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ECOLOGY & ENVIRONMENT

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ASTRONOMY

NASA defines astronomy as, "The study of stars, planets and space."

Universe

- All existing matters and space as a whole forms the Universe. It was termed as cosmos when first conceived as an orderly unit and its study called as **cosmology**. It is believed to be expanding since its creation in the Big Bang about 13 billion years ago.
- In astronomy & cosmology, space is the vast 3-dimensional region that begins where the earth's atmosphere ends. There are inter steller & intergalactic spaces.

Contributors to Geography

- **Ainville** made the first map of India.
- **Anaximander** created the first map of world.
- Anthropogeography was written by **Friedrich Ratzel**.
- **Eratosthenes** was the first person to calculate the circumference of the Earth, calculate the tilt of the Earth's axis and coined the word geography.
- **Ptolemy** first presented India on the world map.

- Normal matters that are visible (star, planet and galaxies) make up less than 5% of the total mass of the universe rest are made of dark matters. These dark matters are not seen by the astronomers but they can study their effects.

Development Theories

Big Bang Theory

- **Big bang theory** was proposed by Georges Lemaitre in 1927.
- According to this theory billion of years ago cosmic matters were in highly compressed state and expansion started with premordial explosion which was bang in superdense ball. These exploded particles travelling at a speed of thousands miles per second gave rise to our galaxies.

Steady State Theory

- The steady state theory was governed by **Hermann Boudi** and **Thomas Gold**.
- It is also known as theory of continuous creation. According to this theory universe has always existed and will always exist and will always look essentially the same, so there is no over all evolution, thus balancing the average density despite the exapansion.
- As old galaxies move apart the new galaxies are being formed.

Galaxy

- A Galaxy is a large collection of stars, gas, dust, and dark matter bounded by gravitational force. At times they are so big that they are called as **Island Universe**.
- There are about 100 billion galaxies (10^{11} galaxies) in the universe, and each galaxy has on an average 100 billion stars (10^{11} stars). So, the total number of stars in the universe is 10^{22} stars.
- The **Milky Way Galaxy** is the home of the Earth and our Solar System. It is spiral in shape.
- Latest known galaxy is the **Dwarf Galaxy**.
- According to the modern thought, universe can be classified into two parts namely— (a) Atmosphere and (b) Space.
- Origin of the universe is explained by the **Big Bang Theory,** formulated and proposed by the Belgian astronomer and cosmologist Georges Lemaitre.
- **Andromeda** is our nearest galaxy.

Elliptical Galaxies

Elliptical galaxies can be classified on the basis of their ellipticity, ranging from nearly spherical (E0) to highly elongated (E7). These have low portion of open clusters and low rate of new star formation.

Spiral Galaxies

Spiral galaxies have a central nucleus with great spiral arms trailing round it resembling pin wheel. **Andromeda Galaxy** and **Milky Way** are the example of such galaxies**.** The spiral arms are thought to be areas of high-density matter, or "density waves".

Mt. Vesuvius (Italy), Mt. Stromboli (Italy), Mt. Etna (Italy) and Mauna Loa (Hawaii) are examples of active volcanoes.

Irregular Galaxies

Irregular galaxies are youthful in nature with no sharp and boundary thinning out gradually, these galaxies contain large amount of gas and dust. This type of galaxy is the result of gravitational interaction or collision between formerly regular galaxies.

The Life Cycle of a Star

Nebula

A nebula is a cloud of gas (hydrogen) and dust in space. **Nebulae** are the birthplaces of stars.

Star: A **star** is a luminous globe of gas producing its own heat and light by nuclear reactions (nuclear fusion).

- Stars are born from nebulae and consist mostly of hydrogen and helium gas.
- Brightest star outside solar system is Sirus also called as **Dog Star.**
- Closest star to our solar system is Proxima Centauri (4.2 light years away) followed by Alpha Centauri (4.3 light years away), and Barnard's Star (5.9 light years away).

Red Giant Star

- Red Giant Star is a dying star, i.e. the later stages of the evolution of a star like the Sun, as it runs out of hydrogen fuel at its centre.
- In few billion years, the Sun will turn into a red giant Star, expand and engulf the inner planets, possibly even the Earth. Red Giant Stars are very cool, faint and small stars, approximately one tenth the mass and diameter of the Sun.

Red Dwarf Stars

- Red Dwarf stars are the most common & longest lived stars.
- They are the smallest of the stars with low temperature, e.g. Proxima Centauri & Barnard's star.

White Dwarf: A small very dense star that is typically the size of planet.

Black Hole is very small, hot star, the last stage in the life cycle of a star like the Sun. The gravitational pull in a black hole is so great that nothing can escape from it, not even light. So, it is invisible.

- **S. Chandrasekhar** has given Chandera-sekhar Limit, which is about the formation of Black Holes.
- The closest star to the Earth is the Sun.
- The closest star to our solar system is **The Proxima Centauri**.

THE SOLAR SYSTEM

Origin of the Solar System
Various theories were given to explain the Origin of the Solar System

Hypothesis	Propounder
Gaseous Hypothesis	Kant
Nebular Hypothesis	Laplace
Planetesimal Hypothesis	Chamberline and Moulton
Tidal Hypothesis	Sir James Jeans and Harold Jeffreys
Binary Star Hypothesis	HN Russell
Supernova Hypothesis	F Hoyle
Interstellar Dust Hypothesis	Otto Schmidt
Electromagnetic Hypothesis	H Alfven
Protoplanet Hypothesis	G Kuiper
Nebular Cloud Hypothesis	Dr. Von Weizsacker

- The Sun, the eight planets (Pluto is not a planet now, considered as a dwarf planet) along with their satellites, the asteroids, the comets, the inter planetary dust and the electrically charged gases called **plasma**, together make up the solar system.
- Our solar system consists of an average star we call it the Sun, the planets – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

Barren Island in India is an active volcano while Mt. Kilimanjaro in Africa is an example of extinct volcano.

- The Sun is an average star. It isn't the hottest, it isn't the coolest, it isn't the oldest. Nor is it brightest, biggest, etc.
- **Sun's Mass:** The Sun's mass is in between 99.8% and 99.9% of the solar system. The rest is split between planets, satellites, comets, asteroids, dust particles and gases surrounding the solar system.
- It is composed mainly of **hydrogen** and **helium**.
- **Nuclear fusion** in the core of the Sun is source of all its energy.
- The glowing surface of the Sun is called **Photosphere**.
- The Sun has a red coloured Chromosphere and beyond it is **Corona** (visible during eclipses).
- The surface of the Sun changes continuously. Bright regions are called **Plages** and dark spots are called **Sun spots** which frequently form and disappear.

Sun Statistics

- Distance from the Earth – 150 mn km
- Diameter – 1391980 km
- Core temperature – 15000000°C
- Rotation time – 25 days
- Age – 5 billion years
- Composition : H_2 - 71%, He - 26.5% and other 2.5%
- Mass – 1.99×10^{33} kg

Solar Eclipse

Solar eclipse is caused when the Moon revolving around the Earth comes in between the Earth and the Sun, thus making a part or whole of the Sun invisible from a particular part of the Earth.

Lunar Eclipse

During the revolution of Earth, when it comes between moon and the Sun the shadow of the Earth hides moon either fully or partially. This is called lunar eclipse.

Planet

A planet must meet three criteria:

(i) It must orbit the Sun,

(ii) It must be big enough for gravity to squash it into a round ball,

(iii) It must have cleared other objects out of the way in its orbital neighbourhood.

- The **Terrestrial Planets or Inner Planets** are the four innermost planets in the solar system, which include Mercury, Venus, Earth and Mars.
- The **Jovian Planets or Outer Planets** are Jupiter, Saturn, Uranus, and Neptune because they are all gigantic compared to Earth, and they have a gaseous nature.

A COMPARATIVE STUDY OF THE PLANETS OF THE SOLAR SYSTEM

Planets	Special Characteristics	Important Physical Properties	Rotation and Revolution Time	Satellite Systems
Mercury	Smallest and the inne most planet. It has no atmosphere. It has a cratered surface, much like the Moon.	It has the maximum diurnal range of temperature.	Rotation: 58.65 days; Revolution: 88 days(Fastest Revolution in the Solar System).	No satellite
Venus	Also called as the veiled planet known as **(Evening and Morning star)** as it is seen in the East in morning and in the	Rotates from East to West unlike the other planets. It is the hottest planet.	It has the slowest rotational speed. It has almost equal rotation and revolution. Rotation:	No satellite

	West in the evening. It is the brightest object in solar system because of almost 70% albedo. It contains 90 to 95% The night and day temperature almost the same.		(Clockwise) 243.02 days and Revolution: 224.7 days	
Earth	The Earth is neither too hot nor too cold. It is called as the **Blue Planet** due to the presence of water.	It is the densest of all and is unique for the presence of higher forms of life.	Rotation: 24 hours. Revolution: 365 days and 6 hours.	Moon is the only natural satellite.
Mars	Called as **Red Planet.** It has a thin atmosphere comprising of nitrogen, argon, Carbon mono oxide.	It is marked by dormant volcanoes. Nix Olympia is the highest mountain which is three times higher than the Mount Everest.	Rotation: 24.6 hour. (almost equal to Earth) Revolution: 687 days.	Two satellites Phobos and Deimos.
Jupiter	It is the largest planet in the solar system with a mass 2.5 times greater than the combined mass of all the remaining planets, satellites and asteroids put together. It contains hydrogen, helium, methane and ammonia. A great red spot is detected on it	It is too massive to solidify as a planet but not massive enough to develop nuclear fusion and become a star. It gives off more energy than it receives from the Sun, because of the heat inside.	Fastest rotational velocity (9.8 hrs)	It has 69 (as of 2017) satellites. Some of the prominent satellites are: Europa, Callisto and Ganymede. These are called as **Galilean Moons.**
Saturn	It is the 2nd largest planet and is surrounded by a set of eight rings, which are made up of Primordial dust and ice particles.	It has the least density of all the satellites. 30 times less dense than the Earth.	Rotation in 10.3 hours. Revolution in 29.5 years.	It has 62 satellites, the largest being Titan.
Uranus	It is unique as its axis of rotation is inclined at 98° to its orbital plane.	Surrounded by a system of 9 faint rings.	Unlike the others, which spin on their axis, Uranus actually rolls apparently from North to South.	It has 27 satellites. The prominent are Miranda, Ariel etc.
Neptune	It is a penultimate planet, has a dynamic atmosphere, which contains an Earth sized blemish called the **Great Dark Spot** that is reminiscent of Jupiter's Great Red spot.	It has 5 faint rings it appears as **Greenish Star.**	Rotation: 16.1 hours and Revolution: 165 years.	It has 14 satellites. The prominent are Triton and Nereid.

PLUTO IS NOT A PLANET NOW

- On the basis of the new definition of planet given by the IAU (International Astronomical Union), the world's top institution on space science research, leading astronomers participating in IAU's meet at Prague (Czech Republic) on August 24, 2006, declared that Pluto would no longer remain a planet.
- In 2006, it was reclassified as a dwarf planet.
- Under the IAU's new guidelines, the number of planets in the Solar System has thus been reduced from nine to eight. Its merits mentioning here that, prior to this decision, Pluto had been holding the planetary status since its discovery in 1930 by Clyde Tombaugh.

DWARF PLANET

A dwarf planet is a planetary-mass object that is neither a planet nor a natural satellite. It shares its orbits around the Sun with other objects such as asteroids or comets. It is massive enough for its shape to be in hydrostatic equilibrium under its own gravity, but has not cleared the neighborhood around its orbit.

The first 5 recognised dwarf planets are – Ceres, Pluto, Eris, Haumea & Makemake.

LIGHT YEAR

A light-year is a unit of astronomical distance. It is the distance that light can travel in one year. It is approximately 9.5 trillion kilometres (or about 6 trillion miles).

Planets Facts

1. Biggest Planet-Jupiter
2. Biggest Satellite-Jupiter's Ganymede
3. Blue Planet-Earth
4. Green Planet-Uranus
5. Brightest Planet-Venus
6. Brightest Planet outside Solar System-Sirus
7. Closest Star of Solar System-Proxima
8. Coldest Planet-Neptune
9. Evening Star-Venus
10. Farthest Planet from Sun-Neptune
11. Planet with maximum no. of satellites-Jupiter
12. Fastest revolution in solar system-Mercury
13. Hottest Planet-Venus
14. Densest Planet- Earth
15. Fastest Rotation in Solar System-Jupiter
16. Morning Star-Venus
17. Nearest Planet to Earth-Venus
18. Nearest Planet to Sun-Mercury
19. Red Planet-Mars
20. Slowest Revolution in Solar System-Neptune
21. Slowest Rotation in Solar System-Venus
22. Smallest Planet-Mercury
23. Smallest Satellite-Deimos
24. Earth's Twin-Venus
25. Atmosphere like Earth-Titan

Cosmic World

Asteroid

A small rocky body orbiting the sun is termed as asteroid. Large numbers of these, are found between the orbits of Mars and Jupiter, though some have more eccentric orbits.

Meteor

A meteoroid is a small rocky or metallic body travelling through space and range in size from small grains to 1 meter-wide objects. When it enters the atmosphere to become visible it is called meteor. It is also known as "**shooting star"** or **"falling star."** One can see nearly 20 million of meteors in a day. Hoba is the largest meteorite found (Namibia – 60 tons).

Oort Clouds

They are roughly spherical, shell of icy objects found in the outermost reaches of the solar system. Astronomers believe that it is remains of the disc of material that formed the Sun and planets. Estimates put it at around 2 trillionicy bodies It is also referred to as Trans-Neptunian object applied to objects in the Kuiper Belt. Astronomers think that long-period comets have their origins in the Oort Clouds.

Light takes about 4.3 years to reach us from the next nearest star Proxima Centauri.

INFORMATION BULLETIN ON EARTH

• Total surface area	:	510,072000 Km^2
• Land area	:	148,094000 Km^2
• Water area	:	361,132000 Km^2
• Percentage of land	:	29.2%
• Percentage of water	:	70.8%
• Water Type	:	97% salt water, 3% fresh water
• Human population of the Earth	:	**7.6 billion** as of October 2017 according to the most recent United Nations estimates elaborated by Worldometers.
• World Population Growth	:	**1.12% per year** (down from **1.14%** in 2016). The current average population increase is estimated at 83 million people per year.
• Countries of the world	:	196 (195 Excluding Taiwan)
• Earth's Circumference at the Equator	:	24,901.55 miles (40,075.16 km)
• Earth's Circumference between the North and South Poles	:	24,859.82 miles (40,008 km)
• Earth's Diameter at the Equator	:	7,926.28 miles (12,756.1 km)
• Average Distance from the Earth to the Sun	:	92, 935, 700 miles
• Average Distance from the Earth to the Moon	:	238.900 miles/384, 400 km
• Highest Elevation on Earth	:	Mt. Everest, Asia : 29,035 feet (8850 m)
• Tallest Mountain on Earth from Base to Peak	:	Mauna Kea. Hawaii: 33,480 feet (rising to 13.796 feet above sea level) (10204 m, 4205 m)
• Point Farthest from the Center of the Earth	:	The peak of the volcano Chimborazo in Ecuador at 20,561 feet (6267 m) is farthest from the center of the Earth due to its location near the equator and the oblateness of the Earth.
• Lowest Elevation on Land	:	Dead Sea: 1369 feet below sea level (417,27 m)
• Deepest Point in the Ocean	:	Challenger Deep. Mariana Trench, Western Pacific Ocean: 36,740 feet (11022 m)
• Highest Temperature Recorded	:	135.80F - A1 Aziziyah, Libya, Sep. 13,1922 (57.7°C)
• Lowest Temperature Recorded	:	–128.5°F - Vostok, Antarctica. July 21, 1983 (–89.2°C)
• Water vs Land	:	4.5 to 4.6 billion years
• Atmosphere content	:	78% nitrogen, 21% oxygen and 1% traces of argon, carbon dioxide and water.
• Rotation on Axis	:	23 hours and 56 minutes and 04.09053 second. But, it takes an additional four minutes for the earth to revolve to the some position as the day before relative to the sun (i.e., 24 hours)

• Revolution Around the Sun	:	365 . 2425 day
• Chemical Composition of the Earth	:	34.6% Iron, 29.5% Oxygen, 15.2% Silicon, 12.7%, Magnesium, 2.4% Nickel, 1.9% Sulphur and 0.05% Titanium.

Planet Earth

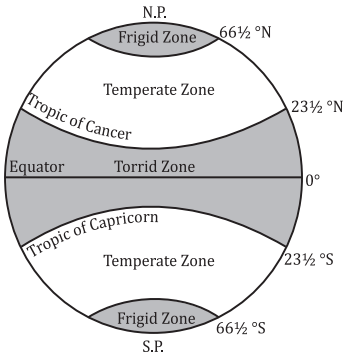
- The shape of Earth is '**Oblate spheroid'**.
- The axis of the Earth is inclined to the plane of Earth's orbit at an angle of 66 1/2°giving rise to different seasons and varying lengths of day and night.
- At equator, day and night are of equal length throughout the year.

Torrid Zone

The Mid-day Sun shines vertically overhead at least once a year between the Tropic of Cancer and the Tropic of Capricorn. Thus, this region receiving the maximum heat and is called **Torrid Zone**.

Temperate Zones

These are the areas where climatic condition is not extreme. The area lies between the tropics and polar region (23½° of 66½°) having moderate climate.



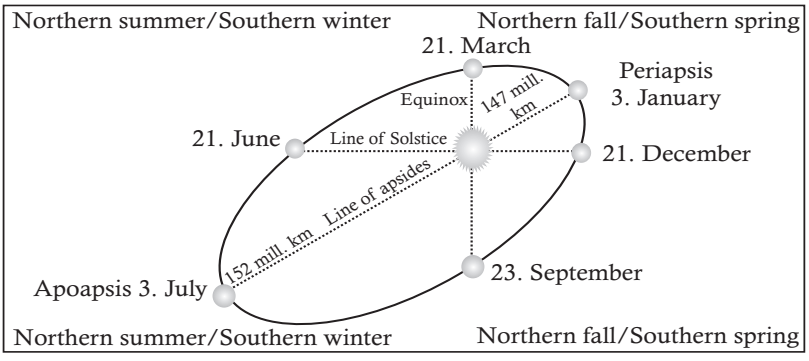
Frigid Zones

These are the two extremely cold zones situated in the Polar regions extending to the Arctic circle in the North and to the Antarctic circle in the South.

Seasons Formation

Revolution of the Earth around the Sun along with it spinning around its axis, which is tilted at an angle of 23.5 degrees, is the main cause of season's formation. Around the June Solstice, the Northern Hemisphere is tilted towards the Sun, therefore experiencing **summer**. The Southern Hemisphere on the other hand, is tilted away from the Sun and thus, experiences **winter**. The opposite occurs around the December Solstice, when the Southern Hemisphere is tilted towards the Sun, while the Northern Hemisphere is tilted away.

Seasons and their Formation



There are **four seasons**: Summer when the Sun's ray falls directly over the tropic of cancer.

In autumn, the Sun's ray falls directly over the equator. During winter it is over tropic of Capricorn and during spring it falls back on equator.

Equinoxes is the day which happens twice a year and day and night are of equal length. March 21 is called as **Vernal equinox** and 23rd September is **autumnal equinox**. **Solstice** in the same ways occurs when the difference between the lengths of day and night are maximum. Occurs twice in a year firstly when the Sun's ray falls on tropic of cancer and secondly when over tropic of Capricorn.

Eclipse

It is related to obscuring light of the sun or the moon by any other body. There are two types of eclipse.

Lunar eclipse occurs when the earth comes in middle of the sun and the moon. It occurs on full moon day but not every full moon day experiences lunar eclipse.

Solar eclipse occurs when the moon comes in middle of the sun and the earth. It occurs on the new moon day when the moon is in line with sun.

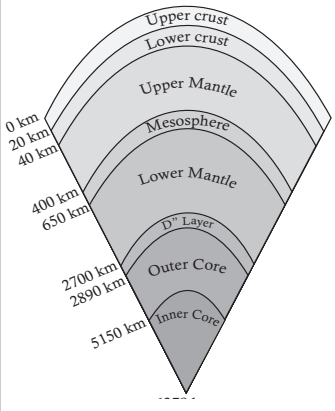
Chronological age of the Earth

EON	ERA	PERIOD		EPOCH	Millions of Years Ago
Phanerozoic	Cenozoic	Quaternary		Holocene	0.011477
				Pleistocene	1.806
		Tertiary	Neogene	Pliocene	5.332
				Miocene	23.03
			Paleogene	Oligocene	33.9
				Eocene	55.8
				Paleocene	65.5
	Mesozoic	Cretaceous			145.5
		Jurassic			199.5
		Triassic			251
	Paleozoic	Permian			299
		Charboniferous	Pennsylvanian		318.1
			Mississippian		359.2
		Devonian			416
		Silurian			443.7
		Ordovician			488.3
		Cambrian			542

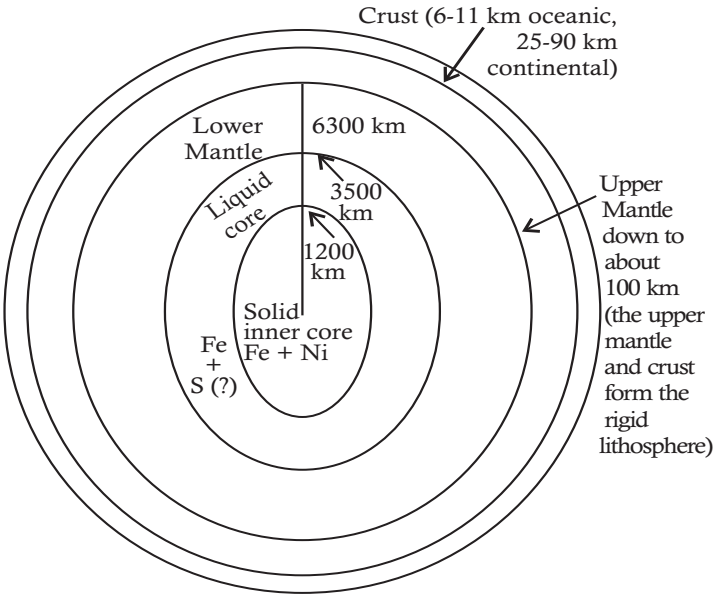
Precambrian	Proterozoic	Neoproterozoic	Ediacaran	630
			Cryogenian	850
			Tonian	1000
		Mesoproterozoic	Stenian	1200
			Ectasian	1400
			Calymmian	1600
		Paleoproterozoic	Statherian	1800
			Orosirian	2050
			Rhyacian	2300
			Siderian	2500
	Archean	Neoarchean		2800
		Mesoarchean		3200
		Paleoarchean		3600
		Eoarchean		4000
	Hadean			4567

Internal Structure of Earth

The thickness and deepness of the Earth is the study of **seismology**. The interior structure of the Earth is layered in spherical shells. It was **Edmund Halley (1692)** who put forth the idea of earth consisting of a hollow shell about 500 miles thick, with two inner concentric shells around an innermost core. These shells can be divided by mechanical properties such as Rheology, or chemically. Mechanically, shells are divided into lithosphere, asthenosphere, mesospheric mantle, outer core, and the inner core. The interior of Earth is divided into 5 important layers. Chemically, Earth crust is divided into the crust, upper mantle, lower mantle, outer core, and inner core.



Depth (Km)	Layers
0-60	Lithosphere (locally varies between 5 and 200 km) (density 2.9-3.3)
0-35	Crust (locally varies between 5 and 70 km)
35-60	Uppermost part of mantle
35–2,890	Mantle
100–200	Upper mesosphere (density 3.3-4.3)
660–2,890	Lower mesosphere (density 4.3-5.5)
2,890–5,150	Outer core (density 10.00-13.3)
5,150–6,360	Inner core (density 13.3-13.6)



GEOMORPHOLOGY

Rock

Rock is a naturally occurring mineral and is relatively hard.

Proportion of Elements Found in Rock

In Earth	In Earth Crust
7% Others	5.5% Others
13% Magnesium	3% Sodium
15% Silicon	8% Aluminium
30% Oxygen	28% Silicon
35% Iron	47% Oxygen

Type of Rocks

Sedimentary Rocks

- Sedimentary rocks are formed through lithification, compression and cementation of sediments deposited in a particular place mainly aquatic areas.
- Sometimes the remains of plants, dead animals etc are found in the deposited material. Such fossil containing sedimentary rocks are useful for studying life on earth.
- Sandstone, limestone, shale are some example of sedimentary rocks.

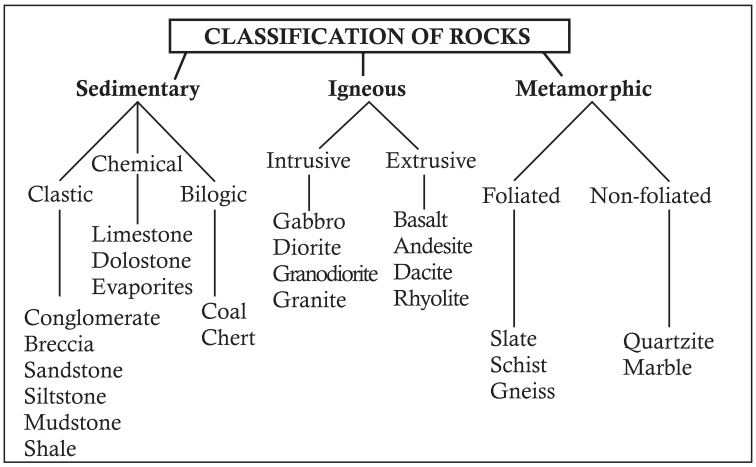
Igneous/Primary Rocks

- Igneous rocks are formed from solidification and cooling of magma. Usually this magma partially melts off the pre-existing rocks from mantle or crust of the earth. This melting of rocks is caused by one or more processes namely: increase in temperature, decrease in pressure, or a change in composition e.g. Basalt, Granite.
- These rocks are generally harder and granular.
- There are no layers in these rocks.
- Fossils are not found there.

