LOTUSARISE IAS

MAINS 2027 EDITION

FREE SAMPLE

UPSC CSE MAINS

GEOGRAPHY OPTIONAL PAPER II

Physical Setting Notes

The complete Physical Setting section of Paper II — India's frontiers, structure and relief, drainage systems, physiographic regions, the monsoon, climatic regions, natural vegetation and soils, with previous year questions.

Compiled by Arvind KrS

STRUCTURE AND RELIEF | DRAINAGE | PHYSIOGRAPHIC REGIONS | MONSOON AND CLIMATE | VEGETATION AND SOILS

36	6	227	288
Chapters	Units	Previous year questions	Diagrams and figures

IN THIS BOOK

01 Space Relationship of India
02 Structure and Relief
03 Drainage Systems
04 Physiographic Regions
05 Monsoon and Climate
06 Natural Vegetation and Soils

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Geography Optional — Physical Setting

Paper II · Geography of India: Physical Setting

Mains 2027 Edition · Compiled November 2026

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The outline map of India on the cover and on the chapter and unit pages is decorative and not to scale.

How to read these notes

Every chapter is marked against the questions UPSC has actually asked on it, so the points that matter most stand out on the first read and are quick to find at revision.

Monsoons are periodic winds that change direction with the season.

Yellow marker: key point. A point that carries the ideas UPSC has asked about in this chapter. Read these first, and make sure each one is in your answer.

Indian monsoon is a seasonal reversal of winds that brings most of the country's rain in four months.

Blue marker: definition. The cleanest definition of a term, ready to open an answer with.

Rain reaches India through the **southwest monsoon in summer** and the northeast monsoon in winter.

Saffron underline: PYQ term. A key term or phrase that appears in this chapter's previous year questions.

Mechanism of Indian Monsoon

PYQ 2026 · 2022 · 2020 +13

PYQ tag on a heading. The years in which UPSC asked about this section. Sections without a tag are background or linking material.

PYQ RADAR **21** questions Last asked **2026**

PYQ radar. At the start of each chapter: how many times the topic has been asked, and how recently. The contents page shows the same count for every chapter.

Suggested method. First read: the whole chapter. Revision: the yellow and blue marks, the tagged headings and the PYQ list at the end of the chapter. Last week before Mains: the PYQ list alone, answering each question in your head from the marked points.

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UNIT 05 | 7 CHAPTERS

Monsoon and Climate

Mechanism of Indian monsoons and rainfall patterns; tropical cyclones and western disturbances; floods and droughts; climatic regions.



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GEOGRAPHY OPTIONAL
PAPER II · PHYSICAL SETTING

Climatic Regions of India



PYQ RADAR 7 questions Last asked **2018** 2018 · 2016 · 2014 · 2012 · 2004 · 1996 · 1988

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01 Schemes of Climatic Regionalisation
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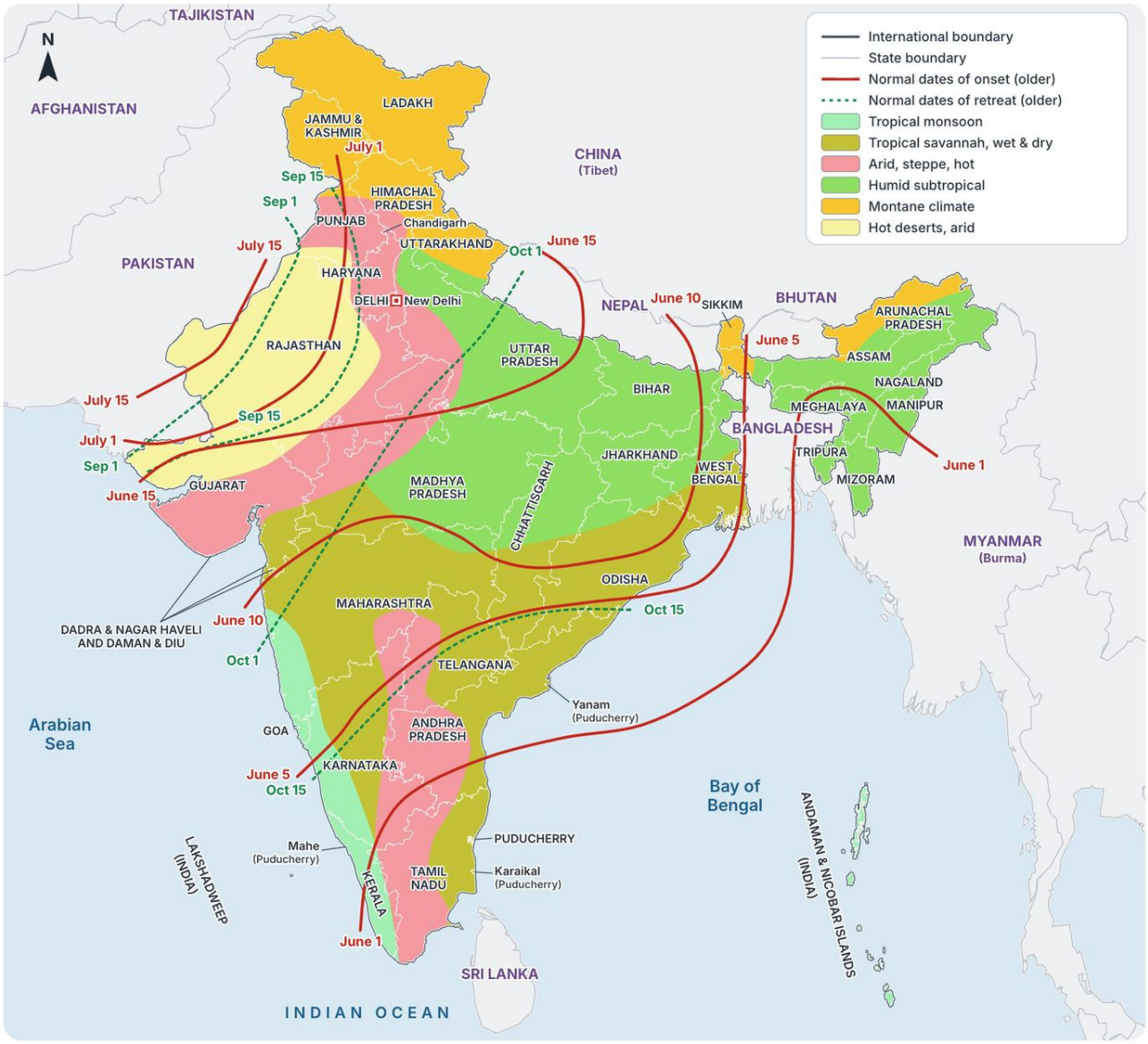
- A **climatic region** has **homogeneous climatic conditions**, the result of a combination of factors.
- **Temperature and rainfall** are the two elements treated as decisive in all schemes of climatic classification. In India, rainfall varies far more than temperature, so most schemes give it greater weight.
- The whole of India has a **monsoon type of climate**, but the mix of weather elements reveals **many regional variations**. Location, altitude, distance from the sea and relief all add to them.
  - In June, Barmer can touch 48°–50°C while Gulmarg stays near 22°C.
  - Mawsynram receives over 1,100 cm a year, Jaisalmer about 12 cm in older figures.
  - Henry Francis Blanford (1889) was so struck by this range that he preferred to speak of India's **climates**, in the plural.

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PHYSICAL SETTING · CLIMATE

Climatic Regions of India

Six broad climatic types, with the older normal dates of the onset and retreat of the monsoon.



Schematic: limits are generalised. Boundaries: Survey of India outline (datameet).

