneplain are:
 - (a) drumlins (b) inselbergs (c) monadnocks (d) stacks
2. Waterfalls and rapids are features of the:
 - (a) youth stage (b) old stage (c) mature stage (d) delta
3. Oxbow lakes form in the:
 - (a) youth stage (b) mature stage only (c) glacial stage (d) old stage
4. Canyons commonly form in:
 - (a) granite (b) horizontally bedded sedimentary rocks (c) hard rocks only (d) basalt
5. Large potholes at the base of waterfalls are:
 - (a) sinkholes (b) plunge pools (c) cirques (d) playas
6. Terraces at the same height on both banks are:
 - (a) unpaired terraces (b) point bars (c) levees (d) paired terraces
7. Deposits in deltas are:
 - (a) well sorted and stratified (b) angular (c) unsorted (d) glacial
8. Point bars are found on the:
 - (a) concave bank (b) river mouth (c) convex side of meanders (d) waterfall base
9. Meanders are deflected partly by:
 - (a) glaciers (b) tidal force (c) magnetism (d) Coriolis force
10. Collapse sinks are also called:
 - (a) uvalas (b) dolines (c) lapies (d) tarns
11. Icicle-like features hanging from cave roofs are:
 - (a) stalagmites (b) pillars (c) stalactites (d) eskers
12. Bhagirathi originates from:
 - (a) Gaumukh (Gangotri glacier) (b) Yamunotri (c) Siachen (d) Alkapuri
13. A lake in a cirque is a:
 - (a) playa (b) tarn (c) lagoon (d) oxbow
14. Everest and Matterhorn are examples of:
 - (a) cirques (b) drumlins (c) horns (d) eskers
15. Moraines along the sides of a glacial valley are:
 - (a) terminal (b) ground (c) medial (d) lateral
16. Sinuous ridges deposited by sub-glacial streams are:
 - (a) eskers (b) moraines (c) arêtes (d) drumlins
17. The west coast of India is a:
 - (a) high rocky coast (b) low sedimentary coast (c) delta coast (d) lagoon coast
18. A barrier bar keyed to one end of a bay is a:
 - (a) stack (b) beach (c) lagoon (d) spit
19. Shallow salt lakes in desert basins are:
 - (a) uvalas (b) playas (c) tarns (d) fjords
20. Crescent dunes with wings pointing downwind are:
 - (a) seifs (b) transverse (c) barchans (d) longitudinal

1 (c) · 2 (a) · 3 (d) · 4 (b) · 5 (b) · 6 (d) · 7 (a) · 8 (c) · 9 (d) · 10 (b) · 11 (c) · 12 (a) · 13 (b) · 14 (c) · 15 (d) · 16 (a) · 17 (a) · 18 (d) · 19 (b) · 20 (c)

Assertion-Reason (6)

(a) Both A and R true, R explains A. (b) Both true, R does not explain A. (c) A true, R false. (d) A false, R true.

1. A: Drumlins indicate the direction of glacier movement. R: Their long axes are parallel to the direction of ice movement.
2. A: Alluvial fans form at the foot of mountains. R: Deltas form at river mouths.
3. A: Meander is a landform. R: Meanders are loop-like channel patterns on gentle gradients.
4. A: Glacial till is well sorted. R: Outwash deposits are roughly stratified and sorted.
5. A: Mangroves and off-shore bars protect coasts. R: They absorb the destructive force of storms and tsunamis.
6. A: Wind is a good sorting agent. R: Grains settle according to their critical velocities as wind slows.

Key: 1 (a) · 2 (b) · 3 (d) · 4 (d) · 5 (a) · 6 (a)

- **Last-night summary:** Landform vs landscape; stages. Running water: overland and linear flow; rills → gullies → valleys; peneplain, monadnocks; youth (V-valleys, waterfalls), mature (meanders, floodplains), old (levees, oxbows). Erosional: gorge (hard rock), canyon (sedimentary, step-like), potholes, plunge pools, incised meanders, terraces (paired). Depositional: alluvial fans (distributaries), deltas (sorted), floodplains (active/inactive), levees, point bars; meanders (lateral work, soft banks, Coriolis), oxbow lakes.
- Groundwater (karst — Balkans): swallow holes, sinkholes (solution/collapse — dolines), uvalas, lapies, pavements, caves, tunnels; stalactites, stalagmites, pillars. Glaciers: continental, piedmont, valley; Gangotri/Gaumukh; cirque (tarn), horn (Everest, Matterhorn), arête, U-trough, hanging valley, fjord; till vs outwash; moraines (terminal, lateral, ground, medial), eskers, outwash plains, drumlins (stoss, tail).
- Coasts: high rocky (west coast; cliffs, wave-cut terraces, caves, stacks) vs low sedimentary (east coast; beaches, dunes, bars, barriers, spits, lagoons, deltas); mangroves as buffers. Wind: deflation, abrasion, impact; sheet floods; pediments, inselbergs, pediplains; playas, alkali flats; deflation hollows, blow-outs; mushroom/table/pedestal rocks; dunes — barchan, parabolic, seif, longitudinal, transverse.