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CUET · GEOGRAPHY · CLASS XI · CODE 313

Landforms and Their Evolution

CUET unit: Soils of India

By **UniDrill** · NCERT-grounded study material

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📌 Snapshot

- Geomorphic agents — running water, groundwater, glaciers, waves, and wind — erode, transport, and deposit material to create a wide variety of landforms.
- Landforms evolve through youth, mature, and old-age stages, much like stages of life.
- Five agents need study: running water (fluvial), groundwater (karst), glaciers (glacial), waves and currents (coastal), and wind (aeolian), each with distinct erosional and depositional landforms.
- CUET tests this chapter for landform identification, agent–landform matching, and distinguishing erosional from depositional features across all five agents.
- Understanding contrasting landform pairs (gorge vs. canyon, stalactite vs. stalagmite, barchan vs. seif, till vs. outwash) is a key NTA focus area.

📖 Detailed Notes

2.1 Core concepts

Introduction and landscape evolution

- Small to medium tracts of the earth's surface are called **landforms**; several related landforms together make **landscapes** (large tracts). (NCERT p. 47)
- Landforms evolve through stages comparable to life: **youth, mature, and old age**. Evolution involves transformation of parts of the earth's surface or of individual landforms after formation. (NCERT p. 47)
- The two important aspects of evolution of landforms are: (i) transformation of parts of the earth's surface from one landform to another, and (ii) transformation of individual landforms after they are formed. (NCERT p. 47)

Running Water

- Running water is the most important geomorphic agent in humid regions. Two components: (i) overland flow as a sheet on the land surface; (ii) linear flow as streams and rivers. (NCERT p. 47)
- In the **youth stage**, streams are few with poor integration, V-shaped valleys, shallow floodplains or none; waterfalls and rapids are common; down-cutting dominates. (NCERT p. 48)

- In the **mature stage**, valleys are still V-shaped but deep; trunk streams are broad with wider floodplains; streams may flow in meanders; waterfalls and rapids disappear. (NCERT p. 48)
- In the **old-age stage**, smaller tributaries are few with gentle gradients; streams meander freely over vast floodplains showing natural levees and oxbow lakes; divides are broad and flat; most landscape is at or near sea level. (NCERT p. 48)
- Overland flow causes **sheet erosion**; due to irregularities, flow concentrates into narrow to wide paths forming rills, which deepen into gullies, which lengthen and unite to form valleys. (NCERT p. 48)
- A residual low-resistant remnant standing on a peneplain is called a **monadnock**; the near-plain formed by stream erosion is called a **peneplain**. (NCERT p. 48)

Erosional Landforms of Running Water

- **Valleys** begin as rills → gullies → valleys. Types depend on rock: V-shaped valley, gorge, canyon. A **gorge** is a deep valley with very steep to straight sides; nearly equal width at top and bottom. A **canyon** is a variant of gorge, wider at top than at bottom, with steep step-like side slopes; canyons form in horizontally bedded sedimentary rocks. (NCERT p. 48)
- **Potholes** are more or less circular depressions over rocky beds of hill-streams formed by stream erosion aided by abrasion of rock fragments. **Plunge pools** are large, deep holes at the base of waterfalls formed by sheer impact of water and rotation of boulders. (NCERT p. 49)
- **Incised or entrenched meanders** are very deep and wide meanders cut in hard rocks, found where streams that previously flowed over gentle slopes have been uplifted; normally meanders form over floodplains and delta plains but can be cut in hard rocks. (NCERT p. 49)
- **River terraces** are surfaces marking old valley floor or floodplain levels; products of erosion resulting from vertical erosion by the stream into its own depositional floodplain. When terraces occur at the same elevation on both sides, they are **paired terraces**. (NCERT p. 49)

Depositional Landforms of Running Water

- **Alluvial fans** form when streams flowing from higher levels break into foot slope plains of low gradient; coarse load is dumped and spread as a broad low-to-high cone shape. Streams flowing over fans are not confined to original channels and shift their position forming many channels called **distributaries**. Alluvial fans in humid areas show low cones with gentle slope; in arid and semi-arid areas they appear as high cones with steep slope. (NCERT p. 50)
- **Deltas** are like alluvial fans but form at a different location — where river load is dumped into the sea. Delta deposits are very well sorted with clear stratification; coarsest materials settle first. River distributaries continue to increase in length as the delta grows. (NCERT p. 50)