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- On this map the **monsoon onset and retreat lines are the older normal dates**, such as 15 July for full cover and 1 September for first withdrawal. IMD revised these dates of the **monsoon** in 2020.

01 Schemes of Climatic Regionalisation

PYQ 2018 · 2016 · 1988

- On the basis of variations in climate, India can be divided into a **number of climatic regions**. The attempts fall into two groups:

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GROUP	SCHOLARS	BASIS
World schemes applied to India	**Wladimir Köppen**, **Charles Warren Thornthwaite**, **Glenn Thomas Trewartha**	Vegetation, temperature, effective rain
Schemes for India	**Henry Francis Blanford** (1889, the first attempt), **Wilfrid George Kendrew**, **Laurence Dudley Stamp**, **Ram Lochan Singh** (1971)	Temperature and rainfall by region
Other attempts	Basil Leonard Clyde Johnson, V. P. Subrahmanyam (1955), Bharucha and Shanbhag (1957)	Regional schemes for India

- Each scheme is judged by how closely its boundaries match **soils, vegetation and farming**. On this test, the scheme of **Trewartha** suits India well: its regions correspond very closely with the soil, vegetative and agricultural regions.

02 Stamp's Climatic Regions

PYQ 2018 · 2016 · 2012 +3

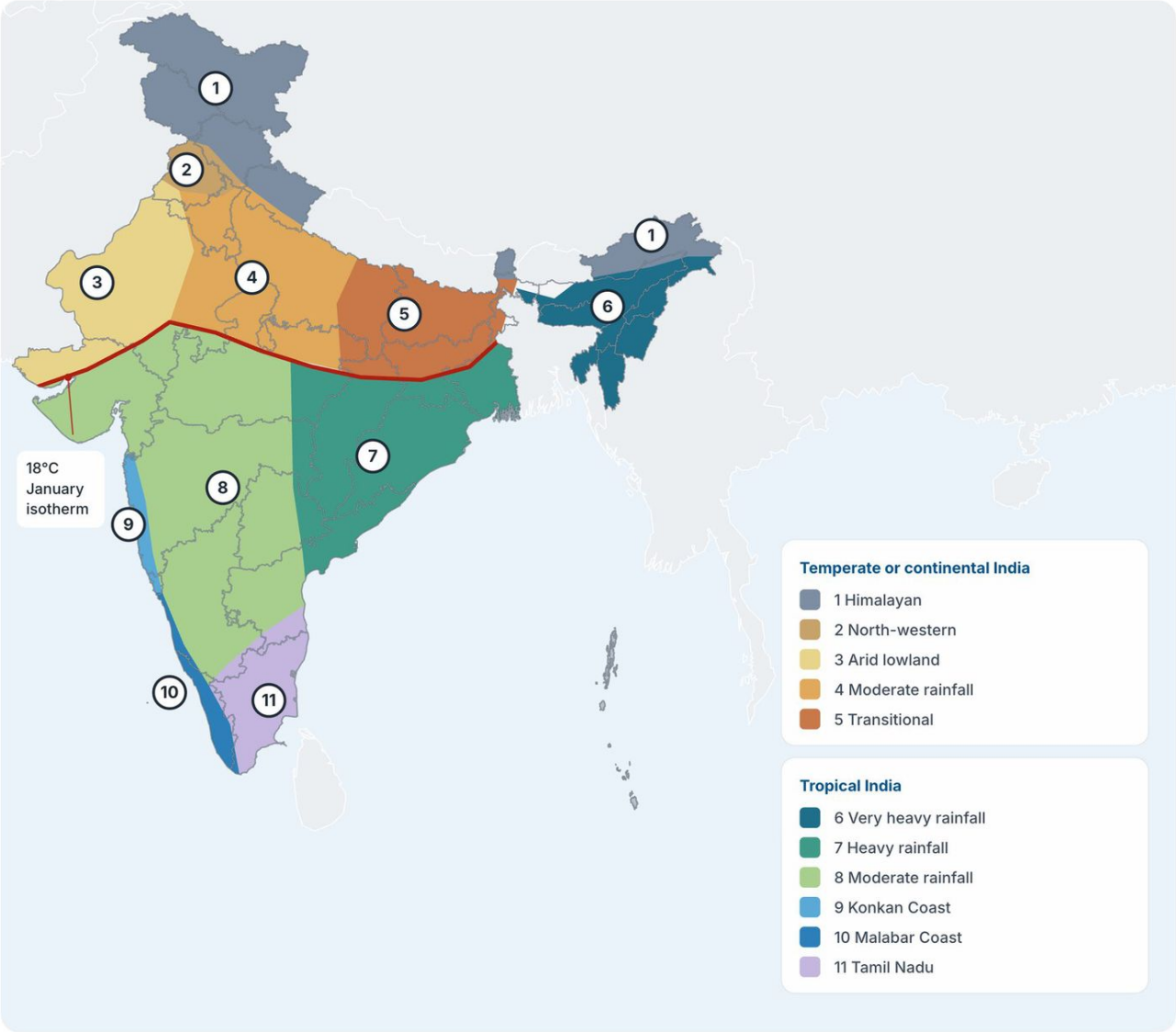
- **Stamp** built on **Kendrew**. The scheme is **empirical, and partly arbitrary and subjective**, but its limits use simple units of temperature and rainfall.
- **The master line:** the **18°C January isotherm** divides the country in two. It runs across the root of the Peninsula, roughly along the Tropic of Cancer.
  - North of it lies **temperate or continental India**, with five regions.
  - South of it lies **tropical India**, with six.
- **The role of rainfall and temperature:** temperature draws the first divide. **Rainfall** then separates the regions within each half, while coastal and cold-mountain regions add temperature range and altitude.

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PHYSICAL SETTING · CLIMATIC REGIONS

Stamp's Eleven Climatic Regions of India

The 18°C January isotherm parts continental from tropical India; rainfall then sets the regions on each side.



After Laurence Dudley Stamp. Schematic: region limits and the isotherm are generalised and are not exact lines.
Boundaries: Survey of India outline (datameet).

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Temperate or Continental India

REGION	AREAS	ANNUAL RAIN (CM)	TEMPERATURE (°C)	CITY
1. Himalayan	Jammu and Kashmir, Ladakh, Himachal Pradesh, most of Uttarakhand, Darjeeling hills, Sikkim, Arunachal Pradesh	Over 200 in the east, far less in the west	Winter 4–7; summer 13–18	Shimla, Darjeeling

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REGION	AREAS	ANNUAL RAIN (CM)	TEMPERATURE (°C)	CITY
2. North-western	Northern Punjab, southern Jammu and Kashmir	Moderate	Winter 16; summer 24	Amritsar
3. Arid lowland	Thar, south-west Haryana, Kachchh	Under 40	Winter 16–24; summer up to 48	Jaipur
4. Moderate rainfall	Parts of Punjab and Haryana, west Uttar Pradesh, Delhi, north-west Madhya Pradesh, east Rajasthan	40–80	January 15–18; July 33–35	Delhi
5. Transitional	East Uttar Pradesh, Bihar	100–150	January 15–19; July 30–35	Patna

Tropical India

REGION	AREAS	ANNUAL RAIN (CM)	TEMPERATURE (°C)	CITY
6. Very heavy rainfall	Meghalaya, Assam, Tripura, Mizoram, Nagaland	Over 200	January about 18; July 32–35	Cherrapunji, Mawsynram
7. Heavy rainfall	Chhattisgarh, Jharkhand, Gangetic West Bengal, Odisha, coastal Andhra Pradesh	100–200	January 18–24; July 29–35	Kolkata
8. Moderate rainfall	Interior between the Western and Eastern Ghats	50–100	Winter 18–24; summer 32	Hyderabad
9. Konkan Coast	Mumbai to Goa	Over 200	24–27; range about 3	Mumbai
10. Malabar Coast	Goa to Kanniyakumari	Over 250	Near 27; range about 3	Thiruvananthapuram
11. Tamil Nadu	Tamil Nadu and adjoining Andhra Pradesh	100–150	Near 24; range about 3	Chennai

- **Why the rain differs:**
  - **Region 6:** the Bay branch meets the Meghalaya hills, where older figures give Cherrapunji 1,102 cm and Mawsynram 1,221 cm.
  - **Region 7:** the Bay branch and Bay cyclones. Totals thin out westward and southward.
  - **Region 8:** it lies behind the Western Ghats, in their **rain shadow**.
  - **Regions 9 and 10:** the Arabian Sea branch. On the Malabar Coast the wet months run to about nine.