Metamorphic Rocks

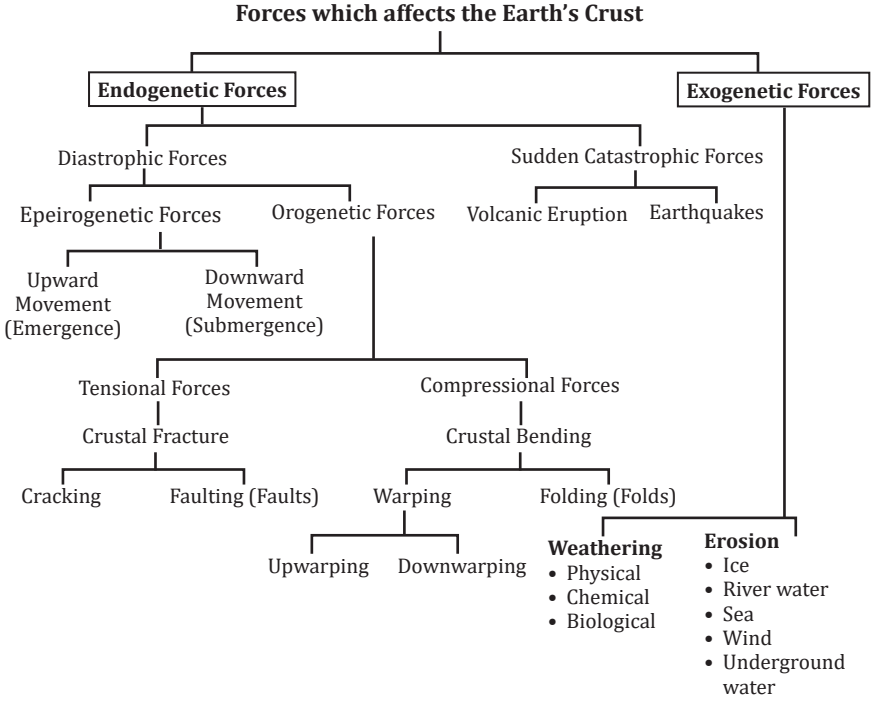
- When the change occurs in the form or composition of the pre-existing rock (igneous or sedimentary) without any disintegration taking place is called metamorphic rock.
- Minerals in the rocks get restructured on account of heat and pressure. This brings about a change in the original formation of rocks.

Aconcagu (6,960 m) is the highest while Valdes Peninsula (–39.9 m) is the lowest point in Latin America.



Earth Movement

The forces affecting earth's crust and the resultant movement can be categorized into two broad categories and further into sub-categories.



Endogenetic Forces

The forces which originate within the Earth surface are defined as endogenetic forces. They can result in both horizontal and vertical movement of the earth surface. Internal heat causing chemical reactions inside the earth and transfer of rock materials on the surface of the earth by external forces results in release of endogenetic energy.

Endogenetic forces are of two types: **Diastrophic movements** and **Sudden movements**.

These movement causes fold, fault, earthquake and volcanic activities.

Folds

These are the wave like structure formed in the crustal rock due to tangential compressive force resulting from horizontal movement caused by endogenetic forces.

Types of Folds

- **Symmetrical fold** is the simple fold, the limbs of which incline uniformly.
- **Asymmetrical Fold** is the fold with unequal and irregular inclination and length.
- **Monoclinal Fold** is the fold with one limb inclined moderately with regular slope while the other limb inclines steeply at right angle and the slope is almost vertical.
- **Isoclinical Fold** is a fold where compressive force, forces both the limbs of the fold to become parallel but not horizontal to its axis.
- **Recumbent Fold** is formed when compression force is strong enough to make both the limbs of the fold parallel as well as horizontal to its axis.

Faults

These are the slippage or displacement occuring in the crust along the fracture plane. Four types of faults: i) normal, ii) reverse, iii) lateral and iv) step faults.

Volcano

It is a fissure or vent in the earth's crust communicating with the interior, from which lava, rock fragments, hot vapour and gases are ejected. A volcano begins to form when magma, which is hot molten rock from deep within the earth, rises toward the earth's surface and collects in magma chambers.

Types of Volcanoes:

(a) **Active Volcanoes:** Alive now
(b) **Dormant Volcanoes:** Have not erupted for quite some time
(c) **Extinct Volcanoes:** Have not erupted for several centuries

Earthquake

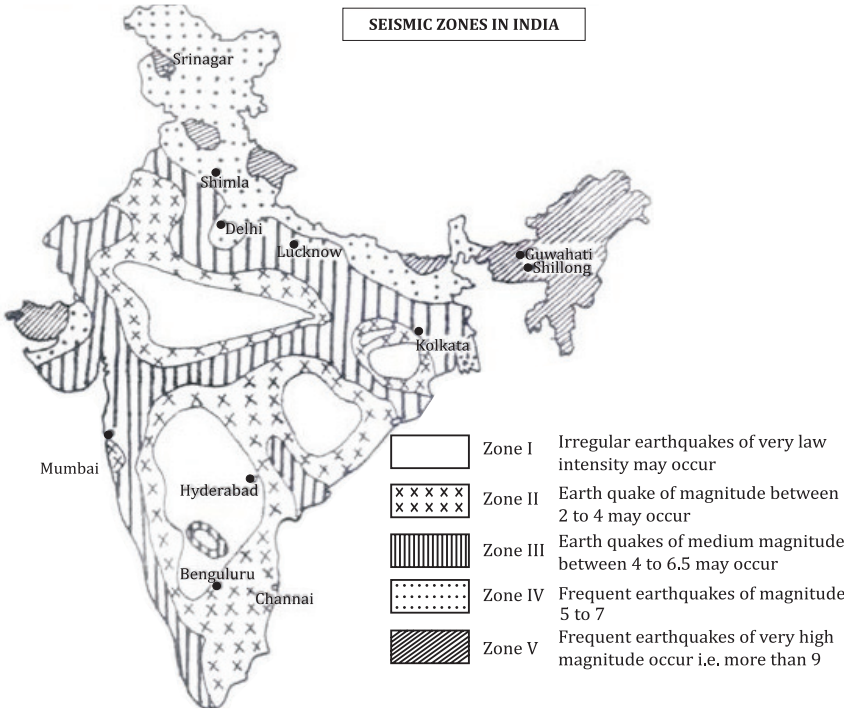
Motion ranging from faint tremor to wild shaking of the earth surface is called **earthquake**. It occurs mainly due to tectonic activities caused by continuous endogenetic processes inside earth's crust. The place from where it starts is called as **focus or hypocenter** and the point directly above it is known as **epicenter**. It is measured in **Richter scale** varying from 0 to 9.

Plate Tectonic Theory

Our earth surface is made up of plates which are in motion due to the convection current flowing beneath it. This movement in the earth's plate is called as tectonic movement. This movement has been widely accepted cause of continental drift, earthquakes, volcanoes, mountains, and oceanic trenches.

Types of Plates	
Major Plates (Primary Plates)	**Minnor Plates (Secondary Plates)**
Africa Plate	Cocos Plate
Pacific Plate	Filipino Plate
North American Plate	Juan de Fuca Plate
Antarctic Plate	Caribbean Plate
Eurasian Plate	Scotia Plate
Australian Plate	Nazca Plate
South American Plate and	Arabian Plate
	Indian Plate

The Mariana Trench is the World's deepest trench with a depth of 11,033 metres.



Exogenetic/Denudational/ Destructional Forces

The forces which act above the earth surface changing relief of earth surface are known as exogenetic forces. These processes are continuously engaged in destructing the relief features created by endogenetic forces. These forces are carried on by the agents of erosion such as wind, water, glacier etc., the process through which these agents work on the earth surface are **weathering and erosion**.

- **Weathering** is a process in which breaking down of the earth surface takes place but the debris do not move from their place.
- **Erosion** refers to the movement in the weathered material.

Denudation is a long-term sum of processes that is caused by weathering, leading to a reduction in elevation and relief of landforms and landscapes and erosion.

Major Landforms

- There are four major landforms such as mountains, hills, plateaus and plains.

Landform	% of the total Global Surface Area
Mountains	12
Plateau	33
Plains	41
Hills	14

Mountains

- On the basis of the mode of formation, five main types of mountain can be distinguished.

Folded Mountains originated by compressive forces. Young, mature and old are its sub types. E.g. Alps in Europe, Rockies in North America, Andes in South America and the Himalayas in Asia.

Block Fault Mountain originated by tensile and compressional forces. E.g. Black

The explorer Ferdinand Magellan, who circumnavigated the Earth, named the Ocean 'Pacific' meaning peaceful.

forest mountains on the border of France and Germany.

Dome Mountain originated by magnetic intrusion and unwrapping of the crustal surface.

Volcanic Mountain formed by accumulation of volcanic materials e.g. Mount Mauna Loa in Hawaii, Mt. Fujiyama in Japan and Mt. Popa in Central Myanmar.

Residual Mountain E.g. Vindhyachal, Aravalli, Eastern and Western Ghats.

Plateau

A second order relief feature characterized by flat and rough top surface and steep wall with a height difference of at least 300 m from its surrounding areas.

Classification of Plateau:

- Plateaus are classified according to their surrounding environment such as intermontane, Piedmont, continental and Coastal plateaus.

(i) **Intermontane Plateau:** When a plateau is surrounded by mountains on all sides, it is referres to an intermontane plateau. (Tibetan, Bolivian, Peru, Columbian Plateau, Mexican, Iranian)

(ii) **Piedmont Plateau:** This plateau is located close to a mountain on one side. (Appalachian Piedmont Plateau, Patagonian Plateau)

(iii) **Continental Plateau:** When a plateau is surrounded by oceans or plains, it is refers to as continental plateau. (Deccan Plateau of India, Chota Nagpur Plateau)

(iv) **Coastal Plateau:** (Coromandel Coastal Upland of India)

Plateaus having more than average height.	
Tibetan Plateau	16,000 ft. (5000 metres)
Bolivian Plateau	12,300 ft. (3750 metres)

Lake

Lakes are static bodies of water surrounded by land from all sides. These are not permanent features on the earth surface. Sometimes lakes are found near the sea coast. There are two type lakes, freshwater lakes and saline lake.

Oceanography

Ocean Structure

- Ocean can be divided into two main groups (i) the ocean (ii) the sea. Ocean covers 70% of the earth surface and has an average depth of more than 12,400 feet.
- An ocean is a large body of water that is saline. Although the oceans of the Earth are all connected and are truly called "World Ocean", most often the world is divided into five different oceans.

Pacific Ocean

- It is located between the Southern Ocean, Asia and Australia and the Western Hemisphere.
- According to the CIA World Factbook, it covers 28% of the Earth and is equal in size to nearly all of the land area on the Earth.
- It includes Arafura Sea, Bering Sea, Celebes Sea, Coral Sea, Java Sea, Gulf of carpentria, Yellow Sea, Japan Sea, Bohol Sea, Gulf of Alaska, Molucca Sea and South China Sea.

Atlantic Ocean

- The Atlantic Ocean is the world's second-largest ocean with an area of 29,637,900 square miles (76,762,000 sq km).
- It is located between Africa, Europe, the Southern Ocean and the Western Hemisphere.
- It includes Caribbean Sea, Celtic Sea, Labrador Sea, Marmara Sea, Norwegian Sea, Bothnia Sea, Beaufort Sea, Amumden Sea, Baffin Bay, Laptev Sea, White Sea, Pechorasea, Kara Sea, East Siberian Sea, Green Land Sea, Prince Gustav Adolf Sea.

Indian Ocean

- This Ocean is the world's third-largest ocean and it has an area of 26,469,900 square miles (68,566,000 sq km).
- It is located between Africa, the Southern Ocean, Asia and Australia.
- It includes Arabian Sea, Andaman Sea, Bay of Bengal, Timor Sea, Red Sea, Laccadive Sea, Gulf of Qman, Gulf of Aden, Mozambique Channel.

The Atlantic Ocean has the longest coastline and is also the busiest ocean for trade and commerce.

Southern Ocean

- The Southern Ocean is the world's newest and fourth-largest ocean.
- In the spring of 2000, the International Hydrographic Organization decided to delimit a fifth Ocean.
- The boundaries of this ocean were taken from the Pacific, Atlantic and Indian Oceans.

Arctic Ocean

- The Arctic Ocean is the world's smallest with an area of 5,427,000 square miles (14,056,000 sq km).
- It extends between Europe, Asia and North America and most of its waters are north of the Arctic Circle.

Inland Seas

- Caspian Sea, Aral Sea, Saltona Sea, Dead Sea and Black Sea.

Continental Shelf

- Continental margin submerged under ocean water upto 100 fathoms (600 feet) with slope of 1° to 3° and often determined by the coastal reliefs. High mountainous coast have narrow self. In Atlantic Ocean it is 2 km to 80 km.

Deep Sea Plain/Abyssal Plain

- Most extensive relief, covering 75.9% of the total area of ocean basin. Flat and rolling submarine having depth of 3000 m to 6000 m. The Mariana Trench near Guam Island is the deepest of all.

Temperature of Ocean

Ocean is divided into three layers according to temperature.

(i) First layer up to 500 m from top having temperature of 20 - 25°C

(ii) Thermocline layer - below 500 m where temperature decreases at a rapid rate with the increase in depth.

(iii) Third layer is very cold and extends upto deep ocean floor. Polar region has this layer from surface to deep ocean form.

Daily range of temperature is the difference of maximum and minimum temperature of a day which is 0.3°C at low latitude and 0.2° to 0.3°C at higher latitudes.
Annual range of temperature: Maximum temperature is recorded in August and minimum in February in the northern hemisphere. Average annual range of temperature of ocean water is - 12°C usually.

Factors Affecting Distribution of Temperature

- Major factors include: Latitude, Unequal distribution of land and sea, prevailing wind and ocean current
- Minor factors include: Submarine ridges, local weather, location and shape of sea

Density of Ocean

- Amount of mass per unit volume of substance, measured in g/cm^3
- Density of pure water is 1 g/cm^3 at 4°C. and ocean water is 1.0278 g/cm^3 (2-3% higher than water) at 4°C.
- It increases with lowering of temperature of ocean. Highest density is recorded at –1.3°C.

Salinity of Ocean

- Average salinity of ocean water is 35%. Salinity of ocean water is affected by marine organism, plant community and physical properties of ocean such as temperature, density, waves, pressure and currents.
- Highest salinity is observed between 20° - 40° N (36%).
- Boiling point of saline water is higher than pure water.
- The line with same salinity is joined by Isohalines.

Source of Salinity

Salts brought by rivers is the main source. It contains 60% of calcium sulphate and 2% of sodium chloride.

SALTS IN OCEAN WATER

Name of Salts	%
Sodium Chloride	77.8
Magnesium Chloride	10.9
Magnesium Sulphate	04.7
Calcium Sulphate	03.6
Potassium Sulphate	02.5
Calcium Carbonate	00.3
Magnesium Bromide	00.2

A shallow lake formed between the sand and the sea coast is called lagoon and kayal in Kerala.

THE WORLD'S MOST SALINE WATER BODIES

Rank	Salinity (percentage)	Name	Type	Region or countries
1.	44%	Don Juan Pond	Salt lake	Antarctica
2.	40%	Lake Retba	Salt lake	Senegal
3.	35%	Lake Vanda	Salt lake	Antarctica
4.	35%	Garabogazkol	Lagoon	Turkmenistan
5.	34.8%	Lake Assal	Salt lake	Djibouti
6.	33.7%	Dead Sea	Salt lake	Israel, Jordan, Palestine

Factors controlling salinity

- Evaporation is positively related to the salinity level.
- Precipitation has a negative relation with it.
- Influx of river water has inverse relation with salinity level.
- Atmospheric pressure and wind are of directional help in the redistribution of water salinity.
- Circulation of ocean water is the controlling factor of salinity in a region.

Ocean Currents

The movement of a mass of oceanic water parallel to the coast is called as ocean current.
Currents are of two types on the basis of temperature.
(i) Warm current
(ii) Cold current

On the basis of velocity, dimension and direction ocean currents are of following types :

Drift

It is slow movement of the ocean current under the influence of prevailing wind.

Current

Movement or circulation of ocean water in a definite path having great velocity.

Stream

Movement of ocean water involving large volume in a definite direction and velocity. It is a continuous flow.

Origin

Origin of ocean current are due to following factors:

- Rotation of earth
- Temperature difference in ocean
- Salinity difference in ocean
- Density Difference
- Air pressure and wind
- Rainfall and Evaporation
- Direction, shape and configuration of coast
- Bottom relief
- Seasonal variation

Distribution of Currents

Atlantic Ocean

- North Equatorial Current (warm)
- South Equatorial Current (warm)
- Counter Equatorial Current (warm)
- Gulf Stream (warm)
- North Atlantic Current
- Canary Current (Cold)
- Labrador Current (Cold)
- Brazil Current (warm)
- Falkland Current (Cold)
- South Atlantic Drift (Cold)
- Benguela Current (Cold)

Pacific Ocean

- North Equatorial Current (Warm)
- South Equatorial Current (Warm)
- Counter Equatorial Current (Warm)
- Kuroshio System (warm)
- Oyashio Current (Cold)
- California Current (Cold)
- Peru Current (Cold)
- El Nino or Counter Current (warm)
- Eastern Australian Current (warm)
- West Wind Drift (Cold)

Indian Ocean

- North-east Monsoon Current (warm)
- Indian Counter Current (warm)
- South West Monsoon (warm)
- Indian Equatorial Current (warm)
- Mozambiqe Current (warm)
- West Wind Drift (cold)

Clinometer is an instrument used for determing the difference in elevation between two points.

Strait is a narrow passage of water connecting two seas or two other large areas of water.
Strait of Malacca is a funnel-shaped narrow waterway 800 km long that connects the South China & Andaman Sea.
Bass strait is the widest (240 km). Bosphorous, the narrowest strait in world used for international navigation, that connects the Black Sea with the Sea of Marmara.

MAJOR STRAIT OF THE WORLD

Name	Joins	Location
Malacca Strait	Andaman Sea & South China Sea	Indonesia - Malaysia
Palk Strait	Palk Bay & Bay of Bengal	India-Sri Lanka
Sunda Strait	Java Sea & Indian Ocean	Indonesia
Yucatan Strait	Gulf of Mexico and Caribbean Sea	Mexico-Cuba
Messina Strait	Mediterranean Sea	Italy-Sicily
Otranto Strait	Adriatic Sea & Ionian Sea	Italy-Albania
Bab-el-Mandeb Strait	Red Sea & Gulf of Aden	Yemen-Djibouti
Cook Strait	South Pacific Ocean	New Zealand (N & S islands)
Mozambique Strait	Indian Ocean	Mozambique - Malagasy
North Channel	Irish Sea & Atlantic Ocean	Ireland-England
Taurus Strait	Arafura Sea & Gulf of Papua	Papua New Guinea - Australia
Bass Strait	Tasman Sea & South Sea	Australia
Bering Strait	Bering Sea & Chukchi Sea	Alaska-Russia
Bonne-Fasio Strait	Mediterranean Sea	Corsika-Sardinia
Bosphorus Strait	Black Sea and Marmara Sea	Turkey
Dardanelle Strait	Marmara Sea and Aegean Sea	Turkey
Davis Strait	Baffin Bay & Atlantic Ocean	Greenland-Canada
Denmark Strait	North Atlantic and Arctic Ocean	Greenland-Iceland
Dover Strait	English Channel & North Sea	England-France
Florida Strait	Gulf of Mexico and Atlantic Ocean	USA-Cuba
Hormuz Strait	Gulf of Persia & Gulf of Oman	Oman-Iran
Hudson Strait	Gulf of Hudson & Atlantic Ocean	Canada
Gibraltar Strait	Mediterranean Sea & Atlantic Ocean	Spain-Morocco
Magellan Strait	Pacific and South Atlantic Ocean	Chile
Makassar Strait	Java Sea & Celebeze Sea	Indonesia
Tsugaru Strait	Japan Sea and Pacific Ocean	Japan (Hokkaido-Honshu island)
Tatar Strait	Japan Sea & Okhotsk Sea	Russia (E Russia-Sakhalin Island)

Gulf

A large area of a sea or ocean partially enclosed by land, especially a long landlocked portion of sea opening through a strait. Gulf and Bay are of economic importance as they serve as excellent harbour in most of the cases. Many important trading centers are located on gulfs. It forms a good fishing ground and oil deposits.

The Gulf of Mexico

Bordering the United States, Mexico, and the island nation of Cuba, is the world's largest gulf. It has a coastline of about 5,000 kilometers (3,100 miles).

The Persian Gulf

In Arabian Sea borders Iran, Iraq, Kuwait, Saudi Arabia, Qatar, Bahrain, the United Arab Emirates, and Oman. There a vast deposit of petroleum is found.
The Gulf of Carpentaria on northeast coast of Australia, is an inlet of the Arafura Sea.

Bay

A bay is a small body of water or a broad inlet that is set off from a larger body of water generally where the land curves inward. Examples of bays include the **Bay of Pigs** (Cuba), **Hudson Bay** (Canada), **Chesapeake Bay** (Maryland and Virginia), and **Bay of Bengal** (near India).

Choke Point

When a body of water such as a strait is capable of being blocked or even closed in order to control transportation routes, the body is called a **"choke point."**

Estuaries

Estuaries are bodies of water and their surrounding coastal habitats typically found where rivers meet the sea. It becomes the home of numerous unique plant and animal communities because their waters are brackish. Brackish is a mixture of fresh water draining from the land and salty seawater.

Barrier Island

Sandbars or barrier islands built up by ocean currents and waves in coastal areas created a protected area fed by small streams or rivers. The barrier islands off the Atlantic coastline of North Carolina and Massachusetts enclose bar-built estuaries.

Delta System

Deltas are formed at the mouths of large rivers from sediment and silt deposition. When the river flow is restricted by the delta, an estuary may form. The Nile River in Egypt and the Mississippi River in Louisiana form delta systems estuaries.

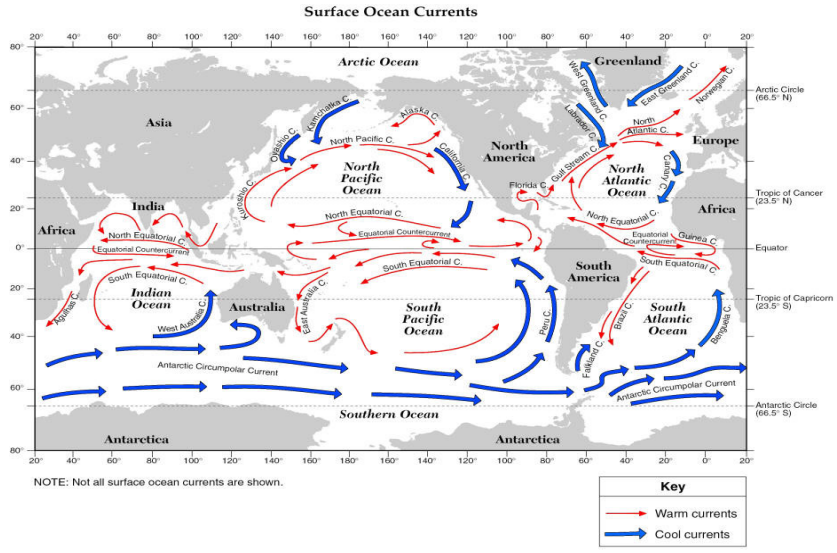
Tectonic Estuary

It is created when a major crack or a large landmass sink, often caused by earthquakes, produces a basin below sea level that fills with water. This type of estuaries usually occurs along fault lines. San Francisco Bay in California is an example of an estuary created by tectonics.

Fjords

Advancing glaciers ground out long, narrow valleys with steep sides. Glacier Bay in Alaska is an example of a fjord.

Clinometer is an instrument used for determing the difference in elevation between two points.