- Floodplains develop by deposition. Fine materials (sand, silt, clay) are deposited over the bed and spill over banks during floods. The active floodplain is the river bed itself; the floodplain above the bank is the inactive floodplain. Floodplains in deltas are called delta plains. (NCERT p. 50)
- Natural levees are low, linear, parallel ridges of coarse deposits along the banks of large rivers, often cut into individual mounds. Point bars (also called meander bars) are found on the concave side of meanders; sediments are deposited in a linear fashion by flowing water; they are almost uniform in profile and width with mixed sediment sizes. (NCERT p. 51)
- Meanders are loop-like channel patterns that develop over flood and delta plains. They form due to: (i) propensity of water flowing over very gentle gradients to work laterally; (ii) unconsolidated nature of alluvial deposits; (iii) Coriolis force; (iv) irregularities along banks. Deposition is on the convex (slip-off) bank; undercutting is on the concave (cut-off) bank. When meanders grow into deep loops and get cut off due to erosion at inflection points, they are left as oxbow lakes. (NCERT p. 51)

Groundwater / Karst Topography

- Groundwater works mainly in limestone or dolomite rocks rich in calcium carbonate through the chemical processes of solution and precipitation. Any limestone region showing typical landforms produced by these processes is called Karst topography (named after the Karst region in the Balkans adjacent to the Adriatic Sea). (NCERT p. 52)
- Erosional karst landforms: Swallow holes are small to medium-sized round to sub-rounded shallow depressions on the surface of limestones. Sinkholes are openings more or less circular at the top and funnel-shaped towards the bottom; sizes vary from a few sq. m to a hectare; depth from less than half a metre to thirty metres. Collapse sinks (dolines) form when the bottom of a sinkhole forms the roof of a cave underground and collapses. Valley sinks or Uvalas form when sink holes and dolines join together. Lapies are irregular surfaces with sharp pinnacles, grooves and ridges due to differential solution activity along parallel to sub-parallel joints. Lapie fields may eventually turn into limestone pavements. (NCERT pp. 52–53)
- Caves form in areas with dense, massive, thick limestone beds; water percolates through cracks and joints, dissolves limestone forming long narrow to wide gaps called caves. Caves with openings at both ends are called tunnels. (NCERT p. 53)
- Depositional karst landforms: Stalactites hang as icicles from the cave roof — broad at the base, tapering towards the free end. Stalagmites rise up from the floor of caves due to dripping water from the stalactite. Stalactites and stalagmites eventually fuse to form columns and pillars. (NCERT pp. 53–54)

Glaciers

- Masses of ice moving as sheets over land (continental or piedmont glaciers) or as linear flows down mountain valleys (mountain and valley glaciers) are called glaciers.

Glaciers move because of gravity at a few centimetres to a few metres per day. (NCERT p. 54)

- Erosion by glaciers is tremendous due to friction caused by the sheer weight of ice; material plucked (large angular blocks) and dragged causes abrasion and plucking, reducing high mountains to low hills and plains. (NCERT p. 54)
- Glacial erosional landforms: **Cirques** are the most common landforms in glaciated mountains — deep, long, wide troughs or basins with very steep concave to vertically dropping high walls. Lakes within cirques after glaciers disappear are called **cirque or tarn lakes**. (NCERT p. 54)
- **Horns** form through headward erosion of cirque walls; when three or more radiating glaciers cut headward until cirques meet, high sharp pointed steep-sided peaks called horns form. (e.g. Matterhorn in Alps, Everest in Himalayas.) (NCERT p. 54)
- **Aretes** are serrated or saw-toothed ridges with very sharp crest and zig-zag outline formed when divides between cirque side walls or head walls get narrow due to progressive erosion. (NCERT p. 54)
- **Glacial valleys/troughs** are trough-like and U-shaped with broad floors and relatively smooth and steep sides. **Hanging valleys** are valleys at an elevation on one or both sides of the main glacial valley. Very deep glacial troughs filled with sea water making up shorelines (in high latitudes) are called **fjords/fiords**. (NCERT p. 55)
- Glacial depositional landforms: Unassorted coarse and fine debris dropped by melting glaciers is called **glacial till**; rock fragments are angular to sub-angular. **Outwash deposits** are glacio-fluvial deposits that are roughly stratified and assorted, with rock fragments somewhat rounded at edges — unlike till. (NCERT p. 55)
- **Moraines** are long ridges of deposits of glacial till. **Terminal moraines** are at the end (toe) of glaciers. **Lateral moraines** form along the sides parallel to glacial valleys. **Ground moraines** are irregular sheets of till left by rapidly retreating glaciers. **Medial moraines** are in the centre of the glacial valley flanked by lateral moraines; imperfectly formed compared to lateral moraines. (NCERT p. 56)
- **Eskers** are sinuous ridges found in the valley of a glacier after the ice melts; formed by streams that flow beneath the glacier carrying coarse materials. (NCERT p. 56)
- **Outwash plains** are broad flat alluvial fans of glacio-fluvial deposits (gravel, silt, sand, clay) at the foot of glacial mountains or beyond continental ice sheets. (NCERT p. 56)
- **Drumlins** are smooth oval-shaped ridge-like features composed mainly of glacial till with some gravel and sand. Long axes are parallel to direction of ice movement. The stoss end (facing glacier) is blunter and steeper; the other end is the tail. Drumlins give an indication of the direction of glacier movement. (NCERT pp. 56–57)