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  - **Region 11:** the **retreating monsoon from the north-east**, mostly in November and December.
- **Evaluation:**
  - **Strength:** easily understood limits, and a clear link with the real pattern of rain.
  - **Weakness:** the boundaries are lines drawn on judgement, with no test for how effective the rain is.
  - The transition from Region 4 to Region 5 shows that the climate changes **gradually**, while a map gives a line.

03 Trewartha's Classification of Climate PYQ 2018

- **Glenn Thomas Trewartha** modified the classification of **Köppen** and presented it in **1954**. His scheme is **empirical**, based on temperature and precipitation data, and he also used English letters as symbols.
- World types: **A** tropical humid, **B** dry, **C** humid mesothermal, **D** humid microthermal, **E** boreal, **F** polar, with **H** for undifferentiated highlands.
- Applied to India, the scheme gives **four major climatic regions (A, B, C, H)**, further divided into **seven meso-climatic divisions**:

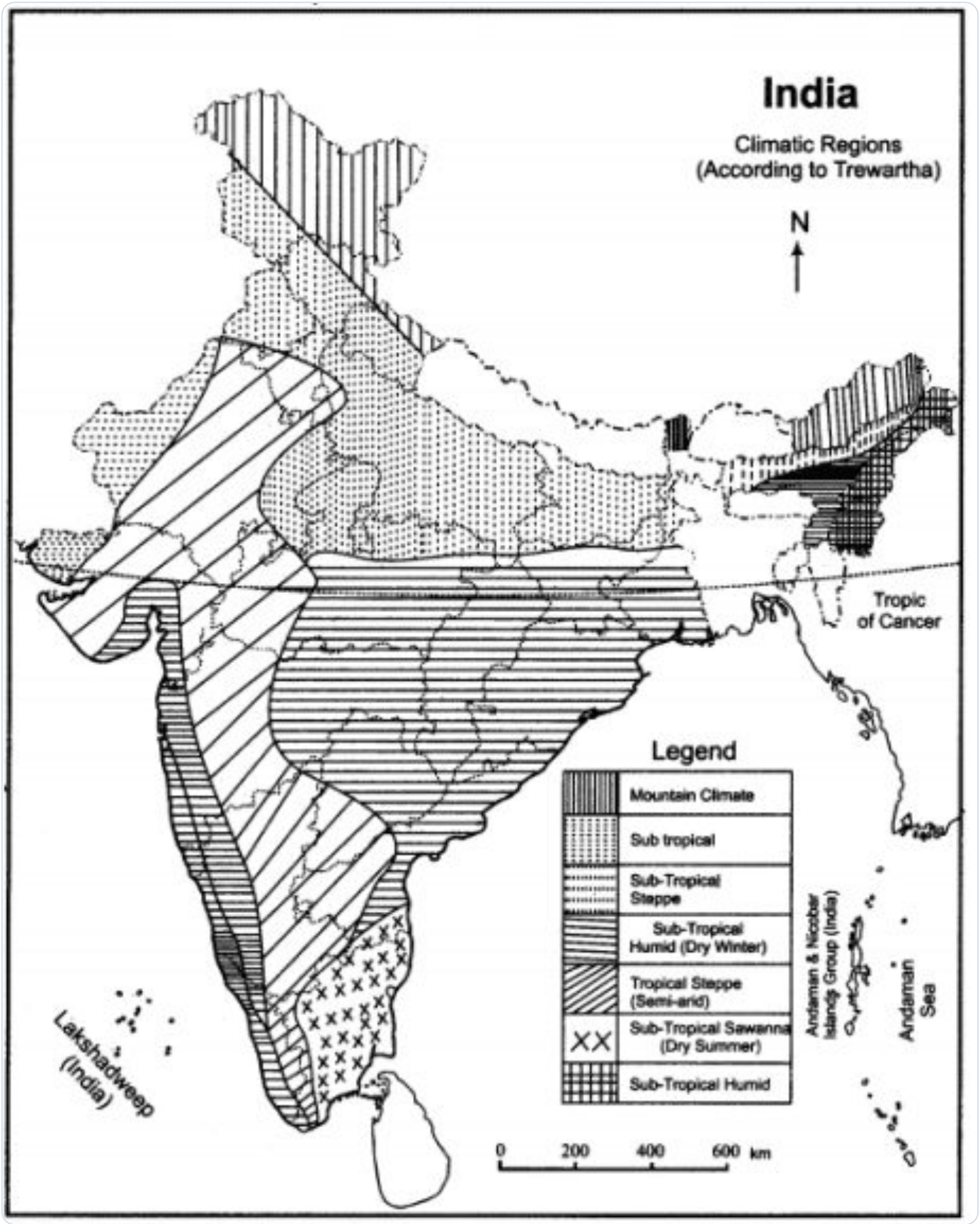
TYPE	NAME	TEMPERATURE	RAIN (CM)	AREAS
Am	Tropical rainforest or monsoon	Above 18.2°C; mean near 27°C	Over 200 (some maps 250)	Western coastal plain, Sahyadris, parts of Assam and Meghalaya, Tripura
Aw	Tropical savannah	Mean about 27°C	Under 100	Most of the Peninsula, except coastal plains and western Ghats; Mizoram
BS	Tropical steppe	Mean about 27°C	Below 100	Rain shadow east of the Western Ghats
BSh	Sub-tropical steppe	Mean over 27°C; January about 15°C	60–75	Parts of Gujarat, east Rajasthan, Maharashtra, Andhra Pradesh, south Haryana
BWh	Tropical arid	May–June maximum over 48°C	Under 25	Thar Desert, west of the Aravallis; Kachchh
Caw	Humid subtropical	January under 18°C; summer maximum over 45°C	250 in the east to about 65 in the west	Great Plains from Punjab to Assam

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TYPE	NAME	TEMPERATURE	RAIN (CM)	AREAS
H	Mountain	Summer about 17°C; January about 8°C	Falls from east to west	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, north-east hills

- **Tropical Rainforest Climate (Am):**
  - High temperature and heavy precipitation.
  - **Dense forests, chiefly of evergreen trees**, are the characteristic vegetation.
- **The Tropical Savannah Climate (Aw):**
  - It has a **marked dry season**, and nearly all the rain falls in summer.
- **The Tropical Steppe Climate (BS):**
  - It covers Peninsular India east of the Western Ghats, the **rain-shadow area** in parts of **Maharashtra, Telangana, Andhra Pradesh, Karnataka and Tamil Nadu**.
  - **Rayalaseema** belongs here. Its low, unreliable rain and high temperatures follow from its place behind the Ghats, with too little of either monsoon to make up the gap.
- **The Sub-tropical Steppe Climate (BSh):**
  - It is semi-arid, and its **annual range of temperature is significantly high**.
- **The Tropical Arid Climate (BWh):**
  - **Thorny bushes** make up the natural vegetation.
  - Older accounts record the country's lowest rainfall in **Ganganagar** district. **Jaisalmer** and the cold desert of **Ladakh** are at least as dry.
- **The Humid Subtropical Climate (Caw):**
  - Winters are dry, and **western disturbances** add light rain in the west.
- **Mountain Climate (H):**
  - Mean temperatures for all months depend closely on **topography and slope**.
  - The **Western Himalayas** get some rain from **western disturbances** in the winter season.