MAJOR GULFS AND THEIR LOCATION

Gulf of Aden of the southwestern corner of the Arabian Peninsula
Gulf of Alaska in the Pacific Ocean south of the state of Alaska
Amundsen Gulf in the Arctic Ocean northwest of Canada
Gulf of Aqaba in the northern end of the Red Sea, leading to Israel and Jordan
Gulf of Bahrain, part of the Persian Gulf
Gulf of Bothnia, part of the Baltic Sea between Sweden and Finland
Gulf of Cádiz, part of the Atlantic Ocean off the southern border of Spain and Portugal
Gulf of California, in the Pacific Ocean in northwestern Mexico
Gulf of Carpentaria, a large bay off northern Australia
Gulf of Cazones, a large gulf in southern Cuba
Gulf of Corinth, which extends into Greece from the Mediterranean
Davao Gulf in the Philippines
Gulf of the Farallones, westward from the opening of the San Francisco Bay and Drakes Bay to the Farallon Islands
Gulf of Finland, between the southern coast of Finland and the northern coast of Estonia in the Baltic Sea.
Gulf of Genoa inside the Ligurian Sea on the northwestern coast of Italy
Gulf of Guinea in the Atlantic Ocean off the coast of Equatorial Africa
Gulf of Izmir in the Aegean Sea between Turkey and Greece. It was formerly called the Gulf of Smyrna.
Gulf of Khambhat in the Arabian Sea, formerly known as the Gulf of Cambay
Gulf of Kutch in the Arabian Sea

Lingayen Gulf of western Luzon, the Philippines, in the South China Sea
Gulf of Lion, a bay on the Mediterranean coastline of Languedoc-Roussillon and Provence in France
Gulf of Maine, off the State of Maine, New Brunswick, and Nova Scotia in the Atlantic Ocean
Gulf of Mannar, between India and Sri Lanka
Gulf of Mexico, between Mexico, the United States, and Cuba
Gulf of Morbihan, a natural harbour on the coast of the Département of Morbihan in the south of Brittany
Gulf of Nicoya, in Costa Rica, Central America.
Gulf of Oman, between the south eastern Arabian Peninsula, Iran, Pakistan and Arabian Sea.
Gulf of Oristano, near Oristano on the Western Sardinian coast
Gulf of Panama in the Pacific Ocean south of Panama
Persian Gulf between Iran and the Arabian Peninsula
Gulf of Roses, the most northeastern bay on the Catalan coast
Gulf of Saint Lawrence, the world's largest estuary and the outlet of the Saint Lawrence River into the Atlantic Ocean
Gulf St Vincent, separated from Spencer Gulf by the Yorke Peninsula
Gulf of Sidra, just north of Libya in the Mediterranean
Spencer Gulf, near Port Lincoln, South Australia
Gulf of Suez, in the northern end of the Red Sea, leading to the Suez Canal
Gulf of Thailand, just south of Thailand in the Indian Ocean
Gulf of Tonkin, just east of North Vietnam in the Pacific Ocean
Gulf of Tunis, in the Mediterranean off the coast of Tunisia

MARINE RESOURCES

The biotic and abiotic resources found in the oceanic water and lagoons are called Marine resources. It includes marine water, inherent energy in ocean water (e.g. wave and tidal energy) biotic life (plants and animals), marine deposits and abiotic elements (minerals, fossils fuels, etc).

Marine Zone

(i) Territoral Sea

It is a region lying between base line and 12 nautical miles towards sea. 12 nautical mile is the seaward limit of territoral sea and called as **contiguous zone.**

(ii) Exclusive Economic Zone

This zone extends upto 200 nautical miles from the base line. The coastal state has the right of survey, exploitation, conservation and management of mineral resources of ocean deposits, ocean floor, marine water energy, water and ocean organisms with exclusive economic zone. No other country can venture without the permission of the concern state.

(iii) High Sea

It extends beyond sea limit of the exclusive economic zone and includes the vast ocean area.

Anemometer is an instrument used for measuring wind velocity and Beufort Scale is used to identify wind strength.

Marine Biological Resources

Those marine - related biological resources such as flora, fauna and micro organism whose inter-community behaviour and action affect or get affected by the piece of marine ecosystem they are living in.

Plankton Community

Planktons are floating and drifting micro plants and animals in photic zone. These are divided into phytoplankton (plant planktons) and zooplanktons (animal planktons). Phytoplankton produces food through the process of photosynthesis with the help of sunlight, water and atmosphere. *Algae* and *Diatoms* are most important member of this community. Algae and diatom are called as **marine pasture**.

MAJOR WETLAND OF THE WORLD AS RANKED BY WORLD HERITAGE SITE

Country	Wetland Name	Area
Canada	Wood Buffalo National Park	44,807 km^2
USA	Everglades National Park	6,110 km^2
USA	Olympic National Park	3,734 km^2
USA	Yellowstone National Park	8,983 km^2
Bulgaria	Srébarna Nature Reserve	6 km^2
Romania and Ukraine	Danube Delta	4,152 km^2
Russian Federation	Lake Baikal	31,722 km^2
Russian Federation	Volcanoes of Kamchatka	43781 km^2
Spain	Doñana National Park	543 km^2
Tunisia	Ichkeul National Park	85 km^2
Malawi	Lake Malawi National Park	94 km^2
Senegal	Djoudj National Bird Sanctuary	160 km^2
Dem. Republic of Congo	Virunga National Park	7,800 km^2
India	Kaziranga National Park	430 km^2
India	Keoladeo National Park	28 km^2
India	Manas National Park	950 km^2
Australia	Fraser Island	1,840 km^2
Australia	Kakadu National Park	19,804 km^2
New Zealand	Te Wahipounamu	26000 km^2
Honduras	Río Platano Biosphere Reserve	5250 km^2
Mexico	Sian Ka'an	3,157 km^2
Panama	Darien National Parks	720 km^2
Colombia	Los Katios National Parks	5,970 km^2
Peru	Manu National Park	17,163 km^2

CORAL REEFS AND ATOLL

It is accumulated and compact skeleton of lime secreting organisms known as coral polyps. They are confined between 25°N - 25°S latitude. They live on lime and in colony form. High mean annual temperature between 68°F to 70°F (20°C - 21°C) is required for the growth of corals. They do not grow in more than 250 feet (60-77 m) of water as they require oxygen and sunlight. Grows in open sea as fresh water is harmful for corals.

Types of Coral Reef: (i) fringing reef (ii) barren reef and (iii) atoll

Ocean Tide

Alternative rise and fall in the sea level is known as tide. The rise of sea water and its movement towards coast is high tide. The fall of seawater and moving towards sea is called ebb/low tide. The difference between high and low tide is called as **tidal range**.

Types of Tide

(i) Spring tide: When the sun, the moon and the earth are in the same line, there is formation of spring tide. The position when all three are in a straight line is called as **syzygy**. When the sun, the moon and the earth are in sequential order in a straight line is called as **conjunction**. It occurs on new moon day. When the earth is in between the moon and the sun are called as **opposition**. It occurs on full moon day.

(ii) Neap tide: It's a quadrature (90°) position between the earth, the sun and the moon on seventh or eighth day of the fortnight. During this time the forces of the sun and the moon acts in opposite direction.

ATMOSPHERE

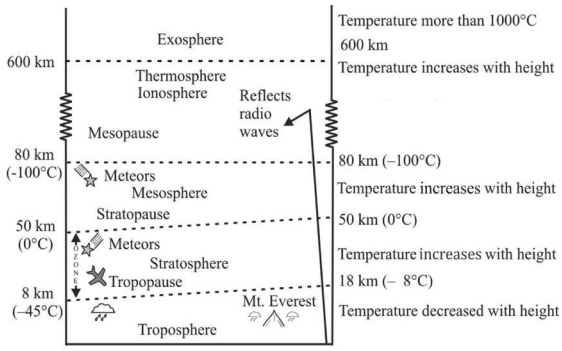
Atmosphere

- Atmosphere is a thick gaseous envelope surrounding the earth from all sides and attached to earth through the force of gravitation.
- It extends to about 1000 km from the surface of the earth, but 995 of the total mass of the atmosphere is found within 32 km.
- It acts as a filter because it absorbs the various unwanted radiation.
- It is the source of various gases.

Proportion of gases in Atmosphere

S.NO.	Gases	%
1.	Nitrogen	78
2.	Oxygen	21
3.	Argon	0.93
4.	CO_2	0.03
5.	Neon	0.0018
6.	Helium	0.0005
7.	Ozone	0.0006
8.	Hydrogen	0.00005

Structure of Atmosphere



Structure of the Atmosphere

Troposphere

- The first layer of atmosphere from the earth surface is known as troposphere.
- It is at the height of 12 km from the earth surface.
- Here temperature decreases at the rate of 6.5°C per km with the increase in height. This is called normal lapse rate.
- The transition layer separating troposphere from stratosphere is known as **tropopause** which is between 16 km at equator to 8 km at pole.

Stratosphere

- The layer which extends from 18 to 50 km above the earth surface is called as stratosphere.
- In this layer temperature increases as altitude increases due the ultra violet rays.
- Ozone forms to be the outer limit for this layer. Turbulence free zone is ideal for flying of jet aircrafts.

Mesosphere

- Mesosphere lies from 50 to 80 km above the ground level with the temperature below 100°C at 80 km. Even pressure drops to 1 mb at 50 km to 0.01 mb at 90 km.
- Mesopause are the upper transitional layer separating mesosphere from ionosphere.
- It is the zone of meteorites activities.

Ionosphere

- The layer between mesosphere and thermosphere is known as ionosphere.
- Aurora Austrialis and Aurora Borealis occur due to penetration of ionizing particles in this layer.
- Temperature rises with increasing height here owing to the absorption of ultra-violet radiation by atomic oxygen.
- Above 100 km the atmosphere is increasingly affected by solar X-rays and ultra-violet radiation, which causes ionization.

Thermosphere

- The thermosphere is the second highest layer of earth's atmosphere just above mesopause.
- It forms lower boundary of exosphere known as exobase.
- Gradual increase of temperature is witnessed with height reaching up to 1500°C (2700°F).

Exoshpere

- Outer most layer extending between of 700 km to 10000 km.
- Gases like nitrogen, oxygen and carbon dioxide are found.
- No meteorological phenomenon is possible. Sometimes Aurora Borialis and Aurora Austrialis occur overlapping into the thermosphere.

Insolation

- Insolation is solar energy received on the earth. The sun emits radiation continuously in the form of short wave and ultraviolet radiation. This radiation has to pass the atmosphere before it reaches the earth.
- The sun is primary source of energy on earth. It enters earth's atmosphere in the form of short waves. This is known as incoming Insolation solar radiation. The earth receives solar radiation at the rate of 1.94 calories per cm^2/m.
- The amount of solar radiation received by earth is affected by four factors i.e; solar constant, distance from sun, altitude of the sun and length of the day.

Heat Budget

Earth balances the incoming solar radiation with the outgoing terrestrial radiation and is called **heat budget**. The energy received if not returned back to the space in the form of long waves would increase the temperature of the earth surface. This balancing of heat affects the amount of insolation absorbed.

Adiabatic Changes

When the air parcel moving towards a low pressure zone without the exchange of heat with surrounding air, it increases volume and reduces the heat available per unit volume and hence temperature falls. Such a change of temperature, where neither addition nor subtraction of heat involves is known as **'adiabatic change'**.

Inversion of Temperatures

It refers to a condition where temperature increases with increasing height of the atmosphere. The five causes of inversion of temperature are radiation, drainage, frontal, advection, subsidence.

- General tendency to decrease in temperature with increasing latitude is known as

The zone on the globe which does not experience an earthquake is known as the shadow zone.

'temperature gradient'. Not only the temperature but even its nature with latitude changes. The rate of change of temperature is comparatively low between tropics. On the other hand the gradient is high at the poles.

Isotherms: The line which join places having equal temperature is called **'Isotherms'**.

Atmospheric Pressure

- Atmospheric pressure is the pressure exerted by the column of air in the atmosphere of Earth.
- The standard air pressure at sea level is 1013.25 mb.
- Air pressure decreases with increase in altitude at the rate of 0.1 inch or 3.4 mb per 600 feet. The rate of decrease is confined to the height of few thousand feet. Lines joining places with equal pressure at sea level are called **isobars**.
- The areas affected by high pressure are called High Pressure zone or Anticyclones and the low pressure are called Low pressure zone or depression or Cyclone. There are seven pressure belts across the globes.

Equatorial Low Pressure Belt

- The geographical region situated between 5° N to 5°S is known as Equatorial Low Pressure Belt.
- This belt gets longer duration of sunshine and sun's ray falls at a straight angle on earth surface. Intense heat is received by the earth surface causing thermal induced atmosphere.
- It is also a convergence zone of north-east and south-east trade winds.
- The area is calm with no wind movement, thus known as Belt of **Calm** or **Doldrums**.

Sub-Tropical High Pressure

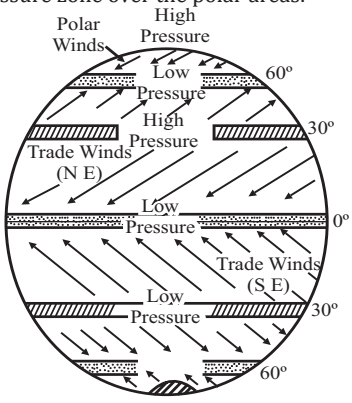
- The sub tropical high pressure belt extends between 25° to 35° in both the hemisphere.
- Here the convergence of winds at higher altitude above this zone results in the subsidence of air from higher altitudes. Thus, descent of wind results in concentration of their volume and ultimately causes high pressure.
- It is not thermally induced, but dynamically induced as it owes its origin to the rotation of the Earth and sinking and settling down of winds.
- This zone of high pressure is also called **Horse Latitude.**

Sub Polar Low Pressure Belt

- The zone is situated between 60° to 65° in both the hemisphere.
- It is more developed and regular in Southern hemisphere than in Northern hemisphere because of the over dominance of water (ocean) in the Southern hemisphere.
- The low pressure belt does not appear to be thermally induced because there is low temperature throughout the year and as such there should have been high pressure belt instead of low pressure belt. Thus, it is dynamically induced.

Polar High Pressure Zone

The Polar High Pressure zone is situated near the pole. As the name suggests the zone is originated due to thermally induced factor as very low temperature is solely responsible for the creation of a high pressure zone over the polar areas.



Major Pressure Belts

Wind Belts

Wind can be defined as the movement of large volume of gases from high pressure area to low pressure area. There are two types of winds 1) Permanent/Prevailing Winds (blow throughout the year) and 2) Seasonal Wind (blow in particular period of the year).

Jupiter is known as winter planet as its average temperature is very low (–148°C).

PERMANENT/PLANETARY/PREVAILING WINDS

Types	Sub Types	Characteristics
Tropical Winds	**Doldrum (5º N - 5ºS) Equatorial westerlies (15ºN – 35ºN)**	• It is called as **"equatorial calms"** because wind has no motion and cumulonimbus cloud are formed bring daily rainfall. • It is not continuous belt. Equatorial fronts are formed and equatorial westerlies blow there. It is associated with strong atmospheric disturbances or cyclonic storm.
	Trade Winds	• A wind flowing from subtropical high pressure to equatorial low pressure belt is termed as Trade Winds. It moves in north east and south east in north and south hemisphere respectively.
Sub Tropical Wind	**Westerlies (35º-65ºN and S)**	Blowing from subtropical high pressure belt **(30º - 35ºN and S)** to the sub polar low pressure belt **(60º - 65ºN and S)** is called Westerlies. In the northern hemisphere these wind blow from south west to north east and in southern hemisphere from north west to south east. **40ºS to 50ºS-Roaring Forties**, **50ºS to 60ºS- Furious Fifties** and **60ºS onwards – Shriecking Sixties** are its name.
Polar Wind		• A low pressure zone is created in between 600 to 650 in both the hemisphere due to the dynamic factor of the earth. • It blows from north easterly and south easterly in northern and southern hemisphere respectively.

VARIABLE WIND

Subtypes	Seasonal Winds Characteristics
Monsoon	• It blows from the south west in summer and from north east in winter. It is consistent and bi-directional regular flow of wind over a year. It is thermally induced complex air circulation where all layers of air circulation that is surface, middle and upper layer are involved.

LOCAL WINDS

Winds	Nature	Region
Fohn	Warm	Alps
Chinook (snow eater)	Warm	Rockies
Kalbaisakhi	Warm	North India
Berg	Warm	S. Africa
Zonda	Warm	Andes
Loo	Warm	Indian subcontinent
Santa Ana	Warm	Coastal Southern California
Southerly	Cold	New South Wales
Khamsin	Warm	Egypt
Harmattan (Doctor)	Warm	Guinea Coast Eastern part of Sahara

Mistral	Cold	S.E. France
Samun	Warm	Iran
Purga	Cold	Russia
Levanter	Cold	France
Pampero	Cold	S. America
Norwester	Warm, dry	New Zealand

Winds	Region
Levante	It blows in western Mediterranean, near the **Strait of Gibraltar**. It is called as the Viento de Levante or the Levanter and even **Solano**. It blows moderately or strongly bringing rain and damp smell to the region.
Norte	The Norte is a strong and cold northeasterly wind which blows in **Mexico** along the **Gulf of Mexico**. It results from an outbreak of cold air from the north.
Etesian	Etesians blow as winds of northeasterly to northerly direction over Northern Aegean Sea while, in the southern Aegean along with the Cretan and the Carpathian Sea, they blow as northern westerlies.
Helm	Generally seen in Columbia and England these strong north-easterly wind blows down the south –west slope of the Cross Fell escarpment.
Buran/ Purga	Extremely cold wind full of ice and snow blowing across Russia and eastern Asia. In tundra region, it is also known as Purga. In Alaska this severe north-easterly wind is known as Burga, bringing snow and ice pellets.
Brick-fielder	It is a hot and dry summer wind blowing in coastal regions of South **Australian desert**. Blows strongly, for several days at a time, along with dust, and parching all vegetation. In one sense it is a healthy wind, as it destroys many harmful germs due to its heat.

Air Mass

A large volume of air defined by constant physical properties i.e. temperature and water vapor, spreading over hundreds or thousands of square miles is called as air mass.

Types of Air mass
Continental Polar (cP) forms over cold and dry land mass during winter near poles north of 50-60° N.
Maritime Polar (mP) is associated with cool or cold, damp and gray day's weather, near polar coastal areas.
Continental Tropical (cT) form over deserts and plains. It is hot and dry during summer and only dry during winter.
Maritime Tropical (mT) is hot and humid sticky weather on the tropical coastal regions.

Cyclones

- Cyclones are the centres of low pressure surrounded by closed isobars having increasing pressure outward and closed air circulation from outside towards the central low pressure in such a way that:
- Air blows inward in clockwise direction in the Southern hemisphere.
- Air blows inward in anti-clockwise direction in the Northern hemisphere.
- On the basis of place of origin there are two types of cyclones given in the table :

Lake Eyre (–15.8 m) is the lowest point in Australia and Kosciuszko mountain (2.228 m) is the highest point.

Tropical Cyclone	Temperate / Extra-tropical cyclone
The tropical cyclones have a thermal origin, exclusively over the tropical seas.	Formed in middle or high latitudes, due to the development of front (350- 650 N and S).
A low pressure zone is created due to extreme heat and further intensifies with the increase in temperature (above 270C). The winds from surrounding high pressure region rushes to the central low pressure (eye) area developing a powerful and destructive storm. The velocity of the cyclone varies from 32-180 km/hour.	Develops when a frontal surface separates two opposing air masses (warm and cold). As the amplitude of the wave increases, the pressure at the centre of disturbance falls, eventually intensifying to the point at which a cyclonic circulation begins.
Its velocity decreases and finally decays as they cross more land mass. Usually ends with heavy downpour of rain and wind bringing devastation to the coastal areas.	When the cold air from the poles sweeps off all the warm tropical air and entire cyclone is composed of the cold air mass temperate cyclone dies.

Different names of cyclone in the different regions of the world.

Cyclone		Region
1.	Tropical Cyclones	Indian Ocean
2.	Typhoons	China Sea
3.	Hurricanes	Caribbean Sea
4.	Willy Willies	Northern Australia
5.	Tornadoes	USA

Humidity

It is the amount of water vapour present in the air at a particular period of time and place. Humidity of a place can be expressed in three ways:

ABSOLUTE HUMIDITY

The measure of water vapour content of the atmosphere which may be expressed as the actual quantity of water vapour present in a given volume of air is called absolute humidity. This is measured as gms per cubic meter air. Absolute humidity changes with place and time. The capacity of air to hold water vapour depends on temperature. Warm air holds more moisture than cold air.

SPECIFIC HUMIDITY

Another way to express humidity as the mass of water vapour per unit weight of air or the proportion of the mass of water vapour to the total mass of air is called the specific humidity. Specific humidity is not affected by changes in pressure or temperature.

RELATIVE HUMIDITY

This is a ratio expressed between actual quantity of water vapour present in the air at a given temperature (absolute humidity) and the maximum quantity of water vapour that the atmosphere can hold at that temperature. Relative humidity determines the amount and rate of **evaporation**.

- **Hygrometer** is the instrument used for measuring relative humidity. It comprises of wet and dry bulb thermometer.

$$\text{Relative humidity} = \frac{\text{Absolute humidity}}{\text{Humidity capacity}} \times 100$$

- Temperature and evaporation are directly proportional to humidity.
- The process of transformation of liquid into gaseous form is called *evaporation*.
- Oceanic and coastal regions record higher humidity capacity of air than the remote continental regions.

- Humidity capacity decreases from equator to polewards as the temperature also decreases.
- The air having moisture content equal to its humidity capacity is called as **saturated air**.

Precipitation

Condensation of atmospheric water vapour that falls under the gravity is called as precipitation. This could be in the form of rain, snow or hail etc. Its form depends on the temperature at which water vapour condenses.

Forms of Precipitation

Hail

It is a form of solid precipitation consisting of large pellets or spheres of ice balls with the diameter varing between 5 to 50 mm. The falling of hail on the ground surface is called *hailstorm*. It is destructive as it destroys agricultural crops and claim human and animal lives.

Snowfall

It is the fall of large snowflakes from clouds on the ground surface. The dew point should be below freezing point for receiving snowfall. It is a result of sublimation.

Sleet

It is a mixture of snow and rain. It is a small pellets formed by freezing of raindrops or melting snowflakes.

Rainfall

It is the most common form of precipitation. It is a process wherein warm air ascends, saturates and condenses. Adiabatic cooling takes place when the relative humidity becomes 100 per cent. The condensation of water vapour takes place where large hygroscopic nuclei (salt and dust) is formed. Such droplets are called as **cloud droplets shade**. Rainfall occurs when cloud droplets change to raindrops which involves two processes:

1. The warm and moist air ascends to such a height that the process of condensation begins below freezing point. Both the water droplets and ice droplets are formed. The condensation takes place as the water droplets evaporates around ice droplets due to difference in vapour pressure. These ice droplets become large and fall when finally they are not able to be held back in the condensed icedroplets.
2. The suspended cloud droplets in the cloud are of varying sizes. They collide among themselves at different rate as their size varies. They combine to form a large droplet. In this process several cloud droplets are coalesced to form raindrops. When these cloud droplets are large enough that they are unable to hold by ascending air they begin to fall.

Types of Rainfall

Rainfall can be classified into three types:

1. Convectional Rainfall
2. Orographic Rainfall
3. Cyclonic or Frontal Rainfall

1. Convectional Rainfall

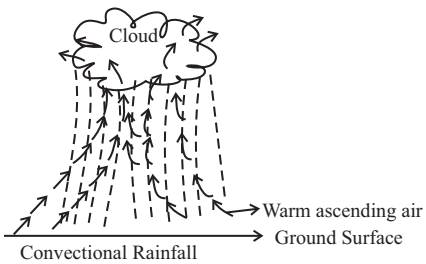
The thermal heating of the ground surface through the process of insolation leads to rise of air as they become warm and light. The process of convectional rainfall mainly depends on two factors.

(i) The supply of moisture through evaporation should be abundant so that its relative humidity becomes high.

(ii) There should be intense heating through insolation process.

The process of convectional rainfall involves intense heating of ground surface through solar radiation. As the warm air rises, the vacant shape is filled by surrounding air which too warm up when come in contact with already warm air. When the air reaches the temperature of its surrounding cumulo-nimbus cloud is formed and there is instantaneous heavy rainfall.

- It occurs daily in afternoon in the equatorial regions.
- It is for short duration but pour down heavily.
- Occurs through thick dark and extensive cumulo-nimbus clouds.
- It is accompanied by number of thunder and lightning.



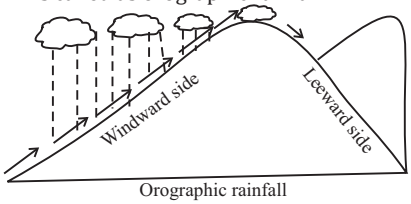
Convectional Rainfall

Kilimanjaro (5,895 m) is the highest while Lake Assai (–156.1 m) is the lowest point in Africa.

2. Orographic Rainfall

When the warm and moist air is obstructed by any hill or mountain, it starts ascending along the slope of the hill or mountain and get saturated after reaching a height. As a result condenses around hygroscopic nuclei. The slope of the mountain facing the wind is called as **windward side** and the other side of that mountain is known as **Leeward side**.

Windward side receives maximum rain and leeward side receives no or little rain. The leeward side is also known as rainshadow region. This type of rainfall is called as orographic rainfall.



Orographic rainfall

3. Cyclone or Frontal Rainfall

Cyclonic or frontal rainfall occurs due to ascending of moist air and adiabatic cooling caused by convergence of two extensive air mass.

Clouds

- Clouds are the visible mass of condensed water vapour floating in the atmosphere, typically high above the general level of the ground.
- It plays a major role in the heat budget of the earth and the atmosphere as they reflect, absorb and diffuse the incoming short wave and outgoing long wave terrestrial radiation.

Clouds are classified according to their appearance, form and height. There are four groups.