Waves and Currents (Coastal Landforms)

- Coastal processes are the most dynamic and destructive. Changes are mostly accomplished by waves. Storm waves and tsunami waves cause far-reaching changes in a short period. (NCERT p. 57)

- Two types of coasts: (i) high, rocky coasts (submerged coasts); (ii) low, smooth gently sloping sedimentary coasts (emerged coasts). (NCERT p. 57)
- High rocky coast erosional landforms: Wave-cut cliffs (steep, ranging from a few m to 30 m or more); wave-cut terraces/platforms (flat or gently sloping platforms at the foot of cliffs occurring above the average wave height); sea caves (hollows widened and deepened by waves at the base of cliffs); sea stacks (resistant rock masses standing isolated as small islands just off the shore, remnants of cliffs). (NCERT p. 58)
- Wave-cut platform develops in front of sea cliffs as cliffs recede; wave-built terrace develops in front of the wave-cut terrace as eroded materials get deposited offshore. (NCERT p. 57)
- Coastal depositional landforms: Beaches are temporary features dominated by deposition; most sediments come from land-carried streams and wave erosion; shingle beaches contain excessively small pebbles and cobbles. Sand dunes form behind beaches from sand lifted and winnowed from beach surfaces. (NCERT p. 58)
- Off-shore bar — a ridge of sand and shingle formed in the sea in the off-shore zone approximately parallel to the coast. Barrier bar — an off-shore bar exposed due to further addition of sand. Spit — a barrier bar keyed up to one end of the bay or headlands/hills. Lagoon — forms when barrier bars and spits form at the mouth of a bay and block it. (NCERT p. 58)
- The west coast of India is a high rocky retreating coast with erosional forms dominant; the east coast is a low sedimentary coast with depositional forms dominant. (NCERT p. 58)

Wind (Aeolian Landforms)

- Wind is one of the two dominant agents in hot deserts. Winds cause deflation (lifting and removal of dust and small particles), abrasion (sand and silt abrading land surfaces), and impact (sheer force of momentum when sand is blown against a rock surface). (NCERT p. 59)
- Many desert features owe their formation to mass wasting and running water (sheet floods), not wind alone. Stream channels in desert areas are broad, smooth and indefinite and flow for a brief time after rains. (NCERT p. 59)
- Aeolian erosional landforms: Pediments are gently inclined rocky floors close to mountains at their foot, with or without a thin cover of debris; they form through lateral erosion by streams and sheet flooding. Pediplains are low featureless plains formed when high relief in desert areas is reduced; the mountain gets gradually reduced leaving an inselberg (remnant of the mountain). (NCERT p. 60)
- Playas are nearly level plains at the centre of basins surrounded by mountains and hills; covered by shallow lakes in times of sufficient water; water is retained only for short duration due to evaporation; playas contain good deposition of salts. Playa plain covered by salts is called alkali flats. (NCERT p. 60)

- Deflation hollows are shallow depressions created by persistent wind currents blowing weathered mantle in one direction. Blow outs are first shallow depressions that become deeper and wider to become caves. (NCERT p. 60)
- Mushroom, table and pedestal rocks — rock outcrops worn out by wind deflation and abrasion leaving resistant remnants polished in the shape of mushrooms with slender stalks and broad rounded caps; sometimes the top is broad like a table; sometimes they stand out like pedestals. (NCERT p. 60)
- Aeolian depositional landforms: Wind is a good sorting agent — different grain sizes are moved by rolling/saltation or suspension; on slowing, grains settle forming well-sorted deposits. Sand dunes — dry hot deserts are good places for sand dune formation; obstacles to initiate dune formation are important. (NCERT p. 60)
- Types of sand dunes: Barchans — crescent-shaped dunes with points directed downwind; form where wind direction is constant and moderate and original surface is almost uniform. Parabolic dunes — form when sandy surfaces are partially covered with vegetation; reversed barchans with wind direction the same. Seif — similar to barchan with only one wing/point; forms when there is a shift in wind conditions; lone wings can grow very long and high. Longitudinal dunes — form when supply of sand is poor and wind direction is constant; appear as long ridges of considerable length but low in height. Transverse dunes — aligned perpendicular to wind direction; form when wind direction is constant and source of sand is at right angles to wind. (NCERT p. 61)