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- Key to the letters: **A** Tropical climate, **B** Dry climate, **C** Humid subtropical climate, **D** Humid temperate climate, **E** Polar climates, **H** Highlands.

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- The legend of this map needs care. Its **"sub-tropical humid (dry winter)" belt over central India** is the tropical savannah (Aw) of the text. Its **"sub-tropical savanna (dry summer)" in Tamil Nadu** is the tropical As type with its winter rain.

04 Other Schemes

PYQ 2018 · 1988

Köppen's Scheme in Brief

- **Wladimir Köppen** first published his world scheme around 1900 and revised it until **1936**. Its **classification system** uses monthly and annual means of temperature and rain, and treats **native vegetation** as the truest sign of a climate.
- Five major types apply worldwide: **A** tropical rainy, **B** dry, **C** mild mid-latitude, **D** severe mid-latitude, **E** polar.
- Small letters add detail: **a** hot summer, **c** cool summer, **f** no dry season, **w** dry winter, **s** dry summer, **g** Ganges-type hot season before the solstice, **h** hot and dry (mean above 18°C), **m** monsoon with a short dry season.
- **Nine regions** are usually mapped in India:

TYPE	CHARACTER	AREAS
Amw	Monsoon, short dry winter	West coast south of Mumbai; over 300 cm
As	Monsoon, dry summer	Coromandel coast; 75–100 cm, mostly in winter
Aw	Tropical savannah	Most of the Peninsular plateau; about 75 cm
BShw	Semi-arid steppe	Rain shadow of the Ghats, Rajasthan, parts of Haryana and Gujarat; 12–25 cm
BWhw	Hot desert	Western Rajasthan; under 12 cm
Cwg	Monsoon, dry winter, Ganges type	Ganga Plain, east Rajasthan, Assam, Malwa
Dfc	Cold, humid winter, short summer	Sikkim, Arunachal Pradesh, parts of Assam
Et	Tundra	Mountains of Uttarakhand
E	Polar	High Jammu and Kashmir, Ladakh, Himachal Pradesh

- **Limit:** it uses no direct measure of evaporation, and its fixed limits sit poorly on a monsoon country with sharp relief.

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Thornthwaite's Scheme

- **Charles Warren Thornthwaite** published his classification in **1931**, and a markedly different one in **1948**.
  - **1931:** the plant is a meteorological instrument. **Precipitation effectiveness** (12 monthly P/E ratios added together) and **thermal efficiency** (T/E) set the types. The Indian map below uses this version.
  - **1948:** vegetation becomes the means by which water passes from soil to air, and **potential evapotranspiration** replaces the old indices, the core of **Thornthwaite's classification**.

HUMIDITY PROVINCE	VEGETATION	P/E INDEX	TEMPERATURE PROVINCE	T/E INDEX
A, wet	Rainforest	128 and above	A′, tropical	128 and above
B, humid	Forest	64–127	B′, mesothermal	64–127
C, subhumid	Grassland	32–63	C′, microthermal	32–63
D, semi-arid	Steppe	16–31	D′, taiga	16–31
E, arid	Desert	Under 16	E′, tundra; F′, frost	1–15; 0

- Seasonal letters: **r** adequate rain in all seasons; **s** summer deficient; **w** winter deficient; **d** deficient in all seasons.
- Of 120 possible combinations he mapped 32 on the world map. **Twelve occur in India:**

TYPE	CHARACTER	AREAS
AA′r	Tropical wet	West coast, Tripura, Mizoram
BA′w	Tropical humid	Eastern slopes of the Western Ghats, West Bengal
BB′w	Temperate humid	Parts of Assam, Meghalaya, Mizoram, Nagaland
CA′w	Tropical subhumid	Much of the Peninsula
CA′w′	The same, with winter rain	Tamil Nadu and neighbouring Andhra Pradesh
CB′w	Temperate subhumid	Most of the northern plain
DA′w	Tropical semi-arid	North Gujarat, south Rajasthan
DB′d	Temperate semi-arid, dry all year	Jammu and Kashmir
DB′w	Temperate semi-arid, dry winter	Parts of Punjab, Haryana, Rajasthan, the rain shadow

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TYPE	CHARACTER	AREAS
D′	Taiga	Western Himalaya; Arunachal Pradesh, Sikkim, upper Assam
E′	Tundra	Higher Himalaya
EA′d	Hot and dry all year	Western Rajasthan

R. L. Singh's Climatic Divisions

- **Singh (1971)**, following Kendrew and Stamp, set **ten divisions** by the temperature of the hottest and coldest months and by annual rain. It keeps close to India's relief and to the humid-to-arid gradient.

DIVISION	AREAS	RAIN (CM)	TEMPERATURE (°C)
1. Per-humid North-East	Sikkim, Assam, Arunachal Pradesh, Nagaland, Tripura, Mizoram, Meghalaya	About 200, locally over 1,000	January 11–24; July 25–33
2. Humid Sahyadri and West Coast	Western Ghats and coast, Narmada to Kanniyakumari	About 200	January 19–28; July 26–32
3. Humid South-East	Odisha, West Bengal, Chhattisgarh, Jharkhand	100–200	January 12–27; July 26–34
4. Sub-humid Transition	East Uttar Pradesh, Bihar, north Jharkhand	100–200	January 9–24; July 24–41
5. Sub-humid Littorals	East Tamil Nadu, coastal Andhra Pradesh	75–150	January 20–29; May 28–38
6. Sub-humid Continental	Ganga plain	75–150	January 7–23; July 26–41
7. Semi-arid Subtropical	Punjab, Haryana, east Rajasthan, Delhi, Chandigarh	25–100	January 6–23; May 26–41
8. Semi-arid Tropical	Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Karnataka, Telangana	50–100	January 13–29; July 26–42
9. Arid	Western Rajasthan, south-west Haryana, Kachchh	About 25, at places 10	January 5–22; June 20–40
10. West Himalayan	Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand	About 150	January 0–4; July 5–30

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Comparing the Schemes

SCHEME	BASIS	REGIONS IN INDIA	STRENGTH	WEAKNESS
Köppen	Temperature, rain, vegetation	9	Worldwide comparison	No direct evaporation measure
Thornthwaite	Effective rain, heat	12	Treats rain by its usefulness	Data-heavy; many letters
Trewartha	Temperature, rain	7	Simple; fits soils and farming	Coarse within the plains
Stamp	18°C line, rain	11	Clear, direct and regional	Judgement-based limits
R. L. Singh	Extreme months, rain	10	Close to India's regions	Overlapping ranges

- The same logic applied at a finer scale for farming gives the **agro-climatic zones**. The wider picture appears under the **world's climatic regions**.

Previous Year Questions

2018 Critically examine the basis and scheme of climatic classification proposed by G. T. Trewartha.

2016 Discuss the role of spatial pattern of rainfall and temperature in the delimitation of climatic regions of India, especially with reference to Stamp's climatic regionalisation.