(i) Low Clouds below 2100 m
(ii) Middle Clouds 2100m to 6000m
(iii) High Clouds 6000m to 12000m
(iv) Clouds of great vertical extent 1500 m to 9000 m

TYPES OF CLOUDS

Low Clouds	Middle Clouds	High Clouds	Clouds with Great Vertical Extent
Strato-cumulus: Large globular masses, bumpy looking, soft and grey in appearance forming a pronounced regular and sometimes wavy pattern.	**Alto-cumulus:** Composed of water droplets in layers and patches.	**Cirrus :** Composed of small ice crystal, white, wispy and fibrous in appearance.	**Cumulus** Round topped and flat based forming a whitish grey globular mass, consists of individual cloud units.
Nimbo-stratus: Dark grey and rainy looking, dense and shapeless, often gives continuous rains.	**Alto-stratus:** Composed of water droplets, forming sheets of grey or watery looking clouds	**Cirro-cumulus:** Composed of ice crystals, but globular or rippled in apprearance.	**Comulo-nimbus:** They have a great vertical extent, white or black globular masses, whose rounded tops often spread out in the form of anvil. It is characterised by convectional rain, lightning and thunder.

INDIAN GEOGRAPHY–MIND MAP

India Physiography	• Himalayan Mountain Range • Indian Desert • Northen Plain • Coastal Plain • Peninsular Plateau • Island
Drainage	• Himalayan Rivers (The Indus, The Ganges & The Brahmaputra) • Peninsular Rivers (Mahanadi, Godavari, Krishna, Cauvery, Narmada, Tapi) • Lakes in India
Soil	• Alluvial • Red • Black • Laterite • Arid • Saline • Peaty and Marshy • Mountain and Forest
Climate	• Factors Affecting Climate in India • State wise Rainfall Distribution
Natural Vegetation	• Classification of Natural Vegetation • Spatial Distribution of Natural Vegetation in India
Language	• Languages spoken in different parts of India
Agriculture	• Major Crops • Land use Pattern • Agro-Climatic Zone • Major Growing Season and its Associated Crops
Industry	• Major Industrial Regions of India • Types of Industry
Minerals	• Minerals & their distribution
Energy	• Conventional Energy • Hydroelectricity • Thermal Electricity • Wind Energy

INFORMATION BULLETIN

1. **Official name:** Republic of India
2. **Capital:** New Delhi
3. **Nationality:** Indian
4. **Continent:** Asia
5. **Region:** South Asia Indian subcontinent
6. **Area:** Ranked 7th
   - Total 3,287,263 km^2 (1,269,219 sq mi)
   - Land 90.08%
   - Water 9.92%
7. **Borders :** Total land borders : 15,106.70 km (9,386.87 mi)

Countries	Bordering States	Distance
Pakistan	Jammu and Kashmir, Punjab, Rajasthan and Gujrat	1751 km
China	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	3380 km
Nepal	Bihar, Uttarakhand, Uttar Pradesh, Sikkim and West Bengal	1751 km
Bangladesh	West Bengal, Mizoram, Meghalaya, Tripura and Asom	4096 km
Bhutan	West Bengal, Sikkim, Arunachal Pradesh and Asom	699 km
Myanmar	Arunachal Pradesh, Nagaland, Manipur and Mizoram	1643 km
Afghanistan	Jammu and Kashmir (Pakistan-Occupied Area).	106 km
Sir Lanka	Tamilnadu	30 km

8. **Highest point:** K2 or Godwin Austin (claimed) 8,611 m (28,251.3 ft) Kangchenjunga (administered) 8,598 m (28,208.7 ft)
9. **Lowest point:** Kuttanad; –2.2 m (–7.2 ft)
10. **Longest river:** Ganges, Brahmaputra
11. **Largest lake:** Wular Lake, Kashmir
    Largest lake (Saline Water): Chilka Lake, Orrisa
    Largest Man-Made Lake: Govind Vallabh Pant Sagar (Rihand Dam)
    Highest rainfall: Cherrapunji (426 inches per annum)
    Highest Waterfall: Nohkalikai Falls (335 meters, 1100 ft. high) in Shora
    Largest Delta: Sunderbans Delta

Major Physiographic Divisons

- The landmass of India can be divided into following major physiographic divisions. The Himalayan Mountain, Northern plain, Peninsular plateau, Indian desert, coastal plains, the islands.

The Himalayan Mountains

- The Himalayas are the youngest mountains in the world.
- They are structurally folded mountains, form an arc of about 2,400 km long from west to east. The width varies from 400 km in Kashmir to 150 km in Arunachal Pradesh.
- The altitudinal variations are greater in the eastern part than in the western part.
- There are four parallel ranges in its longitudinal extent. Zaskar range lies west of Himalayas and Indus gorge is beyond it.

The Great or Inner Himalayas

- It is known as **'Himadri,**
- Average height of peaks here is 6,000 meters.
- Asymmetrical folds having granite in the core are snow covered throughout the year.

The Lesser Himalayas or Himachal

- This lies south of the Great Himalayas and north of Shiwalik with altitude

Name of India has been derived from the river Indus.

varying from 3,700 m to 4,500 m.
- Average width of this range is 60-80 km.
- This range is mainly composed of highly compressed and altered rocks.
- Pir Panjal, Dhaula Dhar, Mahabharat and Mussorie ranges are found as we move west to east.

The Shiwaliks or the Outer Himalayas
- It is an outermost range and is also known as lesser Himalayas.
- The altitude varies between 900 - 1100 km and the width varies between 10 -50 km in this range.
- The longitudinal valleys lying between the Himachal and Shiwaliks are called **'Dun'** and are composed of unconsolidated sediments.

Trans Himalayas
- It includes **Karakoram** and Ladakh Ranges.
- Extended from Pamir crossing **Gilgit** river and reaches Ladakh.
- Elevation is above 5500 m and width is 120-140 Km.
- Ladakh Range is situated in Kashmir between Indus and its tributary Shyok
- Highest peak is Mt. Rakaposhi (7880).

MAJOR MOUNTAIN PEAKS

Peak	Country	Height in meters
Mt. Everest	Nepal	8848
Kanchenjunga	India	8586
Makalu	Nepal	8481
Dhaulagiri	Nepal	8167
Nanga Parbat	India	8126
Annapurna	Nepal	8078
Nanda Devi	India	7817
Kamet	India	7756
Namcha Barwa	India	7756
Gurla Mandhata	Nepal	7694

IMPORTANT STRAITS

Location	Channel
Indira point-Indonesia	Great Channel
Little Andaman and Nicobar	10° Channel
Minicoy-Lakshadweep	9° Channel
Maldives-Minicoy	8° Channel
India-Sri Lanka	Gulf of Mannar and Palk Strait

VALLEYS IN INDIA

Valleys and their locations		
• Araku Valley	:	Andhra Pradesh
• Damodar Valley	:	Jharkhand and West Bengal
• Darma Valley	:	Uttarakhand
• Dzukou Valley	:	Nagaland and Manipur
• Johar Valley	:	Uttarakhand
• Markha Valley	:	Ladakh
• Nubra Valley	:	Ladakh
• Sangla Valley	:	Himachal Pradesh
• Saur Valley	:	Uttarakhand
• Suru Valley	:	Ladakh
• Tons Valley	:	Uttarakhand
• Yumthang Valley	:	Sikkim

Mountain Passes of India

Himalayan passes:

- **Banihal pass** — between Doda and Anantnag (Jawahar Tunnel), J & K.
- **Shipki La** — River Sutluj enters India from Tibet, Himachal Pradesh.
- **Bara Lachan La** — between Kyelang and Leh, Himachal Pradesh.
- **Rohtang pass** — between Kullu and Kyelang, Himachal Pradesh.
- **Bomdila pass** — between Tezpur and Tawang, Arunachal Pradesh.

Himalaya passes between India and China:

- **Shipki La** — Himachal Pradesh.
- **Thaga La and Niti La** — Uttarakhand .
- **Lipu Lekh La** — Tri-junction, India-Nepal-China, Uttarakhand.
- **Jelep La** — Between India and China (Gangtok-Lhasa Road) Sikkim.
- **Nathu La** — Between India and China (Entry to Chumbi Valley) Sikkim.

Trans Himalayan passes:

- Karakoram pass and Aghil pass — Jammu & Kashmir.

Passes in Western Ghats:

- *Palghat* — between Palakkad and Coimbatore.
- *Shenkota* — between Kollam and Madurai.
- *Thalghat* — between Mumbai and Pune.
- *Bhorghat* — between Mumbai and Nasik.

- The best known passes of the **Pir Panjal range** are the *Pir Panjal Pass* (3480 m), the *Bidil* (4270m), *Golabghar* (9812m) and *Banihal Pass* (235m). The Jammu-Srinagar highway uses the Banihal Pass.

Some important facts about peaks

- Highest Mt. Peak in India: ***K2*** *or* ***Godwin Austin***
- Highest peak in Aravalli: Gurushikhar (in Mt. Abu)
- Highest peak in Satpura - Dhupgarh (Mahadeo Hills)
- Highest peak in E. Ghats - Mahendragiri (Odisha)
- Highest peak in W. Ghats - Anaimudi (Annamalai Hills - Kerala)
- Highest peak in Nilgiris - Doda Betta
- Hills in Southern Hill complex - Nilgiri, Annamalai, Cardamom & Palani
- Hills in Eastern Ghats: Shevaroy, Javadi, Palkonda, Nallamalai, Northern Circars
- Oblique ranges to Western Ghats in Maharashtra: Ajanta, Satmala, Harishchandra, Balaghat
- Satpura range from East to West:
  Amarkantak - Maikal- Mahadeo - Gawilgarh - Rajpipala
- Highest peak in Andaman and Nicobar islands- *Saddle Peak*
- The highest peak of Naga hills-Saramati peak.

The Northern Plain

- The northern plain of India is formed by three river systems, viz. the Indus, the Ganga and the Brahmaputra along with their tributaries.
- Alluvial soil has been deposited over millions of years.
- The total area of the northern plain is about 7 lakh square kilometer.
- It is about 2400 km long and about 240 to 320 km broad.
- The northern plain is divided into three sections, viz. the Punjab Plain, the Ganga Plain and the Brahmaputra Plain.

The Highest peak in Andaman and Nicobar Island is the Saddle Peak.

Punjab Plains

It is western part of the northern plain. Formed by the Indus and its tributaries like Jhelum, Chenab, Ravi, Beas and Sutlej.

Ganga Plains

This plain extends between Ghaggar and Tista rivers. The northern states, Haryana, Delhi, UP, Bihar, part of Jharkhand and West Bengal lie in the Ganga plains.

Brahmaputra Plains

This plain forms the eastern part of the northern plain and lies in Assam. Based on the relief features the northern plain can be divided into four regions, viz. bhabar, terai, bhangar and khadar.

The Peninsular Plateau

The peninsular plateau is a tableland. It is composed of the oldest rocks and drifted from Gondwana land with elevation of 600-900 Km. Broad and shallow valleys with rounded hills are the characteristic features of this plateau. The plateau can be broadly divided into two regions, viz. the Central Highlands and the Deccan Plateau. The slope of the Deccan Plateau is from west to east as the rivers flows.

The Central Highlands

It lies to the north of Narmada river (Satpura range), covering portion of Malwa plateau. It is wider in west and narrower in east. **Bundelkhand** and **Baghelkhand** mark the eastward extension. The plateau further extends eastwards into the Chhotanagpur plateau. Touches Aravilli in the west covering Rajasthan uplands.

The Deccan Plateau

- It is triangular in shape, Satpura range makes its northern boundary.
- The Mahadev, Kaimur Hills and Maikal ranges make its eastern part.
- It extends into the north east which encompasses Meghalaya, Karbi-Anglong Plateau and North Cachar Hills. Garo, Khasi and Jaintia hills are the prominent ranges starting from west to east.

The Western and the Eastern Ghats

The average elevation of Western Ghats is 900 – 1600 metres compared to 600 metres in case of Eastern Ghats. The Eastern Ghats stretch from Mahanadi Valley to the Nilgiris in the south.

The Indian Desert

It lies towards the western margins of the Aravali Hills. This region gets scanty rainfall which is less than 150 mm a year. Hence, the climate is arid and vegetation is scanty.

The Thar Desert

- The Thar desert extends across Gujarat, Haryana and Punjab; and covers more than 60% of the geographical area of Rajasthan. The region is also called as '**Marusthali**'.
- **Luni** is the seasonal river and gets very little rainfall.
- It has an arid climate and vegetation is sparse.
- **Ghaggar** flows through Rajasthan and disappears at the heart of the Thar Desert.

The Coastal Plains

- Towards the west and east of Peninsular stretches narrow coastal strips are situated.
- They run along the Arabian Sea in west and along the Bay of Bengal in east.
- The western coast lies between the Western Ghats and the Arabian Sea. It is divided into three sections. The **Konkan** is northern part, comprised of Mumbai and Goa. The **Kannada Plain** makes the central part and the **Malabar** coast is the southernmost coast. The eastern coastal plain is wider and runs along the Bay of Bengal.

The Islands

The **Lakshadweep Islands** are in the Arabian Sea. Its area is 32 sq km. This group of islands is rich in terms of biodiversity. The Andaman and Nicobar Islands can be divided into two groups. The **Andaman** is in the north and the **Nicobar** is in the south. These islands too have rich biodiversity.

The northernmost point of the country is in Jammu and Kashmir, known as Indira Col.

ISLANDS OF INDIA

(Lakshadweep)

Major Island Group

Two major island groups are situated on either side of Indian Peninsula. **Andaman and Nicobar** island group lies on the eastern part, i.e. in **Bay of Bengal** and **Lakshadweep** island group lies on the western part of India, i.e. in Arabian Sea.

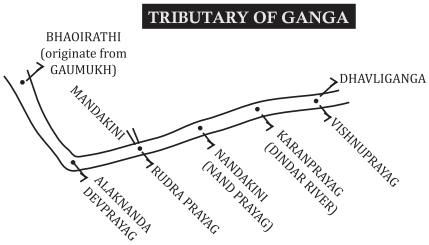
Altogether there are **247** smaller islands from which **204** are in Bay of Bengal and **43** islands are in Arabian Sea.

Drainage in India

The pattern of drainage in India is mostly influenced by its varied physiological divisions. Thus, they are classified into three major types such as: Himalayan, Peninsular and Inland drainage.

Himalayan Rivers

The Himalayan Rivers mostly originate from Himalayan mountain range. These are mostly **perennial** in nature which means availability of water throughout the year as they obtain water from the large ice cover of great Himalayan range. Major rivers of this section are the **Indus**, the **Ganges** and the **Brahmaputra**. Other important tributaries of this section are Jhelum, Chenab, Ravi, Beas and Sutlej of Indus river system, Yamuna, Son, Ramganga, Ghaghara, Gandak, Kosi of the Ganges river System, and Tista, Lohit, Manas, Subansiri River, Dhansiri River of the Brahmaputra River System.



Ravi

- It originates from **Kullu** hills near the Rohtang Pass in Himachal Pradesh.
- It cuts a deep gorge in the Dhaula Dhar range after crossing Chamba.
- It enters Punjab Plains near Madhopur and later enters Pakistan 26 km below Amritsar.
- It debouches into the Chenab a little above Rangpur in Pakistani Punjab.

Beas

- It also originates near **Rohtang Pass**, close to the source of the Ravi.
- It crosses the Dhaula Dhar range through a deep gorge from Lorji to Talwara.
- It debouches on the plain near Pong and meets the Sutlej river at Harike.
- It lies entirely within the Indian territory.

Sutlej

- It rises from the **Mansarovar** - Rakas Lake near Darma Pass in western Tibet, where it is also known as Langcher Khambab.
- In Nari Khorsan province of Tibet, it has created an extraordinary canyon.
- It is joined by the Spiti river at Namgia near the Shipki La.
- Before entering the Punjab Plain, it cuts a gorge in Naina Devi Dhar (Bhakra Dam has been constructed here).
- It enters the plain at Rupnagar (Ropar).
- It is joined by the Beas at Harike.
- From near Ferozepur to Fazilka, it forms the boundary between India and

The most important waterfall by river Narmada is Dhuandhar Falls near Jabalpur, is also called the Marble falls.

Pakistan for nearly 120 km.
- It joins the Indus a few kilometers above Mithankot.

The Ganga River System

- It is the largest in India.
- The total area of the Ganga basin in India is 861,404 sq km which accounts for 26.3% of the geographical area of the country.
- The Ganga basin covers over 12,500 sq km in northern India.

Ganga

- It originates as *Bhagirathi* from the Gangotri glacier.
- *Alaknanda* joins it at *Devaprayag*. Pindar River joins it at Karan Prayag and *Mandakini* or Kali Ganga at Rudra Prayag.
- The combined waters of the Bhagirathi and the Alaknanda flow in the name of the Ganga, below *Devprayag*.
- It debouches on plain from hills in Haridwar.
- It is joined by Yamuna in Allahabad.
- Beyond *Farakka*, it is known as *Padma* in Bangladesh.
- It bifurcates itself into Bhagirathi-Hooghly in West Bengal and Padma-Meghna in Bangladesh.
- The delta formed by the Ganga-Brahmaputra is the largest delta of the world covering an area of 58,752 sq km.
- **Sundarbans** is a part of the world's largest delta.
- The total length, 2525 km, is distributed among states:
  (i) Uttar Pradesh – 1140
  (ii) W. Bengal – 520 km
  (iii) Bihar – 445 km,
  (iv) Uttarakhand – 310 km.

THE DRAINAGE SYSTEM

Name of the river	Source	Length (in km)	Area drained (sq km)
Ganga	Gangotri Glacier at 7,010 m	2,525	861,404
Yamuna	Yamnotri Glacier at 6,330 m	1,376	366,223
Chambal	Near Mhow (Indore-M.P)	1,050	139,468
Ramganga	Garhwal district at 3,110 m	596	32,493
Ghaghra	Near Gurla Mandhota Peak	1,080	127,950
Gandak	South of Manasarovar	425 in India	46,300 (7,620 in India)
Kosi	Tibet-Nepal border at 7,620 m Sikkim-Nepal- Tibet-Himalaya	730 in India	86,900 (21,500 in India)

DIFFERENCE BETWEEN DELTA AND ESTUARY

Delta	Estuary
1. The triangular deposits made by rivers at their mouth form a delta.	1. The sharp edged mouth of rivers, devoid of any deposits is known as estuary.
2. Deltas are found in the regions of tides and coastal plains.	2. Regions of high tides and rift valleys witness estuaries.
3. Deltas are fertile lands.	3. Estuary does not have fertile lands.
4. Ganga, Brahmaputra, Krishna, Kaveri and Mahanadi rivers form Delta.	4. Narmada and Tapi rivers form estuaries.

Yamuna

- It is the largest and the most important tributary of the Ganga.
- It originates from the Yamunotri glacier on the Bandarpunch Peak in Garhwal in Uttarakhand.
- It enters the plains near *Tajewala*.
- **Tons**, a tributary of it, joins it below Kalsi. At this site, the water carried by the Tons is twice the water carried by the Yamuna.
- It takes a southerly course upto Mathura and south easterly in its onward journey upto Allahabad where it unites with the Ganga.

Chambal

- It rises near Mhow in the highlands of Janapao Hills in MP.
- It enters a gorge at Chaurasigarh.
- It joins Yamuna in Etawah district of Uttar Pradesh.
- **Banas** joins it near Sawai Madhopur.
- ***Betwa***, rising in Bhopal, joins the Yamuna near *Hamirpur*. **Dhasan** is an important tributary of Betwa.

Son

- It is a large south bank tributary of the Ganga.
- The Son river springs from the **Amarkantak** Plateau.
- It joins the Ganga near **Danapur** in Patna district.
- Its catchment area is 71,259 sq km.
- Almost all the tributaries join it on its right bank.
- Tributaries are Johilla, Rihand, Kanhar and North Koel.

Damodar

- It rises in the hills of the **Chota Nagpur** plateau and flows through a rift valley.
- It is also called '**Sorrow of Bengal**'.
- It joins the **Hooghly,** 48 km below **Kolkata**.
- The total length of the river is 541 km.
- Its catchment area is 25,820 sq km.

Ramganga

- It rises in the Garhwal district of Uttarakhand.
- It enters the Ganga plain near Kalagarh.
- Its basin covers 30,839 sq km.

Ghaghra

- It originates near the Gurla Mandhota peak, south of Manasarovar in Tibet.
- It is known as the Karnali in Western Nepal.
- It joins Ganga a few kilometres downstream of Chapra in Bihar.
- The total catchment area of the river is 127,950 sq km out of which 45% is in India.

Kali

- It rises in high glaciers of snow covered region of trans-Himalayas.
- It forms the boundary between Nepal and Kumaon.
- It is known as the Sarda or Chauka after it reaches the plains near Tanakpur.

Gandak

- It originates near the Tibet-Nepal border.
- Kali Gandak, Mayangadi, Bari and Trishuli are the major tributaries of it.
- Its drainage area is 46,300 sq km out of which 7620 sq km is in India.

Burhi Gandak

- Originating from the western slopes of Sumesar hills near the India-Nepal border, it joins the Ganga opposite Munger town.
- Its length is 610 km and drainage area is 12,200 sq km.

Kosi

- The Kosi river consists of seven streams, namely, Sut Kosi, Tamba Kosi, Talkha, Doodh Kosi, Botia Kosi, Arun and Tamber and is popularly known as Saptkaushiki.
- Seven rivers mingle with each other to form three streams named the Tumar, Arun and Sun Kosi.
- Then all three streams unite at *Triveni* north of the Mahabharat Range to form the Kosi.

Peninsular Rivers

The Peninsular Rivers are mostly having their origin from Western Ghats running parallel with western coast from north to south. They are seasonal in nature as the source of water is rainfall only. The rivers form deltas at their mouth. Some of the rivers such as Mahanadi, Godavari, Krishna and Cauvery are drained into the Bay of Bengal whereas the other prominent rivers like Narmada and Tapi both fall into the Arabian Sea.

The West Flowing Rivers

Narmada

- It is the largest of all the west flowing rivers of the Peninsula.

Rann of Kutch is believed to have once been a part of the Arabian Sea.

- It rises from the Amarkantak Plateau in Shahdol district of Madhya Pradesh.
- It flows through a rift valley between the Vindhyan Range on the north and the Satpura range on the south.
- The Dhuandhar (Clouds of Mist) Falls is formed by the Narmada river in Jabalpur.
- It makes an estuary studded with several islands. **Aliabet** is the largest island.
- The **Sardar Sarovar *Project*** has been constructed on this river.

Tapi (or Tapti)

- It is the second largest river flowing west of the Indian peninsula.
- It is also known as 'the twin' of the Narmada.
- It originates from Multai in Betul district of Madhya Pradesh.

Sabarmati

- This 320 km long river is the name given to the combined streams-the Sabar and the Hathmati.
- It rises from the hills of Mewar in the Aravalli Range. Its tributaries are Hatmati, Sedhi, Wakul, Meshwa, Vatrak, etc.

Mahi

- It rises in the Vindhyan range and debouches into the Gulf of Khambhat.
- Its length is 533 km.
- It drains an area of 34,862 sq km.
- The main tributaries are Som, Anas and Panam.
- Mahi river *cuts Tropic of Cancer twice.*

Luni (or the Salt River)

- Its water is brackish below Balotra.
- Its source lies to the west of Ajmer (Rajasthan) in the Aravallis.
- The river is known as the **Sagarmati** in its upper course and from Govindgarh, where Sarsuti joins it, becomes Luni. Finally, it gets ends in the Rann of Kachchh.

Inland Drainage

Some rivers of India do not reach upto the sea and constitute inland drainage. These rivers are mostly present in the drier regions of the country like Western Rajasthan, Ladakh and Aksai Chin etc. **Ghaggar river is the most important example of inland drainage**. It is a seasonal stream rising from the lower slopes of Himalayas and is said to flow on the dry bed of ancient river Saraswati. It forms boundary between Punjab and Haryana for much of its length and gets subsumed in Rajasthan desert. Another such river is **Luni**, which is the largest river of Rajasthan. It originates near Pushkar and flows South-West of Aravalis till it reaches Rann of Kutch.