2.2 Definitions to memorise

Term	Definition	Page
Landform	Small to medium tract or parcel of the earth's surface	47
Landscape	Large tract of the earth's surface made up of several related landforms	47
Peneplain	An almost plain formed as a result of stream erosion, a lowland of faint relief with low resistant remnants (monadnocks)	48
Monadnock	Low resistant remnant standing out on a peneplain	48
Gorge	A deep valley with very steep to straight sides; nearly equal width at top and bottom	48
Canyon	A variant of gorge; wider at top than at bottom; step-like side slopes; forms in horizontally bedded sedimentary rocks	48
Pothole	More or less circular depression over rocky beds of hill-streams formed by stream erosion aided by abrasion of rock fragments	49
Plunge pool	Large deep hole at the base of a waterfall formed by impact of water and rotation of boulders	49
Incised/Entrenched meanders	Very deep and wide meanders cut in hard rocks	49

Term	Definition	Page
Paired terraces	River terraces occurring at the same elevation on either side of a river	49
Distributaries	Many channels formed when streams flowing over alluvial fans shift their position across the fan	50
Oxbow lake	A cut-off meander left when a meander loop is cut off due to erosion at inflection points	51
Karst topography	Landscape produced by groundwater through solution and deposition in limestone/dolomite regions	52
Swallow hole	Small to medium-sized round to sub-rounded shallow depression on the surface of limestones	52
Sinkhole	Opening more or less circular at top and funnel-shaped towards the bottom in limestone areas	52
Doline	Term sometimes used to refer to collapse sinks	53
Uvala/Valley sink	Wide trench formed when sinkholes and dolines join together due to slumping or roof collapse	53
Lapies	Irregular surface with a maze of sharp pinnacles, grooves and ridges on limestone due to differential solution activity	53
Stalactite	Icicle-like deposit hanging from the cave roof; broad at base, tapering towards free end	53
Stalagmite	Deposit rising up from the cave floor due to dripping water; may take shape of column, disc or crater	53–54
Cirque	Deep, long, wide trough or basin with very steep concave to vertically dropping high walls, the most common landform in glaciated mountains	54
Tarn lake	Lake seen within a cirque after a glacier disappears	54
Horn	High, sharp, pointed and steep-sided peak formed when three or more radiating glaciers cut headward until their cirques meet	54
Arete	Serrated or saw-toothed ridge with sharp crest and zig-zag outline between cirques	54
Fjord/Fiord	Very deep glacial trough filled with sea water making up shorelines in high latitudes	55
Glacial till	Unassorted coarse and fine debris dropped by melting glaciers; rock fragments angular to sub-angular	55
Outwash deposits	Glacio-fluvial deposits; roughly stratified and assorted; rock fragments somewhat rounded at edges	55
Terminal moraine	Long ridge of debris deposited at the end (toe) of a glacier	56
Lateral moraine	Ridge of till forming along the sides parallel to glacial valleys	56

Term	Definition	Page
Ground moraine	Irregular sheet of till left by rapidly retreating valley glaciers over their valley floors	56
Medial moraine	Moraine in the centre of the glacial valley flanked by lateral moraines	56
Esker	Sinuous ridge formed by streams flowing beneath a glacier after ice melts	56
Drumlin	Smooth oval-shaped ridge-like feature of glacial till; stoss end blunter and steeper; indicates direction of ice movement	56–57
Wave-cut platform	Flat or gently sloping platform at the foot of sea cliffs, above average wave height	58
Spit	A barrier bar keyed up to one end of the bay when barrier bars grow towards headlands or hills	58
Lagoon	Body of water enclosed when barrier bars and spits form at the mouth of a bay	58
Pediment	Gently inclined rocky floor close to mountains at their foot, with or without thin debris cover, formed by lateral erosion	59–60
Pediplain	Low featureless plain formed when high relief in desert areas is reduced through parallel retreat of slopes	60
Inselberg	Remnant of a mountain left behind as pediplains form	60
Playa	Nearly level plain at the centre of a desert basin covered by shallow lake water temporarily; contains good deposition of salts	60
Alkali flat	Playa plain covered up by salts	60
Barchan	Crescent-shaped sand dune with points directed downwind; forms where wind direction is constant and moderate	61
Seif	Sand dune similar to barchan but with only one wing/point; forms when there is a shift in wind conditions	61
Transverse dune	Sand dune aligned perpendicular to wind direction; source of sand is at right angles to wind	61