2014 Describe the salient climatological characteristics of the Rayalaseema region.

2012 Discuss the role of spatial pattern of rainfall and temperature in the delimitation of climatic regions of India, especially with reference to stamp's climatic regionalization.

2004 Discuss the role of spatial pattern of rainfall and temperature in the delimitation of climatic regions of India, especially with reference to Stamp's climatic regionalization.

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1996 Draw a sketch-map in your answer book to delineate the main climatic regions of India and discuss the important climatic characteristics of each region.

1988 Evaluate the Koppen's scheme of climatic regionalisation of India.

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GEOGRAPHY OPTIONAL | PAPER II · PHYSICAL SETTING

Floods: Causes, Impact and Measures



PYQ RADAR **16** questions Last asked **2026** 2026 ×2 · 2025 · 2023 · 2022 · 2021 · 2019 ×2 · 2018 · 2016 · 2015 · 2012 · 2005 · 2004 · 2000 · 1993

CONTENTS

01 Nature and Causes of Floods
02 Flood-Prone Areas of India
03 Flood Management
04 Previous Year Questions

- A **flood** is a high water level that overtops the natural banks along any part of a stream and spreads over land that is normally dry. A flood along a coast comes from a surge of the sea.
- **Flood is natural; flood disaster is partly made by people.** A river in spate turns into a disaster when it reaches crops, homes and roads on its floodplain.
- India's flood-prone area is put at **40 million hectares** by the Rashtriya Barh Ayog (1980), and higher in later official counts. The **Ganga and Brahmaputra plains** carry the largest share.

01 Nature and Causes of Floods

PYQ 2026 · 2025 · 2023 +9

Floods

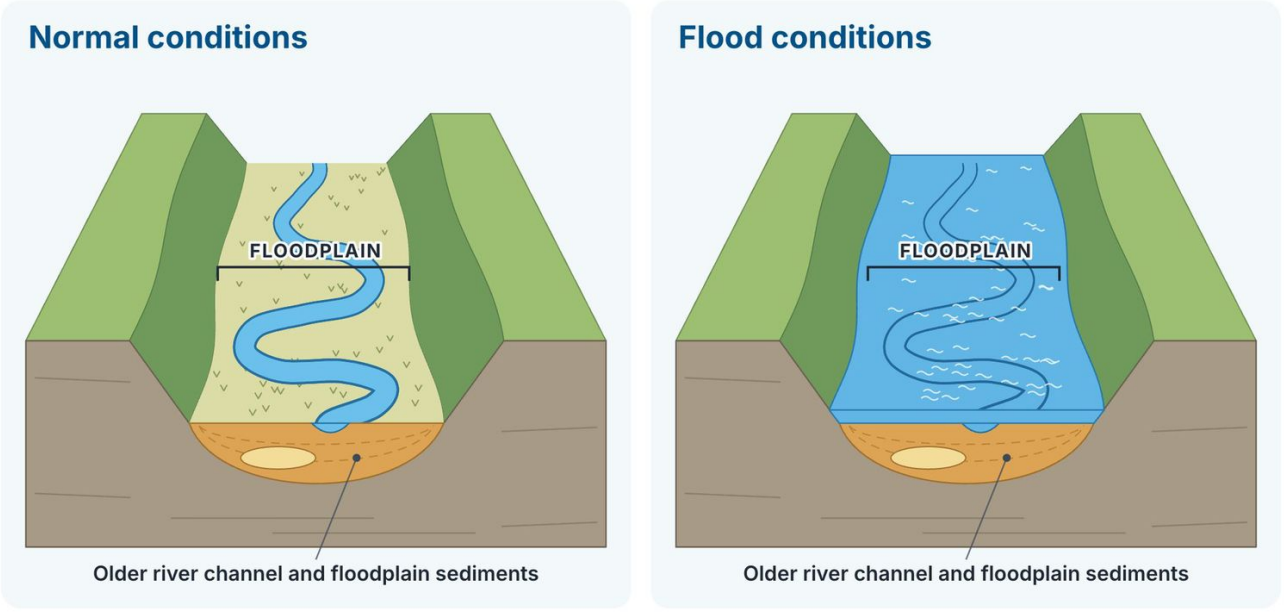
- A stream floods when its **discharge exceeds the capacity of its channel**. The excess spills over the banks and submerges the adjoining land, so the **channel and floodplain together** carry the water.
- Floods are commonly tied to a stream or river, and are a normal part of a basin's **hydrological cycle**.
  - Floods and droughts are its two extremes. Too much monsoon rain gives one, and failed rain gives the other.

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CONTEMPORARY ISSUES · FLOODS

A River Valley in Normal and Flood Conditions

When discharge exceeds the capacity of the channel, the channel and floodplain together carry the water.



Schematic. Not to scale.

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- **Floods and droughts** are, on the one hand, **cumulative hazards** that build up with the season. On the other hand, the peculiar nature of the Indian monsoon can bring both to different pockets of the country in the same year.
  - The Brahmaputra valley can flood while Rajasthan suffers drought.
- Floods are thus **seasonal** for the most part. **Flash floods** also occur, with little warning and a short, violent rise.

Causes of Floods

PYQ 2025 · 1993

- Compared with many other disasters, the causes of floods are **well established**. Riverine floods build up relatively slowly, in well-identified regions, at an expected time of year.
  - **Flash floods and dam failures** are the exceptions.
- A serious flood usually needs several unfavourable factors at once, and human activity now sharpens all of them.

GROUP	FACTORS
Meteorological	Heavy rainfall; tropical cyclones; cloudburst; heavy melting of ice and snow
Physical	Large catchment areas; changes in river systems; inadequate drainage; silting of beds; landslides in river courses; tsunami and sea surges

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GROUP	FACTORS
Human	Deforestation; siltation from land misuse; faulty farming and irrigation; collapse of dams; accelerated urbanisation

Natural Causes

- **Heavy rainfall and cloudbursts:** concentrated rain leaves rivers unable to accept more surface run-off, and the water spills over the adjoining land.
- **Heavy melting of ice and snow**, which swells Himalayan rivers.
- **Changes in river systems and large catchment areas:** the **Kosi** shifts its course and floods new ground, and a large catchment delivers more water to one channel.
- **Sediment deposition and silting of river beds**, which reduce channel capacity.
- **Transgression of the sea** at the time of a **tropical cyclone**.
- **Tsunami** in coastal areas, and **landslides in the course of rivers**, which dam a river and then release a flood.

Cloudbursts

- A **cloudburst** is **very intense rain over a small area**. The working measure is **100 mm or more in an hour, over about 20–30 sq km**. Older accounts describe thunderstorm rain of over 50–100 cm within a few hours.
- **Mechanism:** warm, humid air is forced up a mountain slope and builds towering **cumulonimbus clouds**.
  - Weak upper winds fail to disperse them, and the moisture comes down in one spot.
  - The extra moisture from wet ground on Himalayan slopes may add to it.
- **Where:** most frequent in the **Himalaya in the monsoon**, but rare and severe events occur elsewhere.
  - **Musi river, Hyderabad (1908):** a great flood that destroyed much of the city.
  - **Leh (August 2010):** cloudbursts struck the cold-desert town.
  - **Mumbai (26 July 2005):** the Santacruz station of the India Meteorological Department recorded **944 mm in a day**.
- **Why they do damage:** water, boulders and debris arrive within minutes in narrow valleys, leaving little time to escape.