FAMOUS CITIES AND RIVER BANKS

City	River	City	River	City	River
Allahabad	At the confluence of the Ganga and Yamuna (Sangam)	Ferozpur	Satluj	Mathura	Yamuna
		Guwahati	Brahmaputra	Nasik	Godavari
		Haridwar	Ganga	Patna	Ganga
Agra	Yamuna	Hyderabad	Musi	Panji	Mandavi
Ayodhya	Saryu	Jabalpur	Narmada	Srinagar	Jhelum
Ahmedabad	Sabarmati	Jamshedpur	Swarnarekha	Surat	Tapti
Badrinath	Alaknanda	Jaunpur	Gomti	Sambalpur	Mahanadi
Bareilly	Ram Ganga	Kanpur	Ganga	Serirangapatam	Cauvery
Cuttack	Mahandadi	Kota	Chambal	Tiruchurapalli	Cauvery
Kurnool	Tungabhadra	Kolkata	Hooghly	Ujjain	Kshipra
Delhi	Yamuna	Lucknow	Gomti	Vijayawada	Krishna
Dibrugarh	Brahmaputra	Ludhiana	Sutlej	Varanasi	Ganga

Annual yield of water	
River	**Contribution (%)**
Brahmaputra	33.8
Ganga	25.2
Godavari	6.4
Indus	4.3
Mahanadi	3.6
Krishna	3.4
Narmada	2.9

IMPORTANT RIVERS OF INDIA

Name	Origin From	Fall into	Length (km)
Ganges	Combined Sources	Bay of Bengal	2525
Satluj	Mansarovar Rakas Lakes	Chenab	1050
Indus	Near Mansarovar Lake	Arabian Sea	2880
Ravi	Kullu Hills near Rohtang Pass	Chenab	720
Beas	Near Rohtang Pass	Sutlej	470
Jhelum	Verinag in Kashmir	Chenab	725
Yamuna	Yamunotri	Ganga	1375
Chambal	M.P.	Yamuna	1050
Ghagra	Matsatung Glacier	Ganga	1080
Kosi	Near Gosain Dham Park	Ganga	730
Betwa	Vindhyanchal	Yamuna	480
Son	Amarkantak	Ganga	780
Brahmaputra	Near Mansarovar Lake	Bay of Bengal	2900
Narmada	Amarkantak	Gulf of Khambat	1057
Tapti	Betul Distt. of M.P.	Gulf of Khambat	724
Mahanadi	Raipur Distt. in Chattisgarh	Bay of Bengal	858
Luni	Aravallis	Rann of Kuchchh	450
Ghaggar	Himalayas	Near Fatehabad	494
Sabarmati	Aravallis	Gulf of Khambat	416
Krishna	Western ghats	Bay of Bengal	1327
Godavari	Nasik distt. in Maharashtra	Bay of Bengal	1465
Cauvery	Brahmagir Range of Western Ghats	Bay of Bengal	805
Tungabhadra	Western Ghats	Krishna River	640

IMPORTANT RIVER VALLEY PROJECTS IN INDIA

S.No.	Name	Date of Start/ Complete	On River	Location	Objectives/ Aims
1.	Tapovan Vishnugarh hydroelectric Project	2006	Dhauliganga	Chamoli District, Uttarakhand	to generate hydroelectric power over 2.5 K GWh
2.	Sardar Sarovar Project	1987, Open on Sep, 17, 2017	Narmada	Navagam, Gujarat	both irrigation purposes and power generation
3.	Thein, also known as Rajit Sagar Dam	1981	Ravi River	Basholi & Pathankot (J&K and Punjab)	both irrigation purposes and power generation
4.	Mahi Project	1972/1983	Mahi	Banswara, Rajasthan	to generate hydroelectric power and provide irrigation facility
5.	Ukai Project	1964/1972	Tapti	Surat and Tapi district, Gujrat	irrigation, power generation and flood control
6.	Bhakra Nangal Project	1948/1963	Sutlej	Bilaspur, Himachal Pradesh	both irrigation purposes and power generation
7.	Nagarjuna Sagar Project	1955/1969	Krishna	Nalgonda and Guntur districts of Andhra Pradesh	to provide irrigation facility
8.	Hirakund Project	1948	Mahanadi	Sambalpur in the state of Odisha	irrigation, power generation and flood control
9.	Rihand Project	1954	Rihand	Sonbhadra district, Uttar Pradesh	both irrigation purposes and power generation
10.	Nizamsagar Project	1923-31	Godavari	Nizambad District in Telangana	irrigation

Lakes

Lakes of India are of high importance as they prevent flooding during high rain and on the other hand it stimulater an even water flow during dry seasons. India is bestowed with some really beautiful lakes which are not only of geomorphologic importance but also attracts a large number of tourists every year. Many such lakes are Dal Lake,Wular, Chilka, Loktak, Nakki, Kodaikanal, Sukhna, Puskar, Nakki, Sukhna, Manasbal, Bhojtal, Hussain Sagar, Tam Dil, Pulicat etc.

IMPORTANT LAKES IN INDIA

Lakes Name	State
Kolleru Lake, Pulicat Lake	Andhra Pradesh
Deepor Beel, Chandubi Lake, Haflong Lake, Son Beel	Assam
Kanwar Lake	Bihar
Hamirsar Lake, Kankaria Lake, Nal Sarovar, Sursagar Lake	Gujarat
Brighu Lake, Dashir Lake, Dhankar Lake, Kareri (Kumarwah) Lake, Khajjiar Lake, Macchial Lake, Maharana Pratap Sagar, Manimahesh Lake, Nako Lake, Pandoh Lake,	Himachal Pradesh
Prashar Lake, Renuka Lake, Suraj Taal, Chandra Taal	Himachal Pradesh
Badkhal Lake, Brahma Sarovar, Karna Lake, Sannihit Sarovar, Surajkund Lake, Tilyar Lake, Blue Bird Lake	Haryana
Dal Lake, Pangong Tso, Sheshnag Lake	Jammu & Kashmir
Bellandur Lake, Ulsoor Lake, Sankey Lake, Agara Lake, Karanji lake, Kukkarahalli lake, Lingambudhi Lake, Pampa Sarovar	Karnataka
Ashtamudi Lake, Maanaanchira Lake	Kerala
Upper Lake, Lower Lake	Madhya Pradesh
Moti Jheel	Uttar Pradesh
Gorewada Lake, Lonar Lake	Maharashtra
Umiam Lake	Meghalaya
Loktak Lake	Manipur
Palak Dil Lake, Tam Dil Lake	Mizoram
Anshupa Lake, Chilka Lake, Kanjia Lake	Odisha
Kanjli Wetland, Harike Wetland, Ropar Wetland	Punjab

Soil

As a prime natural resource soil plays an important role in the growth of human activities of a specific location. The type of soil found in India can be classified in number of ways but as per All India Soil Survey Committee of Indian Council of Agricultural Research there are 8 types of soil found in India.

Alluvial soil

Spatial Distribution: Wide spread in northern plains and river valleys such as Indus-Ganga-

Markha River is a tributary of Zanskar river lying within Hemis National Park.

Brahmaputra plain, Narmada-Tapi plain, deltas and estuaries of Peninsular India.
Property: Mixture of Humus, lime and organic matters and hence highly fertile.
Colour: Light grey to ash arey.
Texture: Sandy to silty loam or clay.
Suitable for: Production of wheat, rice, maize, sugarcane, pulses, oilseed.

Red soil

Spatial Distribution: Mainly found in the areas of low rainfall. The states with red soils are Tamil Nadu, Karnataka, South-east part of Maharashtra, Eastern Part of Andhra Pradesh and Madhya Pradesh, Chota Nagpur in Jharkhand, Odisha, Chhattishgarh Parts of South Bihar, Birbhum and Bankura districts of West Bengal, Mirzapur, Jhansi, Banda, Hamirpur district of UP, Aravali Hills and eastern half of Rajasthan.

- **Property:** Abundance of Ferric oxide: Absence of lime matters and hence highly fertile.
- **Colour:** Red
- **Texture:** Sandy to clay and loamy.
- **Suitable for:** Production of wheat, cotton, pulses, tobacco, oilseeds, potato.

Black / Regur soil

- **Spatial Distribution:** Most of the Deccan is occupied by black soil.
- **Property:** Mature soil with high water retaining capacity, become sticky when wet and shrinks when dried. It is rich in Iron, lime, calcium, potassium, aluminum and magnesium.
- **Colour:** Deep black to light black.
- **Texture:** Clayey.
- **Suitable for:** Best soil for cotton production.

Arid / Desert soil

- **Spatial Distribution:** Seen widely under arid and semi-arid conditions such as Rajasthan, parts of Haryana and Punjab.
- **Property:** Lack of moisture and humus and contains impure Calcium carbonate.
- **Colour:** Red to Brown.
- **Texture:** Sandy
- **Suitable for:** Salt tolerant crops like barley , rapeseed, wheat , millet, maize.

Laterite soil

- **Spatial Distribution:** mostly found in Eastern Ghats, the Rajmahal Hills, Vidhyas, Satpura and Malwa Plateau.
- **Property:** Prone to leaching of lime and silica from soil, rich in iron and aluminum,
- Deficient in Nitrogen, Potash, Potassium, Lime, Humus
- **Colour:** Red colour due to iron oxide
- **Texture:** Clayey rocky
- **Suitable for**: Rice, Ragi, Sugarcane and Cashew nuts.

Saline soil

- **Spatial Distribution:** mostly found Andhra Pradesh and Karnatak, in drier parts of Bihar, Uttar Pradesh, Haryana, Punjab, Rajasthan and Maharashtra. In Gujarat the area around gulf of Khambhat, vast estuaries of the Narmada, Tapi and Mahi river.
- **Property:** Mainly saline and alkaline in nature, rich in sodium, magnesium, calcium salt, and sulphurous acid.
- Not suitable for agricultural productivity.

Peaty/Marshy Soil

- **Spatial Distribution:** generally found in coastal areas of Odisha and Tamil Nadu, Sunderbans of West Bengal, Bihar and Almora district of Uttarakhand.
- **Property:** heavy and highly acidic in nature, deficient in Potash and Phosphate.
- **Colour:** Black
- **Suitable for:** Paddy cultivation.

Forest soil and Mountain Soil

- **Spatial Distribution:** Mostly found in Himalayan Region mainly in valley basins, and Western and Eastern Ghats of Peninsular India
- **Property:** Rich in humus, deficient in Potash, Phosphorous and lime.
- **Suitable for:** Wheat, maize, barley in southern India and temperate fruit in Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Tache gompa is an important Buddhist monastry in the Markha valley.

Climate

Although India is basically a tropical country, it experiences wide variation in climatic condition depending upon the altitude, latitude, distance from sea and relief. The variability can be observed in number of factors such as:

- **Western Rajasthan** experiences a high temperature during June whereas the areas close to Kashmir are relatively experiencing a much lower temperature. The coastal lands are comparatively having a moderate climate due to the nearness of sea.
- The amount of rainfall also varies throughout the country. The rainfall in India is primarily governed by Monsoon wind which generally hits the south west coast of India generally in June and known as onset of Monsoon. The wind then starts circulating via the Bay of Bengal covering the entire eastern, north eastern and parts of central India.
- The highest rainfall is experienced in **Mawsynram,** Cherrapunji in Meghalaya i.e. 1221 cm of annual rainfall. On the other hand in the month of October and November the monsoon trough of low pressure starts receding from Northern Plain results into rain in Southern India. About 50% to 60% of rainfall in Tamil Nadu is caused due to retreat of Monsoon from North East.

SEASONS AND THEIR CLIMATIC FEATURES

Season	Temporal Aspect	Precipitation	Other Climatic Features
Summer Season (Pre-monsoon)	March to June	Only 1% of total Indian rainfall is caused mostly by storms originating from convective current	Dry season, high temperature and low humidity
Rainy Season	June to September	Rainfall through South-West monsoon	High heat, high humidity, extensive cloud and several spells of moderate to heavy rainfall
Cool Season	Mid September to November	Retreating monsoon causes rainfall in Tamil Nadu and adjoining areas of Andhra Pradesh and Kerala	No cloud, severe and devastating tropical cyclone, clear sky
Winter Season	November to March	Causes rainfall in Sub-Himalayan belt by Western disturbances	Clear sky, low temperature and humidity, high range of temperature

RAIN FALL DISTRIBUTION IN INDIA

Amount of Rain fall	Heavy Rainfall (200-320cm)	Moderately Heavy Rainfall (100-200 cm)	Less Rainfall (50-100 cm)	Scanty Rainfall <50cms
States	West coasts, on the western Ghats, Sub-Himalayan areas in North East and Meghalaya Hills. Assam, West Bengal, Southern slopes of eastern Himalayas.	Southern Parts of Gujarat, East Tamil Nadu, North-eastern Peninsular, Western Ghats, eastern Maharashtra, Madhya Pradesh, Odisha, the middle Ganga valley.	Upper Ganga valley, eastern Rajasthan, Punjab, Southern Plateau of Karnataka, Andhra Pradessh and Tamil Nadu.	Northern part of Kashmir, Western Rajasthan, Punjab and Deccan Plateau

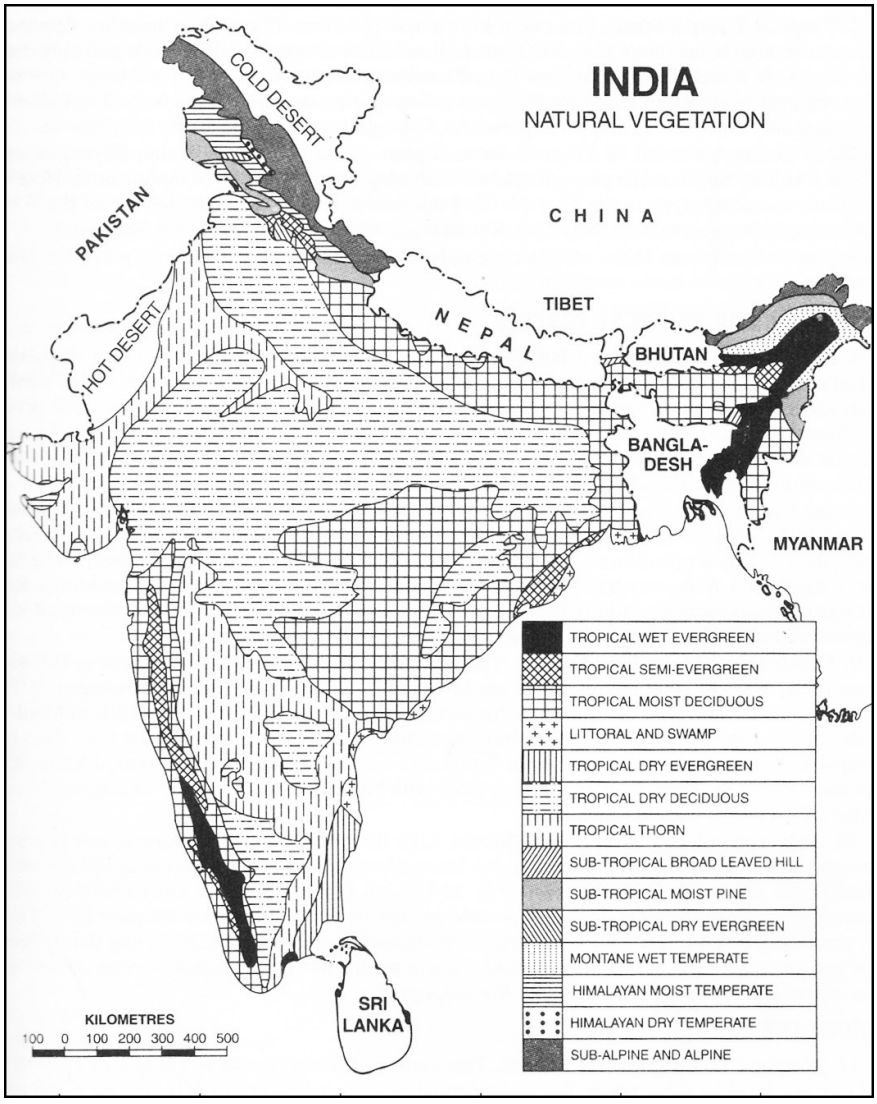
NATURAL VEGETATION

Natural vegetations or the forest type in India vary from place to place depending upon several factors such as climate, soil, rainfall, temperature as well as their seasonal variation along with varied edaphic and biotic conditions. Several botanist and ecologist have given different classification on the basis of climatic and adaptive factors. On the basis of such suggestion a generalised classification can be done with 5 main types and 16 subtypes of vegetation.

CLASSIFICATION OF NATURAL VEGETATION

Type	Sub- Types
Moist Tropical Forest	• Tropical Wet Evergreen • Tropical Semi evergreen • Tropical Moist Deciduous • Littoral and Swamp
Dry Tropical Forest	• Tropical Dry Evergreen • Tropical Dry Deciduous • Tropical Thorn
Mountain Sub-tropical Forest	• Sub tropic Broad leaved Hill • Sub tropical Moist (pine) • Sub tropic Dry Evergreen
Mountain Temperate Forest	• Mountain Wet Temperate • Himalayan Moist Temperate • Himalayan Dry Temperate
Alpine Forest	• Sub- Alpine • Moist – Alpine Scrub • Dry Alpine Scrub

Spatial Distribution of Natural vegetation in India



TRIBAL GROUPS OF INDIA

Tribal Group	Region	Tribal Group	Region
Abhor	Arunachal Pradesh	Kolam	Maharashtra, Andhra Pradesh, Telengana, M.P
Adivasi	A.P, Bihar, Odisha, Jharkhand, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Some Northeastern States, West Bengal, Andaman and Nicobar	Kota	Karnataka
Ahgani	Manipur	Kuki	Mizoram, Manipur
Apatani	Arunachal Pradesh	Lahaula	Himachal Pradesh
Baiga	Madhya Pradesh	Lepcha	Sikkim
Bakarwal	Jammu and Kashmir	Lushai	Mizoram, Manipur
Bhil	M.P and Rajasthan	Muria	Chhattisgarh
Birhor	M.P and Bihar	Miha	Rajasthan
Chang	Nagaland	Moplah	Malabar
Chenchuas	Telengana, Karnataka	Munda	West Bengal, Jharkhand, Odisha, Chhattishgarh
Sutiya	Assam	Nishi	Assam
Gaddis	Himachal Pradesh	Naga	Nagaland
Gallong	Arunachal Pradesh	Oraon	MP, Bihar and Odisha, Chhota Nagpur, W.B,
Garo	Meghalaya	Onges	Andaman & Nicobar
Gond	M.P, Bihar, Orissa and A.P	Singpho	Assam, Arunachal Pradesh
Gujjar	Rajasthan, H.P, J&K, Haryana	Santhal	WB, Odisha, Bihar, Jharkhand, Assam
Irula	Tamil Nadu	Sangtam	Nagaland
Jaintia	Meghalaya	Sema	Nagaland
Jarawa	Andaman, islands	Sentinelese	Andaman & Nicobar
Kanikar	Tamil Nadu and Kerala	Shompen	Andaman & Nicobar
Kalkari	Maharashtra	Toda	Tamil Nadu
Kharia	Maharashtra	Uralis	Kerala
Khond	Jharkhand	Wancho	Arunachal Pradesh
Khasi	Meghalaya	Warli	Maharashtra, Daman and Diu, Bihar, Madhaya Pradesh, West Bengal Dadra and Nagar Haveli
Kharia	Jharkhand, Odisha		
Kol	Madhya Pradesh		

AGRICULTURE IN INDIA

A wide range of crops can be grown in India as the land is supported by element essential for crop growth such as relief, soil, climate, abundant sunshine and long growing seasons.

Kinds of Crops

The major Indian crop can be divided into following categories:

Food crops

Rice, Wheat, Maize, Millet, Jower, Bajra, Ragi, and pulses like Gram, Tur (Arhar)

Cash crops

Cotton, Jute, Sugarcane, Tobacco, Oilseeds, Ground Nut, Linseed, Sesame, Castor seed, Rapeseed, Mustard

Plantation crops

Tea, Coffee, Spices, Cardamom, Ginger, Turmeric, Coconut, Areca nut and Rubber

Horticulture

Apple, Peach, Pear, Apricot, Almond, Strawberry, Walnut, Mango, Banana, Citrus Fruit, Vegetables.

Agro-climatic Regions

(i) Western Himalayan Region

- Jammu and Kashmir, Himachal Pradesh and the hill region of Uttarakhand fall into it.
- Valley floors grow rice, while the hilly tracts grow maize in the kharif season. Winter crops are barley, oats, and wheat.
- Apple orchards and other temperate fruitls such as peaches, apricot, pears, cherry, almond, litchis, walnut, etc. Saffron is grown in this region.

(ii) Eastern Himalayan Region

- Arunachal Pradesh, hills of Assam, Sikkim, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and the Darjeeling district of West Bengal come into this region.
- Annual rainfall is 200-400 cm.
- The main crops are rice, maize, potato, tea. Orchards of pineapple, litchi, oranges and lime are also found.

(iii) Lower Gangetic Plain Region

- Located in West Bengal (except the hilly areas), eastern Bihar and the Brahmaputra valley lie in this region with the rainfall of 100 cm-200 cm.
- Rice is the main crop which at times yields three successive crops (Aman, Aus and Boro) in a year. Jute, maize, potato, and pulses are other important crops.

(iv) Middle Gangetic Plain Region

- Large parts of Uttar Pradesh and Bihar are covered and receive 100 cm and 200 cm of rainfall.
- Rice, maize, millets grow in kharif; wheat, gram, barley, peas, mustard and potato in rabi are important crops.

(v) Upper Gangetic Plains Region

- Central and western parts of Uttar Pradesh and Haridwar and Udham Nagar districts of Uttarakhand fall into it.
- Rainfall is between 75 cm-150 cm. Wheat, rice, sugarcane, millets, maize, gram, barley, oilseeds, pulses and cotton are the main crops.

(vi) Trans-Ganga Plain Region

- Punjab, Haryana, Chandigarh, Delhi and the Ganganagar district of Rajasthan come under it.
- Rainfall varies between 65 cm and 125 cm.
- The main crops are wheat, sugarcane, cotton, rice, gram, maize, millets, pulses and oilseeds etc.
- The region faces the threat of water logging, salinity, alkalinity, soil erosion and fall of water table.

(vii) Eastern Plateau and Hills

- Jharkhand, Odisha, Chhattisgarh and Dandakaranya come under it.
- 80 cm-150 cm of annual rainfall is received.
- Rice, millets, maize, oilseeds, ragi, gram, potato, tur, groundnut and soyabean grow on rainfed areas.

(viii) Central Plateau and Hills

- Bundelkhand, Baghelkhand, Bhander Plateau, Malwa Plateau, and Vindhyachal Hills receive rainfall 50 cm-100 cm.
- Crops like millets, wheat, gram, oilseeds, cotton and sunflower grow in this region.

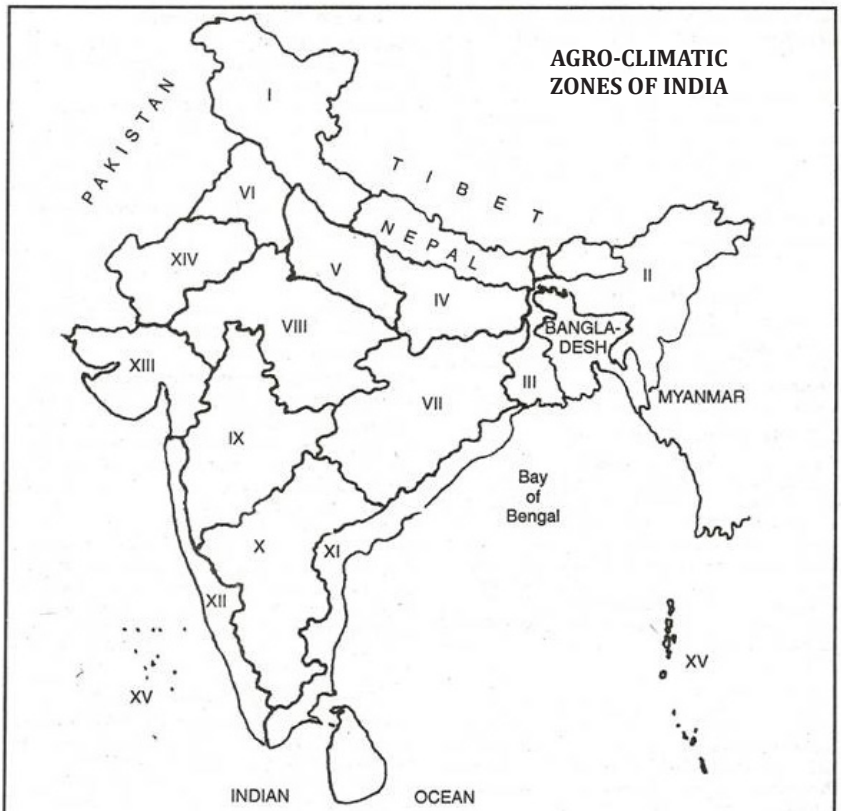
Mining and Smelting of copper in India are managed by Hindustan Copper Ltd (HCL).

(ix) Western Plateau and Hills

- Malwa plateau and Deccan plateau (Maharashtra).
- 25 cm-75 cm. of annual rainfall.
- Wheat, gram, millets, cotton, pulses, groundnut, and oilseeds are the main crops in the rain-fed areas, while in the irrigated areas, sugarcane, rice, and wheat, are cultivated.

(x) Southern Plateau and Hills

- Interior Deccan includes parts of southern Maharashtra, the greater parts of Karnataka, Andhra Pradesh, and Tamil Nadu uplands from Adilabad district in the north to Madurai district in the south.
- Annual rainfall is between 50 cm and 100 cm.
- Millets, oilseeds, pulses grow here.



I.	Western Himalayan Region	IX.	Western Plateau and Hills
II.	Eastern Himalayan Region	X.	Southem Plateau and Hills
III.	Lower Gangetic Plain Region	XI.	Eastern Coastal Plains and Hills
IV.	Middle Gangetic Plain Region	XII.	Western Coastal Plains and Ghats
V.	Upper Gangetic Plains Region	XIII.	Gujarat Plains and Hills
VI.	Trans-Ganga Plains Region	XIV.	Western Dry Region
VII.	Eastern Plateau and Hills	XV.	Island Region
VIII.	Central Plateau and Hills		

(xi) Eastern Coastal Plains and Hills

- Coromandal and northern Circar coasts of Andhra Pradesh and Odisha come into it.
- Annual rainfall here varies between 75 cm and 150 cm.

Gypsum is a hydrated sulphide of Calcium used for reclaiming alkaline soils.

- Main crops include rice, jute, tobacco, sugarcane, maize, millets, groundnut and oilseeds.
- Cultivation of spices (pepper and cardamom) and development of fisheries is also done.

(xii) Western Coastal Plains and Ghats

- Malabar and Konkan coastal plains and the Sahyadris are included in it.
- Annual rainfall is more than 200 cm.
- Rice, coconut, oilseeds, sugarcane, millets, pulses and cotton are the main crops.
- The region is famous for plantation crops and spices.