2.3 Diagrams / processes to remember

- **Figure 6.1** (p. 49): The Valley of Kaveri river near Hogenekal, Dharmapuri district, Tamil Nadu — shows a gorge. Useful to recall that gorge = steep straight sides, equal width top and bottom.
- **Figure 6.2** (p. 49): Entrenched meander loop of river Colorado, USA — shows step-like side slopes typical of a canyon; also illustrates incised/entrenched meanders.

- **Figure 6.5** (p. 50): Diagram of natural levee and point bars — shows the distinction between levees (parallel coarse ridges along river bank) and point bars (on concave side of meanders).
- **Figure 6.6** (p. 51): Satellite scene of meandering Burhi Gandak river near Muzaffarpur, Bihar — shows oxbow lakes and cut-offs; good for understanding meander growth.
- **Figure 6.7** (p. 51): Meander growth diagram — shows inflection point, slip-off bank (convex), cut-off bank (concave), oxbow lake formation; distinguish slip-off bank (deposition) from cut-off/concave bank (undercutting).
- **Figure 6.8** (p. 52): Various karst features — shows swallow hole, sinkhole, collapse sink (in section), cave in section with stalactites/pillars/stalagmites, sink holes (plan view), valley sinks/uvalas. Critical for MCQs.
- **Figure 6.11** (p. 55): Glacial erosional and depositional forms — shows cirque, horn, arete, col, truncated spur, hanging valley, lateral moraine, medial moraine, terminal moraine, outwash plain. Must be memorised.
- **Figure 6.12** (p. 56): Panoramic diagram of glacial landscape with depositional landforms — shows outwash plain, esker, drumlin, terminal moraine.
- **Figure 6.13** (p. 59): Satellite picture of Godavari river delta showing a spit — real-world example of a spit on Indian coast.
- **Figure 6.14** (p. 60): Various types of sand dunes (barchan, seif, parabolic, transverse, longitudinal) with arrows indicating wind direction — essential for dune-type MCQs.

2.4 Common confusions / NTA trap points

- **Gorge vs. Canyon:** Both are deep valleys, but a gorge is almost equal in width at top and bottom; a canyon is wider at top than at bottom and has steep step-like side slopes. Canyon is a variant of gorge. NTA often uses "step-like side slopes" as the defining clue for canyon (confirmed in NCERT exercise Q. ii).
- **Stalactite vs. Stalagmite:** Stalactites hang DOWN from the ceiling (think "c" for ceiling); stalagmites grow UP from the floor. NTA distractors frequently swap these two. Stalactites are broad at base and taper; stalagmites can take disc or crater shapes.
- **Point bar (concave) vs. Natural levee:** Point bars are on the concave side of meanders (inside of a bend); natural levees are along the banks of large rivers, NOT on the concave side of bends. Students commonly reverse these.
- **Glacial till vs. Outwash deposits:** Till is unassorted, angular to sub-angular; outwash is stratified, assorted, and rock fragments are rounded. NTA may ask which is more sorted.
- **Barchan vs. Seif vs. Parabolic:** Barchan = crescent, both wings, constant moderate wind; Seif = one wing (shift in wind); Parabolic = reversed barchan on

partially vegetated surface. NTA uses "crescent-shaped with wings away from wind" as barchan clue.

- **West vs. East coast of India:** West coast = high rocky retreating coast, erosional forms dominant; East coast = low sedimentary coast, depositional forms dominant. Frequently tested in context of barrier bars, lagoons, and deltas.

🎯 Practice MCQs

📊 PYQ Alignment

Chapter 6 on Landforms and Their Evolution is tested in CUET Geography primarily through identification of specific landforms by their characteristics and matching geomorphic agents with their products; questions on distinguishing erosional from depositional forms across fluvial, karst, glacial, coastal, and aeolian systems appear regularly, with gorge/canyon distinction and stalactite/stalagmite identification being recurring NTA favourites.