Man-made Causes

- Unlike many natural disasters, **human beings play an important role** in both the origin and the spread of floods.
- **Deforestation:** it causes soil erosion and landslides.
  - Vegetation holds the soil, which acts as a sponge and soaks up much of the rain. Once it is lost, run-off rises and **river beds silt up**.
- **Unscientific land use and bad farming practice:**
  - Fields left bare let soil and water flush into rivers.
  - Even the **wrong direction of ploughing**, up and down a slope, speeds run-off.

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- **Faulty irrigation:** canals and field systems that cut across natural drainage hold water back.
- **Collapse of dams:** the failure of the **Machhu dam at Morvi (1979)** drowned the town.
- **Increased urbanisation: hard, impermeable surfaces** reduce the land's ability to absorb rain.
  - Less water infiltrates, so **the volume and rate of surface run-off rise**.
  - **Mumbai's floods** turned on this, along with encroachment and blockage of the **Mithi River**.
- **Living on the floodplain:** growing settlement of floodplains and river beds, against the old principle that a river should keep its right of way, places more people in harm's way.

Consequences of Floods

PYQ 2022 · 1993

- Although floods are only a **temporary inundation**, they do extensive damage. Their frequency, intensity and magnitude are rising, and they now cause more damage than almost any other single disaster.
- **Lives and property:** floods take lives and destroy property every year.
- **Crops:** the agricultural season is temporarily lost, and fertile soil cover may go with it.
- **Habitats and animals:** habitats are changed or destroyed, and animals drown.
- **Communication and services:** breaks in rail and road links and in essential services stop the movement of people and goods.
- **Health:** water-borne and infectious diseases such as **cholera and gastro-enteritis** spread soon after floods.
- **Positive consequences:** floods also **deposit fertile silt** on fields, which is good for crops, and **recharge the groundwater table**.
- **Scale:** for 1953–2010, a Parliamentary Standing Committee report gave an average of about **7.2 million hectares** affected each year.
  - **Over three-fourths of the crop and property damage** falls on the northern plains: Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and Assam.
  - The poorest, living at the edge of settlements, are usually **hit hardest**.

Flash Floods and Glacial Lake Outbursts

PYQ 2025 · 2022 · 2019

- A **glacial lake outburst flood (GLOF)** is the sudden release of water from a lake held back by **moraine** or ice.
  - **Triggers:** avalanches, debris flows, rock falls or landslides into the lake; earthquakes; thawing permafrost; heavy rain.
  - **Vulnerable types:** moraine-dammed, ice-dammed and ice-cored lakes.
  - **Effect:** a wall of water and debris that can travel far down the valley with very little warning. Retreating glaciers are enlarging such lakes.
- **Kedarnath, 16–17 June 2013:** heavy rain filled **Chorabari Tal**, less than 4 km above Kedarnath. It overflowed and possibly burst through its moraine rim, and the town was almost wholly destroyed.
  - The National Institute of Disaster Management reported in 2013 that **169 had died and 4,021 were missing**, the missing being later presumed dead.
  - The event was called the **Himalayan Tsunami**, since monsoon and westerly systems had combined over the Himalaya.

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  - **Causes argued over:** rain and glacial melt are the natural side. Environmental groups also blame **illegal construction on floodways, road widening, hydropower blasting and heavy pilgrim traffic**, which they call a man-made share of the disaster.
- **South Lhonak, Sikkim, 3–4 October 2023:** the lake's outburst swept down the Teesta and destroyed the Teesta III dam at Chungthang.
- **Dharali, Uttarkashi, 5 August 2025:** a debris-laden flood down the Kheer Gad buried much of the village. The Ministry of Jal Shakti first reported a cloudburst, but others pointed to a landslide or a blocked valley. The State ordered a technical inquiry.
- **Response:** the **National GLOF Risk Mitigation Project** (2024) has an outlay of **Rs 150 crore** for Arunachal Pradesh, Himachal Pradesh, Sikkim and Uttarakhand. About 195 lakes are listed as at risk.
  - The **Central Water Commission** monitors **2,843 glacial lakes and water bodies over 10 hectares** from June to October each year (May 2026). It reports 46 Himalayan hydropower projects as vulnerable, all now with early warning systems.
  - Other steps include **mapping and monitoring**, heeding forecasts, and building to hydrological and ecological principles.

02 Flood-Prone Areas of India

PYQ 2016 · 2015 · 2005 +1

Flood Distribution in India

PYQ 2005

- Floods recur in India and bring heavy losses to lives, property, livelihoods, infrastructure and public utilities.
- **Extent: 40 million hectares** out of a geographical area of **3,290 lakh hectares** is prone to floods, which is about **12%**, or one-eighth of the land.
  - **The Rashtriya Barh Ayog (National Commission on Floods)**, set up in 1976, gave this figure in **1980**. It found the flood-prone area had grown from **25 million hectares in the 1960s to 34 million in 1978**.
  - Its method, adding each State's worst year, has been criticised, as floods can reach land not hit in that year.
  - The **XII Plan Working Group** revised the figure to **49.815 million hectares**.
- **State shares of damage:** an older State-wise study put **about 27% in Bihar, 33% in Uttar Pradesh and Uttarakhand, and 15% in Punjab and Haryana**.
  - Uttar Pradesh and Bihar hold about a third of the flood-prone area.
- **Main zone:** the **Ganga–Brahmaputra–Meghna basin**, which accounts for nearly 60% of the country's total **river flow**. The flood problem concentrates where the water does.
- **North Indian rivers:** the middle and lower courses of the **Ganga, Brahmaputra and Kosi** flood because of their **very low gradient**. The flat plains offer too little slope to drain the water.
  - The **Damodar and Mahanadi**, though Peninsular rivers, also flood in their lower courses.
- **Peninsular rivers:** these are mature rivers with **hard rock beds** and stable courses, in shallow valleys. Floods are less serious overall and are worst in the **deltas and lower reaches**, where silt builds up.
- **East coast:** parts of it are particularly prone to **cyclones in October–November**, with a smaller season in April–May. These bring strong winds, storm surges, tidal waves and torrential rain.

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FLOOD REGION	RIVERS	WHY IT FLOODS
Ganga River Region	Yamuna, Gomati, Ghaghra, Gandak, Kosi, Son, Burhi Gandak, Bagmati, Mahananda, Damodar	Tributaries from both the Himalaya and the Peninsula; low gradient; silt; drainage congestion
Brahmaputra River Region	Brahmaputra and its tributaries, Barak	Over 250 cm of rain; heavy silt; narrow valley; earthquakes
North-West River Region	Satluj, Beas, Ravi, Chenab, Jhelum, Ghaggar, Markanda	Poor surface drainage; waterlogging; man-made barriers
Central and Deccan India	Mahanadi, Godavari, Krishna, Cauvery, Narmada, Tapi	Stable courses overall; silted deltas; high tides; cyclones