(xiii)Gujarat Plains and Hills

- They includes hills and plains of Kathiawar, and the fertile valleys of Mahi and Sabarmati rivers.
- Annual rainfall varies between 50 cm and 100 cm.
- Groundnut, cotton, rice, millets, oilseeds, wheat and tobacco are the main crops.
- It is an important oilseed producing region.

(xiv)Western Dry Region

- Extended over Rajasthan, West of the Aravallis, this region has an erratic rainfall of an annual average of less than 25 cm.
- Horticultural crops like watermelon, guava and date palm grow here.

(xv) Island Region

- It includes Andaman-Nicobar and Laksha-dweep which have typically equatorial climate (annual rainfall less than 300 cm).
- Main crops are rice, maize, millets, pulses, turmeric and cassava.

Major Growing Seasons in India

Kharif (July to October)

Major crops are rice, maize, sorghum, pearl millet/bajra, finger millet/ragi (cereals), arhar (pulses), soyabean, groundnut (oilseeds), cotton, etc.

Rabi (October to March)

Major crops wheat, barley, oats (cereals), chick pea/gram (pulses), linseed, mustard (oilseeds) etc.

Zaid (March to June)

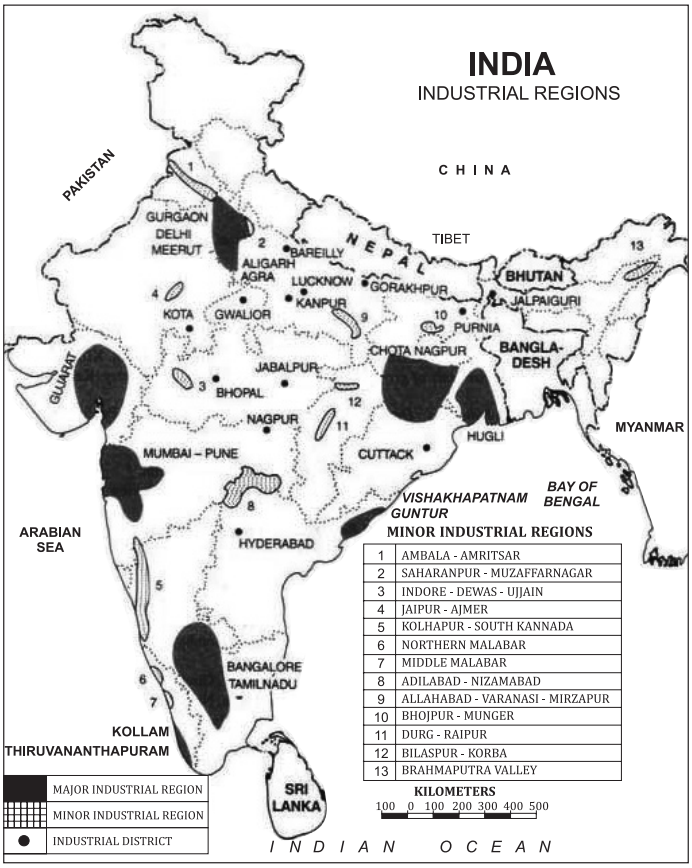
Muskmelon, Watermelon, Vegetables of cucurbitacae family such as bitter gourd, pumpkin, ridged gourd etc.

MAJOR CROPS AND PRODUCING STATES

Crop Type	Crop Name	Major Producers
Cereals	Wheat	Uttar Pradesh, Punjab and Madhya Pradesh
	Rice	West Bengal and Uttar Pradesh
	Gram	Madhya Pradesh and Tamil Nadu
	Barley	Maharashtra, Uttar Pradesh and Rajasthan
	Bajra	Maharashtra, Gujarat and Rajasthan
Cash Crops	Sugarcane	Uttar Pradesh and Maharashtra
	Poppy	Uttar Pradesh and Himachal Pradesh
Oil Seeds	Coconut	Kerala and Tamil Nadu
	Linseed	Rajasthan Madhya Pradesh and Haryana
	Groundnut	Gujarat, Andhra Pradesh and Tamil Nadu
	Rape seed and Mustard	Rajasthan, Madhya Pradesh and Haryana
	Sesame	Uttar Pradesh and Rajasthan
	Sunflower	Andhra Pradesh and Maharashtra Karnataka
Fibre Crops	Cotton	Maharashtra and Gujarat
	Jute	West Bengal and Bihar
	Silk	Karnataka and Kerala
	Hemp	Madhya Pradesh and Uttar Pradesh
Plantations	Coffee	Karnataka and Kerala
	Rubber	Kerala and Karnataka
	Tea	Assam and Kerala
	Tobacco	Gujarat, Maharashtra and Madhya Pradesh
Spices	Pepper	Kerala, Karnataka and Tamil Nadu
	Cashew nuts	Kerala, Tamil Nadu and Andhra Pradesh
	Ginger	Kerala and Uttar Pradesh
	Turmeric	Andhra Pradesh and Odisha

VARIOUS NAMES OF SHIFTING AGRICULTURE

States	Name of Shifting Cultivation
Andhra Pradesh and Odisha	Podu
Assam	Jhum
Kerala	Ponam
Madhya Pradesh	Beewar, Mashan, Penda and Beera



Industry

Major Industrial Regions of India

There are eight major industrial regions in India.

1. Mumbai-Pune Industrial Region
2. Hugli Industrial Region
3. Bangalore-Tamil Nadu Industrial Region
4. Gujarat Industrial Region
5. Chota Nagpur Industrial Region
6. Vishakhapatnam-Guntur Industrial Region
7. Gurgaon-Delhi-Meerut Industrial Region
8. Kolfam-Thiruvananthapuram Industrial Region

Cuttack and Keonjhar district have the largest amount of chromite reserves.

Major Industrial Type

As per the type raw materials used in the industry and its finished product, the categories of Indian Industry can be divided into:

- **Agro Based Industry**
  - Cotton Textile
  - Jute Textile
  - Sugar
  - Silk
- **Metallurgical Industry**
  - Iron and Steel Industry
  - Aluminum smelting Industry
- Engineering Industry
- Fertilizer Industry
- Aircraft Industry
- Glass Industry
- Cement Industry
- Chemical Industry

MINERALS IN INDIA

Minerals are the natural resources which are used in many industries as raw materials. Iron ore, manganese, bauxite, copper, etc. are such minerals.

Minerals are of two types: **metallic** and **non-metallic**. Iron ore and copper are metallic minerals while limestone and dolomite are non-metallic minerals.

Metallic minerals are further sub-divided into **ferrous** and **non-ferrous minerals**. Those metallic minerals which have iron content belong to ferrous group. The metallic minerals belonging to non-ferrous group do not have iron content.

India is rich in iron, mica, manganese, bauxite; self sufficient in antimony, building materials, cement materials, clay, chromite, lime, dolomite, and gold, but deficient in copper, lead, mercury, zinc, tin, nickel, petroleum products, rock phosphate, sulphur, and tungsten.

Mineral Resources

Mineral	State/ Region
Aluminium	Kerala
Antimony	Antimony deposits are found in Punjab and Karnataka.
Asbestos	Karnataka and Rajasthan.
Barytes (Barium Sulphate)	Tamil Nadu, Andhra Pradesh, Manbhum and Singhbhum districts of Jharkhand.
Bauxite	Ranchi and Palamau districts of Jharkhand, Belgaum, Jharia and Thana districts of Maharashtra, Balaghat, Jabalpur, Mandya and Bilaspur districts of Chhattisgarh.
Beryllium Sands	Rajasthan, Tamil Nadu, Kashmir and Bihar.
Cement	Katni (M.P.), Lakheri (Rajasthan), Jabalpur (M.P.), Guntur (Andhra Pradesh), Jhinikapani (Singhbhum district of Jharkhand), Surajpur (Haryana).
China Clay	Rajmahal Hills, Singhbhum district of Jharkhand, Kerala.
Chromite	Singhbhum (Jharkhand) and Bhagalpur, Ratnagiri, Salem (Tamil Nadu), Karnataka, Keonjhar (Odisha), Ladakh (Kashmir).
Coal	Raniganj (West Bengal), Jharia, Bokaro (Jharkhand), Giridih, Karanpur, Panch Valley and Chanda (M.P.), Singareni (Andhra Pradesh) and Mukum (Assam).
Cobalt	Rajasthan and Kerala.
Copper	Jharkhand (Singhbhum and Barajamda), Chhattisgarh, Rajasthan (**Khetri**).

Diamond	Diamond mines are found in **Panna** district of Madhya Pradesh, **Raipur** district of Chhattisgarh.
Feldspar	Burdwan (West Bengal), Rewa (M.P.), Tiruchirapalli (Tamil Nadu), Alwar and Ajmer.
Gold	**Kolar** gold-fields (Karnataka).
Graphite	Rajasthan, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Karnataka, Odisha and Kerala.
Gypsum	Bikaner and Jodhpur (Rajasthan), Tiruchirapalli (Tamil Nadu), Gujarat and Himachal Pradesh.
Iron Ore	Singhbhum (Jharkhand), Chhattisgarh, Keonjhar and Mayurbhanj (Odisha).
Lac	West Bengal.
Lead	Zawar in Udaipur and at the Banjavi mines in Jaipur.
Lignite	Neyveli in South Arcot district (Tamil Nadu).
Limestone	Singareni and Singhbhum (Jharkhand), Panchmahals (Gujarat), Balaghat, Bhandara, Chhindwara, Nagpur, Indore, Vishakhapatnam, Sandur (Tamil Nadu).
Manganese	Madhya Pradesh, Jharkhand and Chhattisgarh.
Marble	Jaipur (Rajasthan).
Mica	**Koderma** in Hazaribagh district, Jharkhand, Munger (Bihar), **Nellore** in Andhra Pradesh.
Monazite Sands	Found in abundance in Travancore Coast (Kerala).
Nitre	Bihar, U.P., Tamil Nadu and Punjab.
Petroleum	**Digboi**, Badarpur, Musimpur and Patharia fields of Assam.
Pitchblende	Gaya (Bihar).
Red Stone	Jodhpur (Rajasthan).
Salt	Sambhar Lake (Rajasthan), and is also obtained from ocean water in **Rann of Kutch**, on the north-western and south-eastern littoral (sea-shore) of India.
Saltpetre	Punjab, U.P. and Bihar.
Silmanite	Khasi Hills (Assam), Rewa (M.P).
Silver	Goldfields (Karnataka), Singhbhum and Manbhum (Jharkhand), Tamil Nadu and Rajasthan.
Tungsten	Bihar, Nagpur (Maharashtra) and Marwar.
Uranium	Bihar
Zinc	Zawar mines in Udaipur (Rajasthan).
Zircon	Beach sands of Kerala and Cape Comorin.

WORLD GEOGRAPHY MIND MAP

Continents

- Asia
- Africa
- North America
- South America
- Europe
- Australia
- Antarctia

Religion

- Christianity
- Islam
- Hinduism
- Chinese Folk Religion
- Buddhism

Climatic Zone

- Equatorial Zone
- Hot Zone
- Warm Temperate Zone
- Cool Temperate Zone
- Cold Zone
- Alpine Zone

Industrial Religion

- USA and Canada Industrial Region
- European Industrial Region
- Asian Major Industrial Region

Things to Remember

- Continent's Highest & Largest Points
- Highest Mountain Peaks
- Deepest Oceans
- Some important Boundary lines
- Longest Rivers
- Deepest Lakes
- Largest Deserts
- Deepest Trenches
- Some important Tribes and their Homeland

CONTINENTS OF WORLD

A continent is one of the large landmasses on Earth generally identified by convention rather than any strict criteria, with up to seven regions commonly regarded as continents. They are Asia, Europe, Africa, North America, South America, Australia and Antarctica.

Continent	Area in Square Miles (Square Km)	% of Total Land Area on Earth	No. of Countries
The World	57,308,738 Sq. Miles (148,429,000 Sq. Km)	100%	200
Asia (including the Middle East)	17,212,000 Sq. Miles (44,579,000 Sq. Km)	30.0%	50
Africa	11,608,000 Sq. Miles (30,065,000 Sq. Km)	20.3%	55
North America	9,365,000 Sq. Miles (24,256,000 Sq. Km)	16.3%	23
South America	6,880,000 Sq. Miles (17,819,000 Sq. Km)	12.0%	12
Antarctica	5,100,000 Sq. Miles (13,209,000 Sq. Km)	8.9%	….
Europe	3,837,000 Sq. Miles (9,938,000 Sq. Km)	6.7%	46
Australia (plus Oceania)	2,968,000 Sq. Miles (7,687,000 Sq. Km)	5.2%	14

Asia

Asia covers to the east of the Suez Canal, the Ural River, and the Ural Mountains, and south of the Caucasus Mountains and the Caspian and Black Seas. It is bounded on the east by the Pacific Ocean, on the south by the Indian Ocean and on the north by the Arctic Ocean.

Physical Features

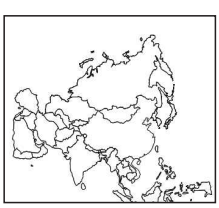
Region-wise it can be classified into 6 regions which are:

Central Asia : Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

Eastern Asia : China, Hong Kong, Japan, North Korea, South Korea, Macau, Mongolia, Taiwan

Northern Asia : Russia

Southeastern Asia: Brunei, Myanmar, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Timor-Leste, Vietnam



Southern Asia: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

Western Asia : Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, State of Palestine, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen.

Natural Vegetation of Asia

- The Tundra
- The Taiga
- Temperate Grasslands, the Steppes
- Mediterranean Scrubland and Forest
- Desert Vegetation
- Monsoon Region
- Tropical Rainforest
- Vegetation in the Mountains

Africa

- **Algeria** is Africa's largest country by area, and **Nigeria** by population.
- Africa's population is the youngest among all the continents; 50% of Africans are 19 years old or younger.

- Separated from Europe by the

Madagascar is often called the land of the living fossils.

Mediterranean Sea, it is joined to Asia at its northeast extremity by the **Isthmus of Suez** 163 km wide.

Physical Features

Region-wise it can be classified into 6 regions which are listed below.

Northern Africa : Algeria, Canary Islands, Santa Cruz de Tenerife, Ceuta, Egypt, Libya, Madeira, Melilla, Morocco, Sudan, Tunisia, Western Sahara.

Northeast Africa : Djibouti, Eritrea, Ethiopia, Somalia

Eastern Africa : Burundi, Comoros, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Reunion, Rwanda, Seychelles, South Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

Central Africa : Angola, Cameroon, Central African Republic, Chad, Republic of the Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe.

Southern Africa: Botswana, Lesotho, Namibia, South Africa, Swaziland

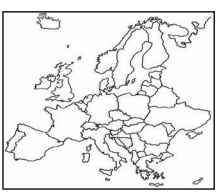
Western Africa: Benin, Burkina Faso, Cape Verde, Gambia, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Saint Helena, Senegal, Sierra Leone, Togo

Natural Vegetation of Africa

- Tropical Rain Forests
- Tropical Savannas
- Tropical Steppes and Deserts
- Mediterranean Forests
- Montane Forests
- Mangrove Forests

Europe

The continent comprises the westernmost part of Eurasia bordered by Arctic Ocean in north, the Atlantic Ocean in west, and the Mediterranean Sea to the south. To the east and southeast, it is separated from Asia by the watershed divides of the Ural and Caucasus Mountains, the Ural River, the Caspian and Black Seas, and the waterways of the Turkish Straits. It is the second smallest continent in the world.



Physical Features

Region-wise classification of Europe

Western Uplands: Landscape of Scandinavia (Norway, Sweden, and Denmark), Finland, Iceland, Scotland, Ireland, the Brittany region of France, Spain, and Portugal.

Central Uplands : Central Europe, western France and Belgium, southern Germany, the Czech Republic, and parts of northern Switzerland and Austria.

Alpine Mountains : The Italian and Balkan peninsulas, northern Spain, and southern France. The region includes the mountains of the Alps, Pyrenees, Apennines, Dinaric Alps, Balkans, and Carpathians.

North European Plain: France, Belgium, the Netherlands, Germany, Denmark, Poland, the Baltic states (Estonia, Latvia, and Lithuania), and Belarus.

Island : British Isles, Corsica, Alba, Sardinia, Crete , Malta , Cyprus, are some of the major Islands of Europe.

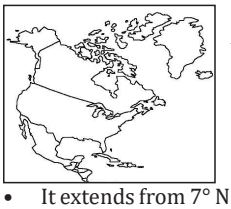
Deserts : Accona Desert, Bardenas Reales, Bledowska Desert, The Stone Desert, Larzac, Santorini and Anafi, are some of the major deserts of Europe

Natural Vegetation of Europe

- Subtropical Dry Forest
- Subtropical Mountain Forest
- Temperate Oceanic Forest
- Temperate continental Forest
- Boreal Coniferous forest
- Boreal Tundra Forest
- Boreal Mountain

North America

It is the third largest continent by area, following Asia and Africa and fourth largest in terms of population with the density of 24 million/sq km.



- It extends from 7° N to 85° N latitudinal-wise and longitude-wise 20°W to 179°W.

Physical Features

It can be classified into 5 regions:

Western Region : Young Mountains rise

The inhabitants of Madagascar refer themselves as Malagasy.

in the west. The most familiar of these mountains are probably the Rockies, North America's largest chain. They stretch from the province of British Columbia, Canada, to the U.S. state of New Mexico.

Great Plains : In the middle of the continent lies the Great Plain. Deep rich soil blankets large areas of the plains in Canada and the United States. Grain grown in this region, called the "**Bread basket of North America**," feeding a large part of the world.

Canadian Shield: The Canadian Shield is a raised but relatively flat plateau. It extends over eastern, central, and north western Canada. The Canadian Shield is characterized by a rocky landscape packed by an astounding number of lakes.

Eastern Region: This varied region includes the Appalachian Mountains and the Atlantic coastal plain. North America's older mountain ranges, including the Appalachians, rise near the east coast of the United States and Canada

Caribbean Region: The Caribbean Region includes more than 7,000 islands, islets, reefs, and cays. The region's islands and smaller islets are varied in their topography.

Natural Vegetation of North America

- Arctic/ Tundra Forests
- Boreal Forests/ Taiga/ Coniferous forests
- Eastern Deciduous Forests
- Grasslands
- Desert Scrub
- Mediterranean and Madrean Scrublands and Woodlands
- Pacific Coast Coniferous Forests
- Western Montane Coniferous Forests
- Tidal Wetlands

South America

This is a triangular shape continent, stretching from 12° N to 55°S latitude. Towards its west lies Pacific Ocean, Atlantic Ocean on the east and North America and the Caribbean Sea lie to the northwest. It is the fourth largest continent of the world with smooth and inlet coastline.

Physical Features

It can be classified into 5 regions :

The Pacific Coastal Strip lies between the west Pacific and Andes.

The Andes stretches through entire continent in length running in north-south direction from Isthmus of Panama to Strait of Magellan.

The Central Lowland: Two great river system are covered under it namely the Amazon-Orinoco and Parana-Paraguay rivers.

The Eastern Highland consists of Brazilian and Guiana Highlands along with Patagonia.

Natural Vegetation of South America

- Equatorial Forest
- Temperate Forests
- Mediterranean Forests
- Savanna Grasslands
- Pampas
- Desert

Australia

- It is an inland continent.
- Latitude – 10° 41' S and 39°S
- Longitude – 114°E and 154°E
- It is smallest continent of the world and lies entirely in south hemisphere.

- Tropic of Capricorn runs almost through the middle of the continent and divides the continent in two equal parts.

Physical Features

It can be classified into 3 regions such as:

The Great Western Plateau covers two third of Australia.

The Central Lowland extends from the shallow Gulf of Carpentaria in the north to the Southern Ocean.

The Eastern Highlands stretch along the eastern edge of Australia, all the way from Cape York to Tasmania.

Natural Vegetation

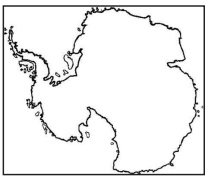
- The tropical Rainforest

The southwestern sections of Africa are rimmed by the Cape Fold Mountains and Karoo rock series.

- The deciduous forest Savanna
- The dry desert and desert scrub

Antarctica

- Antarctica was discovered in 1820.
- It was Ronald Amundsen, who for the first time reached the South Pole in Antarctica.



- It provides unique opportunity to the scientists to learn about the world; therefore it is called the land for science.
- It is the only continent, which is completely frozen. It is therefore known as white continent.

Physical Features

As a frozen continent it has only a few prominent physiographic units such as:
Trans – Antarctic Mountain dividing the continent into West Antarctica and East Antarctica.

The Antarctic Peninsula

The islands of the Antarctic region which contains South Orkney Islands, South Shetland Islands, South Georgia, and the South Sandwich Islands, all claimed by the United Kingdom.

Major Industrial Regions of the World

- These are areas where manufacturing industries are carried out on a relatively large scale and employ a relatively large proportion of population.
- With the development of machinery, many industrial centres have come up where there is abundance of coal, iron, and extensive water-power are in abundance.

The major industrial regions of the world are as follows:

USA and Canada Industrial Regions

Industrial region of USA and Canada comprises the New England Regions, The New York - Mid-Atlantic Region, North - Eastern Region. The Southern Region, Western Region & Pacific Region. These regions include several major American industrial cities & Metropolitans like Hartford, New Haven, areas from New York to Baltimore with New Jersey, Chicago, Detroit, Houston, etc.

European Industrial Region

- **Western Europe** major industrial regions.
- **United Kingdom's** industrial regions are located in Lancashire, London's basin, Scotland, Midland, South-Wales, etc. producing manufacturing products like engineering, ferrous, chemical textile, food & beverages, etc.
- **The Saar Region**, the Hamburg Region, Berlin Region & Leipzig Region with iron & steel heavy chemicals, textiles & different consumer goods Industries.
- **France's industrial** region produces iron & steel, textile, glass, leather, automobiles with Northern, Lorraine & Paris Industrial Regions. Other European countries like Italy, Switzerland, Holland Belgium and Sweden are industrial giants.
- **Eastern Europe** has six major industrial regions out of which four are in Russia, one in Ukraine, and one in southern Poland and northern Czech Republic.

Asian major

- **China** is the most dominant and powerful industrial agglomeration of Asia. The regions of Manchurian region, Yangtze region, North-China region, South China region, etc. with many manufacturing units producing steel, heavy chemical's textiles, paper, cement, automobiles, toys, etc are major industrial regions.
- **Japan** has several industrial cities producing steel, pedro-chemical, cement, footwear. toys, etc. at Tokya-Yokohama region, Osaka - Kobe region, north Kyushu region.
- **India's** conurbation of Kolkata, the Mumbai-Pune Industrial belt, Ahmedabad-Vadodara belt, Southern industrial regions with Chennai, Coimbatore, Bangalore industrial belt, Damodar Valley industrial belt, Northern regions with centers like Delhi, Ambala, Ghaziabad, Mathura, etc. Other major industrial regions include Allahabad, Varanasi, Hyderabad,

The Okarango region of Kalahari is called the Jewel of Kalahari.

Patiala, Jaipur, Bilaspur, Jalandhar, Meerut, Lucknow, Kanpur, etc.

Trans-Continental Railways of World

- **Canadian Pacific Rail Route :** It runs from Halifax to Vancouver.
- **Candian National Rail Route:** It joins St. John City to Vancouver.
- **Trans-Siberian Rail Route:** It connects Yaroslavsky Termiral Moscow to Vlalivostok.
- **Trans-caucasus Rail Route:** It starts from Batum, cross Tergana and reaches Krusk.
- **North Trans Continental Rail Route:** It originates at Seattle (USA) New York.
- **Mid Transcontinental Rail Route:** It joins San Francisco to New York.
- **Southern Transcontinental Rail Routes :** It runs from Los Angeles to New York and then reaches New Orleans.
- **Oriental Express Rail Route:** Connects Paris to Kustuntunia (Turkey).
- **Cape-Cairo Rail Route:** It is the longest rail route of Africa running from Cape Town in Southern part of continent and reaches Ciro near the coast of Mediterranean sea situated in the northern part of continent.
- **Trans-Andean Rail Route:** Starting from Valparais (Chile) reaches other end of the continent running west to east to Buenos Aires (Argentina).
- **Trans-Australian Continental Rail Route:** It connects west end of Australia to east end starting from Perth and reaches Sydney.

Transe-Asiatic Railways Line : This is a proposed project of United Nations Economic and Social Commission for Asia and Pacific. It will connect 28 countries including China, Thailand Bangladesh, India, Pakistan, Iran and Turkey.