- **Ganga River Region:**
  - **Uttar Pradesh:** eastern districts flood through the Rapti, Sharda, Ghaghra and Gandak. The west has **drainage congestion** around Agra, Mathura and Meerut.
  - **Bihar:** floods are almost annual in the north, through the Burhi Gandak, Bagmati, Kamala, Kosi and Mahananda. The **Kosi** is known for its shifting course: on **18 August 2008**, its embankment breached at Kusaha in Nepal and the river took up an old channel, flooding land long thought safe.
  - **West Bengal:** the south and centre flood through the Mahananda, Bhagirathi, Ajoy and Damodar, because of **inadequate channel capacity and tidal effect**. Floods have continued on the Damodar even after its dams were built.
  - **Delhi:** the Yamuna reached a record **208.66 m on 13 July 2023**, above the 207.49 m of 1978.
- **Brahmaputra River Region:**
  - Floods are almost annual on the **Brahmaputra and its tributaries**, where heavy rain, silt and valley form all work against drainage.
  - **The valley is narrow**, about 80 km at its widest, and the bed has been raised by silt. Earthquakes such as those of 1897 and 1950 have changed river levels.
  - **31.05 lakh hectares out of 78.52 lakh hectares**, nearly 40% of Assam, is flood-prone (Rashtriya Barh Ayog, on Assam's official figures).
  - **Assam, 2026:** the State Disaster Management Authority's count reached **104 deaths by 14 August 2026**, with **Upper Assam districts** such as Sivasagar and Golaghat badly affected.
- **North-West River Region:**
  - **Punjab:** floods are near-annual, with intense ones every 4–5 years. Canals, highways and railways built **across the natural slope** obstruct drainage, along with building in low-lying areas near Ludhiana and Patiala.
    - In **2025**, 12 of its 23 districts were affected by early September.
  - **Haryana:** a **saucer-shaped surface** stops free run-off, so that even moderate rain can flood it.
  - **Ghaggar:** it once died out in the Rajasthan sands, and now occasionally submerges land there.
  - **Jammu and Kashmir:** the Jhelum raises Wular Lake and threatens Srinagar. The Chenab and Tawi endanger Jammu and Akhnoor.

- **Central and Deccan India:**
  - Rivers are mostly stable, so floods are a smaller problem. The **Mahanadi, Godavari, Krishna and Cauvery deltas** flood through silting and shifting channels, and high tide makes it worse.
  - **Keralam (Kerala):** short rivers from the Western Ghats do heavy damage when in spate.

CONTEMPORARY ISSUES · FLOODS

India: Flood-Prone Areas

The shaded States are the eleven in the box of older figures. Telangana is shaded as part of the Andhra Pradesh of those figures.



Flood-prone areas
Other areas
Country capital

Older figures, from 2012
Flood-prone area of eleven States

State	Million hectares
1. Uttar Pradesh	7.34
2. Bihar	4.26
3. Punjab	3.70
4. Rajasthan	3.26
5. Assam	3.15
6. West Bengal	2.65
7. Haryana	2.35
8. Odisha	1.40
9. Andhra Pradesh*	1.39
10. Gujarat	1.39
11. Keralam (Kerala)	0.87
Total	**31.76**

* Andhra Pradesh as it was before Telangana was formed in 2014.

India as a whole
40 million hectares
Rashtriya Barh Ayog, 1980
49.815 million hectares
XII Plan Working Group

Boundaries: Survey of India outline (datameet). Not to scale.

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03 Flood Management PYQ 2026 · 2025 · 2023 +7

Flood Control Management PYQ 2023

- The Central and State Governments use **structural** measures, which modify the flood, and **non-structural** measures, which modify the damage.
  - After the floods of 1954, the main thrust was on reservoirs, embankments, channel works, town protection and river training.

Flood Forecasting

- **Purpose:** advance notice of a flood gives time to move people, cattle and goods, and so cuts the loss.
- **Start:** the **Central Water Commission (CWC)** began flood forecasting in **November 1958**, with its first station at the **Old Railway Bridge, Delhi**.
- **Network:** the older figure of **175 stations** dates from 2014. By **2 May 2026**, the network had grown to **360 flood forecasting stations (201 level and 159 inflow)**, drawing on **1,543 hydrological stations** and 1 central and 36 divisional control rooms. It covers the flood-prone States and Union Territories.

YEAR	FORECASTING STATIONS
1958	1
1985	145
2014	175
2019	325
2026	360

- **Season:** daily warnings run through the flood season, usually given as **May to October**. The Commission now uses three periods:
  - 1 May–31 October in the Brahmaputra, Barak and Jhelum basins;
  - 1 June–31 October in other basins up to the Krishna;
  - 1 June–31 December south of the Krishna.
- **Activities:** collecting river and weather data; sending it to forecasting centres; analysis and formulation of a forecast; and dissemination.
  - State **control rooms** pass warnings on and organise relief and rescue.
- **Accuracy:** a level forecast is counted accurate if within 15 cm, and an inflow forecast if within 20% of actual discharge.
- **New tools:** the Commission now issues **7-day advisory forecasts** and runs the **FloodWatch India** app.
  - **C-FLOOD**, launched on **2 July 2025** with the National Remote Sensing Centre and the Centre for Development of Advanced Computing, gives **2-day inundation forecasts down to village level**. It

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began with the Godavari, Tapi and Mahanadi basins and is planned to cover all forecasting stations by 2027.

- **Across borders:** a **flood data arrangement with Nepal** dates from 1988. India's data memoranda with China on the Brahmaputra and Satluj **lapsed in June 2023 and November 2020**, and India has pressed for renewal.

Reduction in Run-Off

- This works well because run-off falls when more surface water **infiltrates** in the catchment, above all through **large-scale afforestation in the upper catchment**.
  - The canopy intercepts raindrops, while **roots, leaf litter and humus** hold water.
  - Less run-off means **less soil erosion**, so there is **less silt** and the channel keeps its capacity.
- In the Indo-Gangetic plain, **dug wells along seasonal channels** can force water underground, as its soft soils and large aquifers allow.

Construction of Dams

- **Dams and multipurpose projects** store surplus water in reservoirs and release it under control, cutting flood peaks.
  - Several were built in the First Five-Year Plan, and many more in later plans.
  - **Examples:** Tilaiya, Konar, Maithon and Panchet in the Damodar system; Bhakra on the Satluj; Hirakud on the Mahanadi; Pong on the Beas; Nagarjuna Sagar and Tungabhadra in the Krishna basin; Ukai on the Tapi.
- Ponds, tanks, marshes and old quarries serve as **smaller detention basins**.

Channel Improvements and Construction of Embankments

- **Channel improvement:** flood-prone rivers are **deepened and widened**, and their beds cleared and straightened. Banks are held by riprap, spurs and deep-rooted trees.
- **Diversion into canals and depressions:** water from such rivers is led into canals, which store it for a time. The **Ghaggar scheme** diverts **340 cumecs** into depressions before the river enters Rajasthan.
- **Embankments:** the Central and State Governments have raised many, along the **Brahmaputra, Krishna, Godavari, Gandak, Kosi, Narmada, Tapi, Son, Satluj** and their tributaries.
  - Older figures show the scale: about **10,821 km by 1978** and more than **33,630 km by March 2000**. Assam holds about a third, with 934 km on the Brahmaputra and 2,400 km on its tributaries, and Bihar about a fifth.
  - **Limits:** they shift a flood more than they control it. Silt confined to the channel **raises the bed**, and a breach can then be worse than the flood it was built to stop. The Kosi in 2008 is the standard case.

Flood Plain Zoning

- This rests on **information about floodplains**: which strips act as floodways, and how the land along them is used. Flood-prone land is mapped and graded, and the use of each zone is controlled.
- The Central Flood Control Board proposed zoning in **1957**, and a **model bill** went to the States in **1975**.
  - Its features were a zoning authority, delineation and notification of limits, restrictions on use, compensation, and power to remove constructions.