THINGS TO REMEMBER

EXTREME ELEVATIONS (HIGHEST & LOWEST) PER CONTINENT

Continent	Highest point	Elevation (m)	Country or territory containing highest point	Lowest point	Elevation (m)	Country or territory containing lowest point
Asia	Mount Everest	8,848	China and Nepal	Dead Sea	-427	Israel and Jordan
South America	Aconcagua	6,960	Argentina	Laguna del Carbo′n	-105	Argentina
North America	Denali	6,198	United States	Death Valley	-86	United States
Africa	Mount Kiliman-jaro	5,895	Tanzania	Lake Assal	-155	Djibouti
Europe	Mount Elbrus	5,642	Russia	Caspian Sea	-28	Russia
Antarctica	Vinson Massif	4,892	(none)	Deep Lake, Vestfold Hills	-50	none
Australia	Puncak Jaya	4,884	Indonesia (Papua)	Lake Eyre	-15	Australia

DEEPEST POINTS OF OCEANS

Name	Greatest depth (in metres)	Greatest depth location
Pacific Ocean	11,033	Mariana Trench
Atlantic Ocean	9,460	Puerto Rico Trench
Indian Ocean	7,542	Java Trench

LONGEST RIVERS

Name/Nation/Continent	Length in kms	Origin
Nile, Africa	6695	Victoria Lake
Amazon, South America	6516	Andes (Peru)
Yangtze Kiang, China	6380	Tibetan Kiang
Mississippi, Missouri, USA	5959	Itaska Lake
Ob Irtysh, Russia	5568	Altaimountain
Yenisey Angari a Selenga, Asia	5550	Tannu-ola
Yellow (Hwang Ho), China	5464	Kunlun Mountains
Congo (Zaire), Africa	4667	Lualaba and Luapula rivers
Irtysh, Asia	4440	Altai Mountains
Mekong, Asia	4425	Tibetal Highlands

SHORTEST RIVERS IN THE WORLD

Rank	Name of River	Length	Location
1	Roe River	201 ft (61m)	Great Falls, Montana, USA
2	D River	440 ft (130m)	Lincoln, Oregon, USA
3	Vrelo River	772 ft (234m)	Mali Zvornik, Serbia
4	Fiumelatte River	820 ft (250m)	Varenna, Italy
5	River Bain	827 ft (252m)	North Yorkshire, England

LARGEST DESERT OF THE WORLD

SUBTROPOCAL

Desert	Area (Miles Square)
Sahara	9,000,000
Arabian Desert	2,330,000
Kalahari Desert	900,000
Great Victoria Desert	647,000
Chihuahuan Desert	450,000
Thar Desert	200,000

COLD WINTER

Desert	Area (Miles Square)
Antarctica	14,000,000
Arctic	13,700,000
Gobi Desert	1,000,000
Patagonian Desert	620,000
Great Basin Desert	492,000

DEEPEST LAKES

Baikal, Russian	1620 m
Tanganyika, Africa	1463 m
Caspian Sea, Asia-Europe	1025 m
Malawi of Nyasa, Africa	706 m
Issyk-Kul, Kyrgyzstan	702 m

DEEP SEA TRENCHES

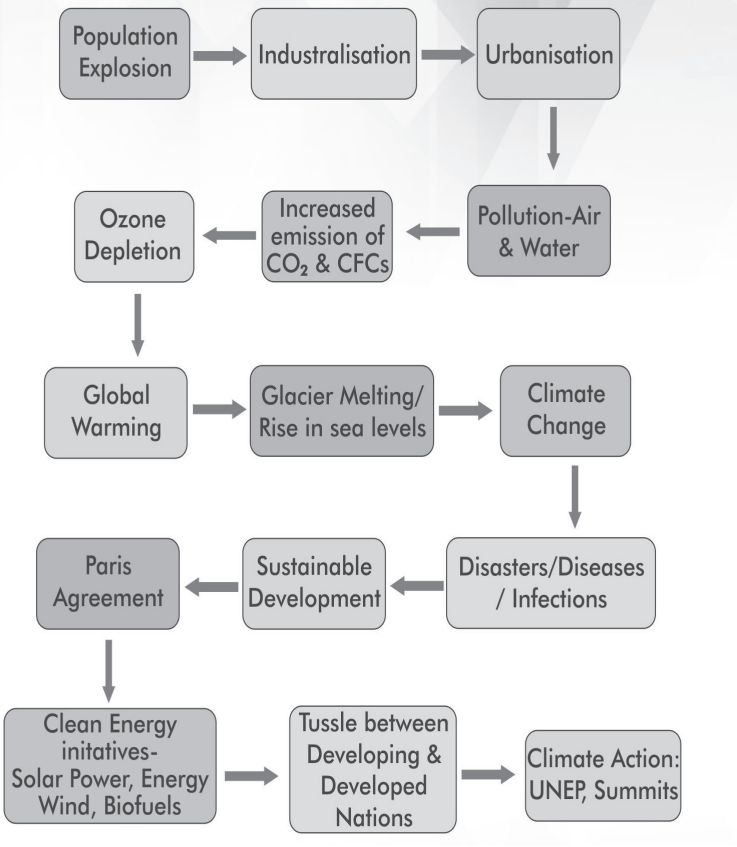
Name	Length (km)	Depth (km)	Deepest Pt.
Mariana	2250	10.924	Challenger Deep
Tonga Kermadec (S. Pacific)	2575	10.850	Vityaz 11 (Tonga)
Kuril-Kamchatka	2250	10.542	-
Philippine	1350	10.539	Galathea Deep
Java-Indian	2250	7725	Planet Deep

SOME IMPORTANT TRIBES AND THEIR HOME (WORLD)

Aleuts : Alaska
Ainus : Japan
Aeta : Phillip Cines
Bushman : Kalahari
Buryak : Central Asia
Berbers : N. Africa
Bedouin : Sahara and Middle East
Bindibu or Aborigins : Australia
Chukchi : N.E. Asia, U.S.S.R., North Siberia
Eskimos : Greenland, North Canada, Alaska, N. Siberia
Fulani : Western Africa
Gobi Mongols : Gobi
Guicas : Amazon forest area
Hausa : North Nigeria
Hotten tots : Hot tropical Africa
Ibans : Equatorial rain forest region of South-East Asia
India Tribes : Amazon basin
Koryaks : N. Siberia, Eurasian Tundra, N.E. Asia
Kalmuk : Central Asia
Kareus or Meos : Myanmar
Kirghiz : Asiatic Steppes
Kazakhs : Kazakhstan
Lapps : N. Finland, Scandinavia
Maoris : New Zealand
Masai : East and Central Africa
Orange Asli : Malaysia
Pygmies : Congo basin, Zaire
Red Indian : N. America
Somoyeds : Siberia
Semangs : East Sumatra
Turregs : Sahara
Tapiro : Papua New Guinea
Yoakuts : Siberia
Zulus : South Africa

ECOLOGY AND ENVIRONMENT

TOP TRENDS THAT CHANGED THE WORLD
ECOLOGY & ENVIRONMENT



INTRODUCTION

Ecology is a branch of biology that deals with the distribution and interaction of living organisms among themselves and their environment.
There are four basic concepts of ecology which are as follows:

- **Holism:** is a term which is conceived as a directive and creative principle operating from initial to last level in ecology. It means whole are much important than individual element.
- **Ecosystem**: involves both the living and non-living factors interacting together, working in a complex web.
- **Succession**: the living organisms and their environment commonly react and influence each other in different ways. Increase in the capacity of tolerance towards changing environment by modifying their adaptability as the process of growth, dispersal, reproduction, death and decay follows changing the abiotic component of ecosystem is called as succession.
- **Conservation:** Regulation of the population through naturally-operating trophism ensures resilience of the system.

Realm of Ecology

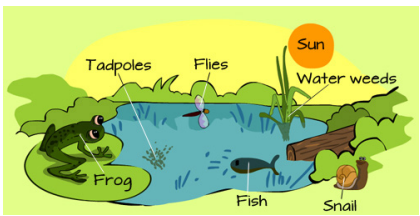
Ecology as a basic division of biology which explains patterns within and among organism. The hierarchical level of ecology is shown below.

- **Biosphere**
- **Ecosystem**
- **Communities**
- **Population**
- **Organism**

Biosphere

Biosphere is the layer of the planet Earth where life exists.
This layer ranges from heights of up to ten kilometers above the sea level.
Biosphere is an ecological system integrating all living beings and their relationship including their interaction with the elements of the lithosphere, hydrosphere and atmosphere.

Ecosystem



Pond Ecosystem

Ecosystem is defined as a specific and recognizable landscape such as forest, wetland, coastal area, grasslands, deserts, etc. having interaction of biological community and physical and chemical factors that is made up of non-living or abiotic environment.

Components of Ecosystem

- **Abiotic components** are the non-living elements of an ecosystem as air, water, climate and soil, etc. containing both organic and inorganic matters.
- **Biotic components** consist of all the living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water.

Function of Ecosystem

- Ecosystem is a functional and life sustaining environmental system.
- Consists of biotic and abiotic components in any particular habitat.
- The function of ecosystem can be referred as producer consumer arrangement of nutrients known as **energy cycles** and each food level of this pyramid is known as **trophic level.**
- The three major aspects of energy cycles are food chain, food web and ecological pyramids.

Food chain

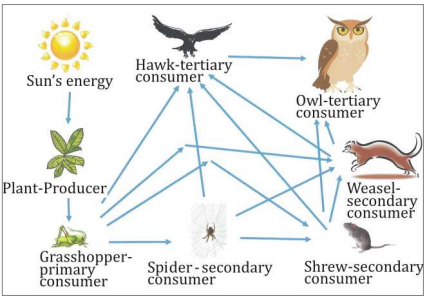
- It is a chain or series of feeding relationship among different living things in a particular environment or habitat.

Fresh water ecosystem can be categorised as Lentic (pools, ponds and lakes), Lotic (streams and river) and Wetlands.

- Plant is always the first step of food chain as it produces its own food from non living things and eventually eaten by the next higher level of living orgasm such as herbivores who only takes plant as their food item.
- Plants are known as producers and animals depending upon producers are known as primary consumer.
- The next level in this hierarchy is known as secondary consumer who depends on primary consumer for food.

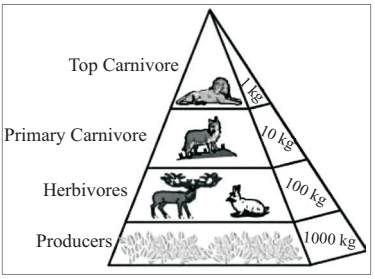
Food Web

It is defined as the system of interlocking and interdependent food chains.



Energy Pyramid

- It is a graphical presentation of the trophic levels in an ecosystem where the energy from the sun is transferred through the ecosystem by passing through various trophic levels.



Energy Flow in Ecosystem

- Ecosystem obtains energy from sun, which is trapped by producers via photosynthesis and is converted into chemical energy.
- The chemical energy is converted into mechanical and heat energy in cellular activities.
- Energy enters in the ecosystem as light and exits as heat.
- Energy flows in a one way direction through ecosystem i.e. not recycled.
- It passes from one trophic level to another.
- Only 10% energy passes to another trophic level. It is called 10% *law* or *LENDEMANN LAW*.
- In the same way carnivores store only 10% of the stored energy of herbivore.

Types of Ecosystem

Ecosystems are classified on the basis of climate, habitat and plant communities.

Types of Ecosystem

Aquatic Ecosystem	Terrestrial Ecosystem
• Fresh water	• Tropical rainforest
• Estuarine	• Temperate deciduous
• Marine	• Coniferous forest
	• Grassland
	• Desert
	• Taiga
	• Tundra

Aquatic Ecosystem

- The aquatic ecosystem has been classified in a number of ecological ways.
- On the basis of salt content in water they are further divided into fresh water, estuarine and marine ecosystem.

Terrestrial Ecosystem

It is further divided into forest, grassland, desert ecosystem and artificial ecosystems such as crop fields, gardens, etc.

Aquatic Ecosystem

On the basis of salt content in water they are further divided into:

- Fresh water
- Estuarine and
- Marine ecosystem

World Wetland Day is celebrated on 2nd February every year.

Fresh Water

- Freshwater ecosystem can be categorised into three types i.e. lotic, lentic & wetlands.

Lotic and Lentic

Lotic ecosystem refers to the dynamic (moving) water habitat eg. river, brook etc. Lentic ecosystem refers to the static water habitats like ponds, lake, swamps and marshes.

Wetlands

- Wetlands are lands which, due to geological or ecological factors, have a natural supply of water – either from tidal flows, flooding rivers, connections with groundwater, or because they are perched above aquifers.
- The periodicity of water level fluctuations is termed as hydroperiod and it is the key factor that determines the productivity and species composition of the wetland community.
- Generally low lying areas, covered by shallow water, have characteristic soils and water tolerant vegetation.
- Wetlands occupy only 6% of the surface area of earth and they are estimated to contain 20-25% of carbon in soils.
- Man-made wetlands: paddy fields, fishery ponds, Trapa & Euryale cultivation ponds and other aquaculture habitats.

Significance of Wetlands

- Nutrient rich and have high primary productivity.
- Since they have both aquatic and semi-aquatic environmental conditions so support specialized vegetation and fauna. Often a prime breeding habitat for waterfowl, many migratory birds and other aquatic or semi aquatic vertebrates.

- Helps in controlling flood by holding excess water, and the flood water stored in wetlands then drains slowly back ino the rivers, providing a steady flow of water throughout the year.
- Serve as groundwater recharging areas.
- Provide important commercial products, including wild rice and various types of berries (such as black berries, blue berries, etc.).
- Hold sediments and accumulate soil along the shoreline.
- National Wetland Conservation Programme (NWCP) has been initiated for identified wetland which are at present 66 covering 21 states.

Estuaries

- An estuary is a semi-enclosed coastal body of water, which has a free connection with the open sea.
- Nutrients from the river enrich estuarine waters, making estuaries one of the most biologically productive ecosystem on earth and thus have more biodiversity in unit area.
- It is strongly affected by tidal action which is an important physical regulator and an energy subsidy.
- They are transitional zones/ecotones between the freshwater and marine habitats.
- Examples include river mouths, coastal bay, tidal marshes and bodies of water behind barrier beaches and extensive intertidal mudflats or salt marshes often border them.
- Estuary provides the "nursery grounds" for most coastal shellfish and other fishes. e. g. shrimp and spawn.

Marine Ecosystem

It is Earth's largest aquatic ecosystem, which includes salt marshes, intertidal zones, lagoons, mangroves, coral reefs and sea floor.

Mangroves

- Found in tropical and sub tropical land-sea ecotones.

The Gulf of kachchh & the Gulf of khambhat constitute the major mangrove zones of the Gujarat Coast.

- They are potential "land builders" that help to form islands and to extend seashores.
- On the basis of salinity, five zones of mangrove distribution are considered, namely euhaline, polyhaline, mesohaline, oligohaline and limnetic zones.
- Indian coastline covers about 7500km and it accounts for 8% of the world's mangrove area which is approximately 700,000 ha.

Significance of Mangroves

- Mangroves perform a variety of productive as well as protective functions. The resilient mangroves protect the hinterland against cyclonic storms during cyclones, super cyclones, and ingress of sea water during tidal surges and other natural catastrophes acting as an effective shelterbelt.

- They are considered as "land builders". It is belived that the roots of mangroves secrete a substance, which modifies the coarse particles into fine ones and help in soil formation. The tangles of stilt roots also trap the sediments.
- Support a range of interconnected food webs, which directly sustain the fisheries. Algae and detritus sustain shrimps and prawns, which provide a food source for fishes and prawns.
- They are repositories of immense biological diversity.
- The mangrove conservation programme was launched in 1987 and so far 35 mangrove areas have been identified for intensive convervation and management in our county.
- A mangrove genetic resource center is established in the Pichavaram mangrove area, Chidambaram, India where the endangered mangrove species are being conserved.

Coral Reefs

- Corals are marine invertebrates which grow in tropical oceans and secrete calcium carbonate.
- Located generally between 30 degrees North and 30 degrees South of the equator.
- Found scattered in coastal zones above contineantal shelves throughout the tropical and subtropical western Atlantic and Indo-pacific oceans.
- The polyp is able to feed itself using stinging cells found on its tentacles, but is able to feed itself partially. The ramainder comes from the zooxanthellae and the carbohydrates are also used by the polyp to make calcium carbonate via calcification. This material forms the skeleton of the coral and eventually the framework known as the coral reef.
- Polyps secrete hard limestone deposits (calcium carbonate that ramain when polyps die.
- Coral reefs are sometimes referred to as 'tropical rainforests of the deep'.
- Bleaching: Under environmental stress much of the algae are lost and corals appear white in colour. If the symbiotic green algae leave the coral animal and the mutumlism is not restored then the coral slowly dies of starvation.

Importance of Coral Reefs

- Apart from tropical rain forests, they are the other most productive natural ecosystems in the world.

- They protect coastline from storms & high waves by breaking the force of the waves, thereby allowing mangroves and sea grass to flourish.

Major reef formations in India are restricted to the Gulf of Mannar, Palk strait, Gulf of Kutch, Andaman and Nicobar Island and the Lakshadweep Islands.

- They serve as nurseries for many fish species and provide resources for fisheries.
- Coral skeletons are being used as bone substitutes in reconstructive bone surgery. The pores and channel in certain corals resemble those found in human bone. Bone tissue and blood vessels gradually spread into the coral graft. Eventually, bone replaces most of the coral implant.

Terrestrial Ecosystem

Biomes

Biome can be defined as major ecological communities of flora and fauna, which generally extend over a large part of the earth surface and usually characterized by a distinct type of vegetation.

The main terrestrial biomes are:

1. Tundra
2. Coniferous forests/Temperate evergreen forests
3. Temperate Broadlead deciduous forests
4. Mediterranean Shrublands
5. Grasslands
6. Deserts
7. Tropical deciduous forests
8. Tropical scrubs/Thornwoods
9. Tropical rain forests

- F.E Clements and V.E shelford (1939) introduced the biome concept.
- Ecotone: boundary between two biomes.
- Bailey (1976) developed the concept of ecoregion.
- Ecoregions: Ecosystems based on a continuous geographical or landscape area across which the interactions of climate, soil and topography are sufficiently uniform to permit the development of similar types of vegetation.

Community

A group of population of different species living together in a given area with mutual tolerance and beneficiary interactions is defined as **community**. The species may be plant, animal or microorganism.

Characteristics

- Biodiversity
  1. Species richness
  2. Relative abundance
- Dominant vegetation
- Stability/disturbance
- Succession

Population

A population is a summation of all the organisms of the same group or species, which live in a particular geographical area, and have the capability of interbreeding.

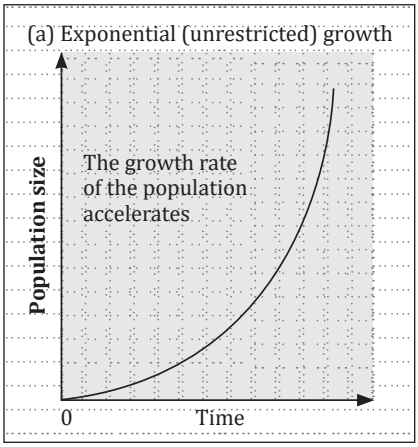
Population Dynamics

It is the change in the number of individuals in a population or the vital rates of a population over time. It is the key to

- Examine the response of species to ecosystem manipulation,
- Analyze the endangered species
- Understand ecosystem dynamics and ecology

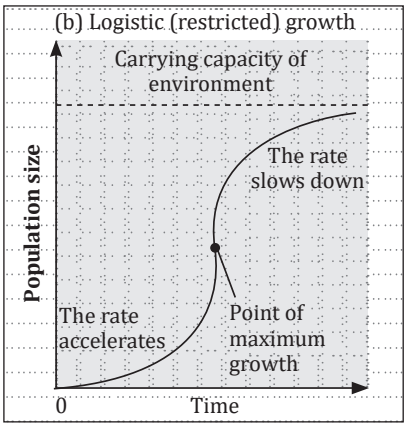
Theories of Population Dynamics

- **Exponential population growth** is when the birth rate is constant over a period of time and isn't limited by food or disease.
- A species growing exponentially would also affect other species directly due to competition for food and other resources.
- Exponential growth can be affected by modern medicine, quality and quantity of food and the overall standard of living for a species.



The term Biodiversity was given by Walter Rosen

- **Logistic growth** describes a sustainable growth of populations which slows down after a period of significant development as the availability of living space and resources, along with other factors, limits its growing ability.
- The logistics growth model is a more reliable measure of population growth than the exponential model because it accounts for the real-world factors that inhibit population growth.



Organism

An organism, is any form of contiguous living system such as an animal, plant or bacterium with cell as its basic units.

- All organism have developed with some degree of response to stimuli, reproduction, growth and development and homeostasis.
- As the basic unit of every organism is cell it can be categorized into both uni cellular and multi cellular depending upon the no. of cells present in the organism.

Biodiversity

Biodiversity means diversity or heterogeneity at all levels of biological organization, i.e. from macromolecules of the cells to the biomass.

The important levels of biodiversity are

1. Genetic diversity, 2. Species diversity,
3. Ecological diversity

1. Genetic Diversity

- It is the diversity at genetic level, or at subspecies level, i.e. below species level, in a single species.
- The genetic diversity helps the population to adapt changing environment. If a population has more diversity it can adapt better to the changed environmental conditions.
- The low diversity leads to uniformity. The genetic variability is therefore, considered to be the raw material for specialisation.

2. Species Diversity

- The measurement of species diversity is its richness, i.e. the number of species per unit area.
- The greater is the species richness the more will be the species diversity.
- In nature, the number and kind of species, as well as the number of individual per species, vary, and this leads to greater diversity.

3. Ecological Diversity

It is the diversity at community level. It can be of 3-types:

Alpha (α) diversity: It is the diversity of organisms within the same community or habitat.

Beta (β) diversity: It is the diversity between communities or different habitats. Higher the heterogeneity in the altitude, Humidity and Temperature of a region, the greater will be the dissimilarity between communities, and higher will be the β diversity.

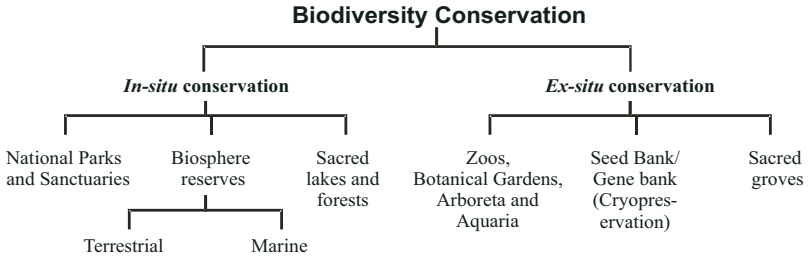
Gamma (γ) diversity: It is the diversity of organisms over the entire geographical area, covering several ecosystems or habitats and various trophic levels and food webs. Such diversity is most stable and productive.

Causes of Loss of Biodiversity

The accelerated rate of species-extinction is largely due to human activities. There are 4-major causes, called **'The Evil Quartet',** for the loss of biodiversity –

1. Habitat loss and fragmentation
2. Overexploitation
3. Invasion of Alien or exotic species
4. Co-extinctions

The first national park of the world, Yellow Stone, in U.S.A., was founded in 1872 and India's first national park was established in 1936 as Jim Corbett National Park.



The **Conservation of biodiversity** can be *in situ* (on site) or *ex situ* (off site)–

In Situ Conservation

- In such conservation the endangered species are protected in their natural habitat with entire ecosystem.
- The conservationists, on global basis, have identified certain Biodiversity Hot Spots.
- The 4-**biodiversity hot spots of India,** that cover rich-biodiversity regions, are

1. Western Ghat
2. Himalaya
3. Indo-Burma
4. Sundaland

India, has **18–Biosphere reserves, 103-National Parks,** more than **543 sanctuaries** and several **Sacred Groves** or the tracts of forests.

Biosphere Reserves

They represent natural biomes which contain unique biological communities. They include land as well as coastal environment.

(i) Core (natural) zone – It is inner most zone

(ii) Buffer zone – In this zone limited human activity is allowed for research and education purposes.

(iii) Transition (manipulation) zone – It is the outermost zone of biosphere reserve in which large number of human activities are permitted,

Red Data Book

- The Red Data Book is a type of a public document, which is created for the recordings of rare and endangered species including animals, plants and fungi as well as some local subspecies, which are present within the region of the state or country.
- The red data book helps us in providing complete information for research, studies and also for monitoring the programs on rare and endangered species and their habits.
- This book is created to protect those species, which are in danger of being extinct, lost, harmed or not able to continue their life cycle.
- These species can either be animals or birds or plants.

National Parks

- They are reserved for the betterment of wild life, both **fauna and flora.**
- In national parks private ownership is not allowed. The grazing, cultivation, forestry etc. is also not permitted.

Sanctuaries

- In sanctuaries the protection is given to **fauna** only**.**
- The activity like harvesting of timber, collection of forest products and private ownership rights are permitted so long as they do not interfere with the well being of the animals.
- The important wildlife sanctuaries are Chilka wildlife sanctuary (Odisha), Bharatpur Bird Sanctuary (Rajasthan),

The Sacred Groves

These are found in Khasi and Jaintia Hills (Meghalaya), Aravalli Hills (Rajasthan), Western Ghats (Karnataka and Maharashtra) and Surguja, Chanda and Bastar areas of Madhya Pradesh.

Cryopreservation is the process of freezing biological material at extreme temperature, most common –196°C in liquid (N_2).

Ex situ Conservation

In such type of conservation the threatened animals and plants are taken out of their natural habitat and are protected in special parks or areas like, zoological parks, wild life safari parks and botanical gardens, etc. The *ex situ* conservation also includes Cryopreservation.