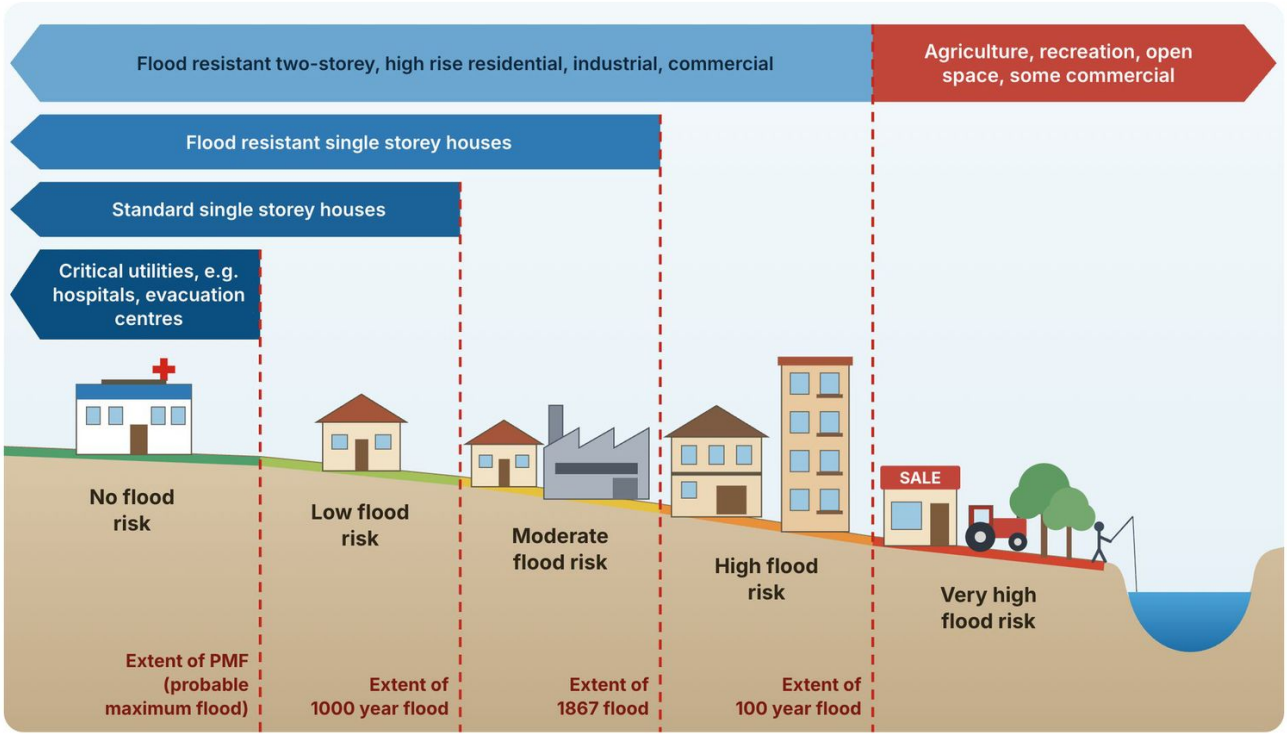
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- By May 2026, **eight States** had adopted it through an Act or policy: Manipur, Rajasthan, Jammu and Kashmir, Uttarakhand, Bihar, Arunachal Pradesh, Assam (Bodoland Territorial Council) and Tamil Nadu.

CONTEMPORARY ISSUES · FLOOD PLAIN ZONING

Graduated Planning Controls

Each use is kept behind a set flood line. The example is from Australia: the 1867 mark is the Hawkesbury–Nepean flood, and an Indian plan would set zones from its own flood records.



Schematic. Not to scale.

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NDMA Guidelines for Flood Management

STRUCTURAL	NON-STRUCTURAL
Reservoirs, dams, other water storages	Flood plain zoning
Embankments and flood walls	Flood proofing
Drainage improvement	Flood management plans
Desilting and dredging of rivers	Integrated watershed management
Diversion of flood water	

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STRUCTURAL	NON-STRUCTURAL
Afforestation and catchment area treatment	

- **Watershed management** links run-off control with both land and water use.

Government Programmes for Flood Management

- **Legislative measures:** construction of industrial and residential units in flood-prone areas is to be restricted, and buildings, factories and houses are to be kept out of zones next to the channel.
  - Land flooded only occasionally should stay under **green belts**, with **social forestry** encouraged on the floodplain.
- **National Flood Control Management Programme, 1954:** the first national policy statement on flood control, given on **3 September 1954**, set out three types of measures:
  - **Immediate** (about two years): data collection and emergency protection.
  - **Short-term** (the next few years): spurs and embankments at selected sites.
  - **Long-term:** storage reservoirs on rivers and tributaries, and further embankments.
- **National Hydrology Project, 2016:** a central sector scheme of **Rs 3,679.77 crore**, with **50% of the outlay from a World Bank loan**. It gathers hydro-meteorological data for storage and analysis in real time, open to any user at State, district or village level.
- **Flood Management and Border Areas Programme, 2021–26: Rs 4,100 crore** in all, approved in February 2024.
  - Rs 2,940 crore is for flood control, anti-erosion, drainage and anti-sea erosion works, with central funding of 90% for special category States and 60% for others.
  - Rs 1,160 crore is for works on rivers shared with neighbouring countries.
- **Protection so far:** of the 40 million hectares, about **32 million** was judged protectable by structural means.

Mitigation (Post-Flood Management)

- Rescue operations
- Speedy restoration of the transport system
- Supply of safe drinking water
- Repairing power, telephone and sewerage lines
- Providing food, shelter and clothing
- Survey to assess the loss and compensation
- Rehabilitation of properties
- Desilting and dewatering of inundated areas
- Contingency plan for the agriculture sector
- **Community resilience:** local warning, shelters and trained volunteers, along with risk-based planning, reduce the toll at each stage of the flood cycle.

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Previous Year Questions

2026	Disaster risk reduction and community resilience are the two pillars that need to be prioritized in the flood prone areas of India. Critically analyse.
2026	With suitable examples describe the hazards of flood plain settlement.
2025	Explain the causes of glacial lake outburst flood.
2023	Discuss the problems of floods and their management with special reference to the Indo-Gangetic Plain.
2022	The incidence of extreme rainfall events and flash floods in recent times has led to devastating consequences for people living in low-lying areas and flood plains of the country. Discuss.
2021	Describe the problems of cloudburst in India, giving suitable examples.
2019	Examine the problems of Glacial Lake Outburst Flood (GLOF) in India.
2019	The impact of floods on life and property can be most effectively reduced by hazard mapping. Comment.
2018	Explain the natural and anthropogenic causes and mitigation measures of frequent flooding in Mumbai.
2016	Describe the flood-prone areas and their management problems in the Ganga Plains.
2015	Account for the growing frequency and intensity of floods in India, and suggest short- and long-term remedial measures indicating the chronically flood-prone areas.
2012	Explain the causes, impact and remedial measures of flood-hazards in the middle Ganga plain. Represent the flood-affected areas of middle Ganga plain on a sketch map in your answer-book.
2005	Give an account of the distribution of flood-prone areas of India and the programmes and policy of controlling the impact of floods in the country.
2004	Explain the causes, impacts and remedial measures of flood-hazards in Middle and Lower Ganga plain.

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2000 Give a reasoned account of either flood hazards or drought hazards occurring in India, and also suggest measures for controlling them.

1993 Delineate the flood-prone areas of India by drawing a sketch map in the answer book and discuss the causes and consequences of floods in the North Indian plains.

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IN THE COMPLETE BOOK

01 **Space Relationship of India** 1 chapter · from page 6

02 **Structure and Relief** 2 chapters · from page 51

03 **Drainage Systems** 11 chapters · from page 92

04 **Physiographic Regions** 13 chapters · from page 262

05 **Monsoon and Climate** 7 chapters · from page 472

06 **Natural Vegetation and Soils** 2 chapters · from page 575

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