ENDANGERED SPECIES IN INDIA	
Birds	White-bellied heron Great Indian bustard (*Ardeotis nigriceps*) Forest owlet (*Athene blewitti*) Baer's pochard (*Aythya baeri*) Spoon-billed sandpiper (*Eurynorhynchus pygmeus*) Siberian crane (*Grus leucogeranus*) White-rumped vulture (*Gyps bengalensis*) Indian vulture (*Gyps indicus*) Slender-billed vulture (*Gyps tenuirostris*)
	Bengal florican (*Houbaropsis bengalensis*) Himalayan quail (*Ophrysia superciliosa*) Jerdon's courser (*Rhinoptilus bitorquatus*) Pink-headed duck (*Rhodonessa caryophyllacea*) Red-headed vulture (*Sarcogyps calvus*) Sociable lapwing (*Vanellus gregarius*) Bugun liocichla (*Liocichla bugunorum*)
Fish	Knifetooth sawfish (*Anoxypristis cuspidata*) Pondicherry shark (*Carcharhinus hemiodon*) Ganges shark (*Glyphis gangeticus*) Deccan labeo (*Labeo potail*) Largetooth sawfish (*Pristis microdon*) Longcomb sawfish (*Pristis zijsron*) Humpback mahseer
Reptiles and Amphibians	Northern river terrapin (*Batagur baska*) Red-crowned roofed turtle (*Batagur kachuga*) Hawksbill sea turtle (*Eretmochelys imbricata*) Gharial (*Gavialis gangeticus*) Ghats wart frog (*Fejervarya murthii*) Gundia Indian frog (*Indirana gundia*) Toad-skinned frog (*Indirana phrynoderma*) Charles Darwin's frog (*Ingerana charlesdarwini*) Rao's torrent frog (*Micrixalus kottigeharensis*) Amboli bush frog (*Pseudophilautus amboli*) White-spotted bush frog (*Raorchestes chalazodes*) Griet bush frog (*Raorchestes griet*) Munnar bush frog (*Raorchestes munnarensis*) Ponmudi bush frog (*Raorchestes ponmudi*) Sacred Grove bush frog (*Raorchestes sanctisilvaticus*) Shillong bubble-nest frog (*Raorchestes shillongensis*) Resplendent shrubfrog (*Raorchestes resplendens*) Anaimalai flying frog (*Rhacophorus pseudomalabaricus*) Patinghe Indian gecko (*Geckoella jeyporensis*)

Biodiversified hotspots are geographic area that contain high levels of species diversity but are threatened with extinction.

Mammals	Asiatic cheetah (*Acinonyx jubatus venaticus*) Namdapha flying squirrel (*Biswamoyopterus biswasi*) Himalayan wolf (*Canis himalayensis*) Andaman Shrew (*Crocidura andamanensis*) Jenkins' shrew (*Crocidura jenkinsi*) Nicobar shrew (*Crocidura nicobarica*) Northern Sumatran rhinoceros (*Dicerorhinus sumatrensis lasiotis*) Kondana soft-furred rat (*Millardia kondana*) Pygmy hog (*Porcula salvania*) Indian Javan rhinoceros (*Rhinoceros sondaicus inermis*) Malabar large-spotted civet (*Viverra civettina*) Elvira rat (*Cremnomys elvira*) Chinese pangolin (*Manis pentadactyla*) Kashmir stag (*Cervus canadensis hanglu*)
Coral	Fire corals (*Millepora boschmai*) Spiders Rameshwaram Ornamental or Parachute Spider (*Poecilotheria hanumavilasumica*) Gooty Tarantula, Metallic Tarantula or (*Poecilotheria metallica*)

NATIONAL PARKS IN INDIA

Name	State	Notability
Bandipur National Park (1974)	Karnataka	Chital, grey langurs, Indian giant squirrel, gaur, leopard, sambar deer, Indian elephants, honey buzzard, red-headed vulture and other animals.
Bannerghatta National Park (Bannerghatta Biological Park) (1974)	Karnataka	White Tiger, Royal Bengal Tiger, Bear, other animals
Betla National Park (1986)	Jharkhand	Tiger, Sloth Bear, Peacock, Elephant, Sambar deer, mouse deer and other animals.
Bhitarkanika National Park (1988)	Odisha	Mangroves, Saltwater crocodile, white crocodile, Indian python, black ibis, wild pigs, rhesus monkeys, chital and other animals
Buxa Tiger Reserve (1992)	West Bengal	Tiger
Dachigam National Park (1981)	J&K	Only area where Kashmir stag is found
Dudhwa National Park (1977)	U.P	Swamp deer, sambar deer, barking deer, spotted deer, hog deer, tiger, Indian rhinoceros,
Gir Forest National Park (1965)	Gujarat	Asiatic lion
Great Himalayan National Park (1984)	Himachal Pradesh	UNESCO World Heritage Site
Gulf of Mannar Marine National Park (1980)	Tamil Nadu	Green turtles and Olive Ridley turtles and whales.
Indravati National Park (1981)	Chhattisgarh	Wild Asian Buffalo, Tiger Reserve, Hill Mynas

Dobson unit is measurement for the total amount of ozone in the atmosphere above a point on the earth's surface. 1 Dobson unit is equivalent to a layer of pure ozone 0.01 mm.

Jaldapara National Park (2012)	West Bengal	Indian one horned rhinoceros
Jim Corbett National Park (1936)	Uttarakhand	Tiger
Kanha National Park (1955)	Madhya Pradesh	Swamp Deer, Tigers
Kaziranga National Park (1905)	Assam	Indian rhinoceros, UNESCO World Heritage Site
Keibul Lamjao National Park (1977)	Manipur	Only floating park in the world
Keoladeo National Park (1981)	Rajasthan	UNESCO World Heritage Site
Manas National Park (1990)	Assam	UNESCO World Heritage Site
Mandla Plant Fossils National Park (1983)	Madhya Pradesh	Plant Fossils National Park
Marine National Park, Gulf of Kutch (1980)	Gujarat	70 species of sponges, Coral 52 species along with puffer fishes, sea horse and sting ray
Namdapha National Park (1974)	Arunachal Pradesh	Snow Leopards, Clouded Leopards, Common Leopards and Tigers
Nanda Devi National Park (1982)	Uttarakhand	UNESCO World Heritage Site
Neora Valley National Park (1986)	West Bengal	Clouded leopard, red panda and musk deer
Nokrek National Park (1986)	Meghalaya	UNESCO World Biosphere Reserve
Periyar National Park (1982)	Kerala	Tigers
Ranthambore National Park (1981)	Rajasthan	Tigers, Leopards, Striped Hyenas, Sambar deer and Chital
Sariska Tiger Reserve (1955)	Rajasthan	Tiger
Simlipal National Park (1980)	Odisha	Tiger, Leopard, Asian elephant, Sambar, Barking deer, Gaur, Jungle cat, Wild boar, and other animals
Sultanpur National Park (1989)	Haryana	Siberian crane, greater flamingo, ruff, black-winged stilt, common teal, northern pintail, and yellow wagtail
Sundarbans National Park (1984)	West Bengal	UNESCO World Heritage Site
Valley of Flowers National Park (1982)	Uttarakhand	Flying squirrel, Himalayan black bear, red fox, Himalayan weasel, Himalayan yellow-throated marten, and Himalayan goral

Biosphere Reserves has three zones – core, buffer and transition.

WILDLIFE SANCTUARIES

India has 543 animal sanctuaries referred to as wildlife sanctuaries category IV protected areas. Among these, the 48 tiger reserves are governed by Project Tiger, and are of special significance in the conservation of the tiger.

WILDLIFE SANCTUARIES IN INDIA

Name of the Sanctuary	Location	Major Species
Gir Wildlife Sanctuary	Sasan Gir, Junagadh, Amreli	Lion, Leopard, Chausinga, Chital, Hyena, Sambar, Chinkara, Herpetofauna, Crocodiles and birds
Wild Ass Sanctuary	Little Rann of Kutch	Wild Ass, Chinkara, Blue bull, Houbara bustard, Wolf, Waterfowls, Herpetofauna
Hingolgadh Sanctuary	Hingolgadh, Rajkot	Chinkara, Blue bull, Wolf, Hyena, Fox, Birds, Herpetofauna
Marine Sanctuary	Gulf of Kutch, Jamnagar	Sponges, Corals, Jellyfish, Sea horse, Octopus,Oyster, Pearloyster, Starfish, Lobster, Dolphin, Dugong, waterfowls
Simlipal Sanctuary	Odisha	Elephant, Tiger, Leopard, Gaur, Cheetal
Kutch Desert Sanctuary	Great Rann of Kutch	Chinkara, Hyena, Fox, Flamingo, Pelicans & other waterfowls, Herpetofauna
Rampara Sanctuary	Rampara, Rajkot	Blue bull, Chinkara, Wolf, Fox, Jackal, Birds, Herpetofauna
Ghana Bird Sanctuary	Rajasthan	Water Bird, Black-buck, Cheetal, Sambar
Pachmarhi	Madhya Pradesh	Tiger, Panther, Sambhar, Nilgai, Baskeng, Deer
Dandeli Sanctuary	Karnataka	Tiger, Panther, Elephant, Cheetal, Sanbhar, Wild Boar
Kutch Bustard Sanctuary	Near Naliya, Kachchh	Great Indian Bustard, Lesser Florican, Houbara bustard, Chinkara, Blue bull, Herpetofauna
Manas Wildlife Sanctuary	Srinagar	Tigers, buffaloes, elephants, sambhars, swamp deer, langurs
Periyar Wildlife Sanctuary	Kerala	Wild dogs, Niligiri langurs, otters, tortoise, hornbills
Calimere Wildlife Sanctuary	Kodiyakadu, Tamil Nadu	Flamingos, black bugs, spotted dear, wild pigs
Anamalai Wildlife Sanctuary	Pollachi, Tamil Nadu	Elephants, gaurs, tigers, panthers, deer, boars, wild cats

Material that get into the stratosphere can stay there for long time, such the case for the ozone-destroying chemicals called CFCs (Chlorofluorocarbon).

BIOSPHERE RESERVES IN INDIA

Name	State	Key Fauna
Nilgiri Biosphere Reserve	Tamil Nadu, Kerala and Karnataka	Nilgiri tahr, lion-tailed macaque
Nanda Devi National Park & Biosphere Reserve	Uttarakhand	Himalayan musk deer, mainland serow, Himalayan tahr
Gulf of Mannar	Tamil Nadu	Dugong or sea cow
Nokrek	Meghalaya	Red panda
Sundarbans	West Bengal	Royal Bengal tiger
Manas	Assam	Golden langur, red panda
Simlipal	Odisha	Gaur, Royal Bengal tiger, elephant
Dihang-Dibang	Arunachal Pradesh	Mishmi takin, red goral, musk deer
Pachmarhi Biosphere Reserve	Madhya Pradesh	Giant squirrel, flying squirrel
Achanakmar-Amarkantak Biosphere Reserve	Madhya Pradesh, Chhattisgarh	Four horned antelope (Tetracerus quadricornis), Indian wild dog (Cuon alpinus), Saras crane (Grus antigone), Asian white-backed vulture (Gyps bengalensis), Sacred grove bush frog (Philautus sanctisilvaticus)
Great Rann of Kutch	Gujarat	Indian wild ass
Cold Desert	Himachal Pradesh	Snow leopard
Khangchendzonga	Sikkim	Snow leopard, red panda
Agasthyamalai Biosphere Reserve	Kerala, Tamil Nadu	Nilgiri tahr, elephants
Great Nicobar Biosphere Reserve	Andaman and Nicobar Islands	Saltwater crocodile
Dibru-Saikhowa	Assam	Golden langur
Seshachalam Hills	Andhra Pradesh	Yellow-throated bulbul
Panna	Madhya Pradesh	Tiger, chital, chinkara, sambhar and sloth bear

ENVIRONMENTAL ISSUES

Deforestation

- It is the conversion of forest to another land use or the long-term reduction of the tree canopy cover.
- This includes conversion of natural forest to tree plantations, agriculture, pasture, water reservoirs and urban areas but excludes timber production areas managed to ensure the forest regenerates after logging.

Delhi government ran odd even plan in two phases — 1st to 15th January 2016 and 2nd phase from 15th to 30th April 2016 to combat pollution in Delhi.

Causes	Impact
Subsistence farming (48%) Commercial agriculture (32%) Logging (14%) Fuel wood removals (5%)	• Physical and ecological processes, (e.g. disruption of hydrological regimes and loss of watershed protection). • Soil and water resources, (e.g. soil erosion, loss of nutrients and increase in sediment loads in river systems)on local and global climate, e.g. albedo changes, changes in surface energy budget, and alteration of biogeochemical cycles (such as the global carbon cycle) leading to an increase in atmospheric CO_2 and other trace gases, affecting the climate and causing global temperature change, Diversity and abundance of terrestrial species through destruction and fragmentation of habitats and the "edge effects", decreasing ecological complexity.

Desertification

- The U.N. Convention to Combat Desertification (UNCCD) defines it as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities."
- This process is the result of a long-term failure to balance human demand for ecosystem services and the amount the ecosystem can supply.
- The stress mounts on dry land ecosystems for providing services related to basic human existence.
- The situation worsens when combined with human factors (such as population pressure and land use patterns) and climatic factors (such as droughts).

Causes	Effects	Measures
Overgrazing	Soil becomes less usable	Afforestation and planting of soil binding grasses can check soil erosion, floods and water logging
Farming of Average Land	Vegetation is lacking or damaged	Crop rotation and mixed cropping improve the fertility.
Destruction of Plants in Dry Regions	Causes Famine	Artificial bunds or covering the area with vegetation.
Incorrect Irrigation in Arid Regions Causes a Build-up of Salt in the Soil	Food Loss	Salinity of the soil can be checked by improved drainage

Ozone Layer Depletion: Causes and Effects

Chlorofluorocarbons or associated hydrocarbons start dissociating in presence of UV rays which release chlorine, which is catalyst of destroying ozone.

Ozone Layer Depletion:

A process wherein oxygen molecules are photolyed splitting into two atoms, weakening the ozone as solar UV enters accentuating conversion

Effects on Human Health: Causes nonmelanoma skin cancer, malignant melanoma development and clouding of eyes

Effects on Biogeochemical Cycles: Increased UV radiation affects terrestrial and aquatic biogeochemical cycles

Effects on Marine Ecosystem: Phytoplankton lead aquatic food webs which are effected by amount of sunlight received

Effects on Materials: Synthetic polymers and naturally occurring biopolymers are affected by UV rays

Effects on Plants: amount of UVB in present-day sunlight affecting the plant growth directly

According to UNICEF, more than 3000 children die everyday globally due to consumption of contaminated drinking water.

ENVIRONMENTAL POLLUTION

Pollution Types and Measures for their Control

Pollution: The process which contaminates natural environment resulting in adverse change.

Air Pollution: Photochemical smog, Acid rain

Primary Pollutants enter the atmosphere directly from various sources (CO, HCs, SO_2, NO)

Secondary Pollutant formed during chemical reaction between primary pollutant and other atmospheric constitution (water vapour) eg–Ozone

Anthropogenic Sources: Combustion from power plant, vehicles, household fuel etc.

Pollution control devices:
- Vapour recovery systems
- Phytoremediation
- Sewage /industrial waste treatment
- Scrubber (Baffle spray, Cyclonic spray, Ejector venture, mechanically aided Spray tower)
- Bag houses

Littering: It is caused by man-made objects, piling onto public and private properties.

Radioactive contamination: It is caused by nuclear power generation and nuclear weapons research, manufacture and deployment.

Visual pollution: It is caused by overhead power line, motorway billboard, municipal solid waste, debris.

Plastic pollution: It is caused by plastic products in the environment, adversely affects wildlife, wildlife habitat, or humans.

Light pollution: It is caused by light trespass, over- illumination and astronomical interference

How to Control?
- recycling
- reusing
- Waste minimization
- mitigating
- preventing
- compost

Noise pollution: It is created by vehicles, aircraft, sonar, underground leakage etc.

Thermal pollution: It is caused by temperature change in natural water bodies (using water as a coolant).

Water Pollution: It is caused by waste disposal in the water bodies (sewage, commercial by-products, surface runoff).

Soil Pollution: It is caused by Chemical spill or underground leakage (hydrocarbons, heavy metals, MTBE, pesticides).

The pollutants may be inorganic, biological or radiological in nature.

(i) **Bio-degradable pollutants** are domestic wastes which are rapidly decomposed by micro-organisms. Eg – paper, wood, garbage

(ii) **Non-biodegradable pollutants** include chemicals, mercuric salts, lead compounds, pesticides, etc.

(iii) **Natural pollution** is caused by radioactive substances, volcanic eruptions, forests and mines fires, floods, etc.

Pollen and aeroallergan in high levels also leads to rising temperature. This causes asthma which affects 300 millions people worldwide.

(iv) **Artificial pollution** is caused by industries, thermal plants, automobile, exhausts, sewage, etc.

Environment: The conditions existing around animal or human life.

Atmosphere : The gaseous envelop surrounding the earth. It has been classified into following regions:-

(i) Stratosphere: The layer of the earth's atmosphere above the troposphere and below the mesosphere.

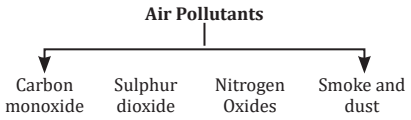
(ii) Troposphere: The lowest region of the atmosphere extending from earth's surface to the lower boundary of the stratosphere. In this region, human beings along with other organisms live. It contains water vapour and is greatly affected by air pollution.

Note: The other two layers are **Thermosphere** and **Mesosphere**.

Material that get into the stratosphere can stay there for long time, such is the case for the ozone - destroying chemicals called CFCs (chlorofluorocarbons).

Air Pollution

- The WHO defines air pollution as, "the presence of materials in the air in such a concentration which are harmful to man and his environment."
- Infact, pollution is the addition of foreign particles, gas and other pollutants into the atmosphere which have an adverse effect on human beings, animals, vegetation, buildings, etc.



***Air pollutants*:** The major air pollutants are

(i) **Carbon monoxide (CO):** It is produced by incomplete combustion of gasoline in motor vehicles, wood, coal, incineration and forest fires.

- It is deadly poisonous gas. It induces headache, visual difficulty, coma and death. It blocks the normal transport of oxygen from the lungs to other parts of the body.

(ii) **Sulphur dioxide (SO_2):** It is produced by petrol combustion, coal combustion, petrol refining and smelting operations.

- It hinders the movement of air in and out of lungs.
- It is particularly poisonous to trees causing chlorosis and dwarfing. In presence of air it is oxidised which is also irritant.
  $2SO_2 + O_2$ (air) $\rightarrow 2SO_3$
- In presence of moisture it is converted into highly corrosive sulphuric acid.
  $SO_3 + H_2O$ (moisture) $\rightarrow H_2SO_4$
- It attacks marble, limestone, vegetation, paper and textiles and are injurious to human beings.

(iii) **Oxides of nitrogen:** Source - combustion of coal, gasoline, natural gas, petroleum refining, chemical plants, manufacturing explosives and fertilizers, tobacco smoke.

- Breathing of NO_2 causes chlorosis in plants and chronic lung conditions in humans leading to death. It reacts with moisture to form acids.

(iv) **Smoke, dust:**

Sources: cement works, iron and steel works, gas works, power generating stations.

Smog: It is a mixture of smoke and fog in suspended droplet form. It is of two types:

(a) **London smog or classical smog:** It is coal smoke plus fog.
- The fog part is mainly SO_2 and SO_3.
- It has sulphuric acid aerosol.
- It causes bronchial irritation and acid rain.

(b) **Photochemical smog or Los Angeles smog:** The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog.
- Hydrocarbons + O_2, NO_2, NO, O, $O_3 \rightarrow$ Peroxides, formaldehyde, peroxyacetylnitrate (PAN), acrolein etc.
- It is oxidising in nature and causes irritation to eyes, lungs, nose, asthmatic attack and damage plants.

To address climate change, countries adopted the Paris Agreement at the COP 21 in Paris on 12 December 2015. In this agreement, all countries agreed to work to limit global temperature rise to well below 2 degree celsius, and given the grave risk, to strive for 1.5 degrees celsius.

Acid rain: The oxides of C, N and S present in the atmosphere, dissolve in water and produce acids and lower the pH of water below 5.5.

- The acids are toxic to vegetation, react with marble and damage buildings.
- Acids corrode water pipes and produce salts with heavy metals ions viz Cu, Pb, Hg and Al.

Air Pollution is a major factor for the world's leading causes of death					
		Global burden of disease		Burden attributable to motorized road transport	
Rank	**Cause**	**Deaths**	**DALYs**	**Deaths**	**DALYs**
1	Ischemic heart disease	7,029,270	129,795,464	90,639	1,909,563
2	Stroke	5,874,181	102,238,999	58,827	1,148,699
3	COPD	2,899,941	76,778,819	17,266	346,376
4	Lower respiratory infections	2,814,379	115,227,062	5,670	489,540
5	Lung cancer	1,527,102	32,405,411	11,395	232,646
6	HIV/AIDS	1,465,369	81,549,177	--	--
7	Diarrheal disease	1,445,798	89,523,909	--	--
8	Road injury	1,328,536	75,487,102	1,328,536	75,487,104
9	Diabetes Mellitus	1,281,345	46,857,136	--	--
10	Tuberculosis	1,195,990,	49,399,351	--	--
	All other causes	24,207,527	1,682,995,639	--	--
	Total	52,769,676	2,482,258,070	1,512,333	79,613,928

Air pollution can also pose a significant cost on GDP			
	CO_2 emissions (million tons)	Deaths	%GDP
China	8287	1,233,890	9.7%-13.2%
United States	5433	103,027	3.2%-4.6%
India	**2009**	**627,426**	**5.5%-7.5%**
Russia	1741	94,558	6.9%-9.8%
Japan	1171	64,196	4.9%-7.7%
Germany	745	41,582	5.1%-7.3%
Iran	572	32,288	4.7%-6.2%
South Korea	568	23,036	4.6%-7.1%
Canada	499	7,171	2.0%-3.2%
United Kingdom	494	23,373	3.7%-5.5%
Saudi Arabia	464	8,550	3.4%-4.4%
South Africa	460	3,208	0.6%-1.0%
Mexico	444	20,496	1.9%-2.5%
Indonesia	434	63,826	2.8%-3.9%
Brazil	420	7,582	0.3%-0.7%

The Red list of 2012 was released on 19 July 2012 at Rio +20 Earth Summit, nearly 2000 species were added, with 4 species to the extinct list, 2 to the rediscovered list.

TOP 10 POLLUTED CITIES OF INDIA

S. No.	City	State	Source of pollution
1	Delhi	Delhi	Automobile, industry
2	Patna	Bihar	Domestic waste, automobile
3	Gwalior	Madhya Pradesh	Automobile, burning of waste
4	Raipur	Chattisgarh	Power plant and industry
5	Ahmedabad	Gujarat	Textile industry
6	Firozabad	Uttar Pradesh	Glass industry
7	Amritsar	Punjab	Automobile
8	Kanpur	Uttar Pradesh	Leather industry
9	Agra	Uttar Pradesh	Mining, dry sand
10	Ludhiana	Punjab	Urbanisation, industry

TOP 10 POLLUTED CITIES OF WORLD

S. No.	City	State	Source of pollution
1	Zabol	Iran	Dust storms; drying of wetland, rivers, lakes
2	Gwalior	India	Automobile, burning of waste
3	Allahabad	India	Automobile, power plants, deforestation
4	Riyadh	Saudi Arabia	Automobile, petrochemical industry
5	Al Jubail	Saudi Arabia	Petrochemical industry
6	Patna	India	Domestic waste, automobile
7	Raipur	India	Power plant and industry
8	Bamenda	Cameroon	Deforestation
9	Xingtai	China	Coal mining, industry
10	Baoding	China	Automobile, industry

Greenhouse Effect

- The retention of heat by the earth and atmosphere from the sun and its prevention to escape into the outer space is known as greenhouse effect.
- Global warming is average increase in the temperature of earth due to increase in concentration of greenhouse gases.

Consequences of global warming:

(i) Rise in sea level due to increased rate of melting of glaciers and floods.

(ii) Increase in infectious diseases like malaria, dengue, etc.

Control of air pollution

It can be controlled by

1. Dissolving HCl, HF in water and, in alkaline solution.
2. Adsorbing gas and liquid molecules over activated charcoal and silica gel.
3. Chemical reactions.
4. Use of precipitators to settle charge particles.

Greenhouse gas emission in the atmosphere absorbs and emits radiation within the thermal infrared range. The primary green house gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

India's Western Ghats and Eastern Himalayas are amongst the 32 biodiversity hotspots on Earth.

5. Use of settling chambers under the action of gravity.
6. Use of natural gas in place of diesel, petrol, etc.

Water Pollution

- The contamination of water by foreign substances which would cause a health hazard and make it harmful for all purposes (domestic, industrial or agriculture, etc.) is known as water pollution.
- The polluted water may have bad odour, bad taste, unpleasant colour, murky oily, etc.

Sources of water pollution

(a) **Domestic sewage:** Discharges from kitchens, baths, lavatories, etc.
(b) **Industrial waters:** Wastes from manufacturing processes which includes acids, alkalines, pesticides, insecticides, metals like copper, zinc, lead, mercury, fungicides, etc.
(c) **Oil:** From oil spills or washings of automobiles.
(d) **Atomic explosion** and processing of radioactive materials.
(e) **Suspended particles** (organic or inorganic) viruses, bacterias, algae, protozoa, etc.
(f) Wastes from fertilizer plants such as phosphates, nitrates, ammonia, etc.
(g) **Clay:** Ores, minerals, fine particles of soil.

Aerobic and anaerobic oxidation

The oxidation of organic compounds present in sewage in presence of good amount of dissolved or free oxygen (approx. 8.5 ml/*l*) by aerobic bacteria is called *aerobic oxidation.*

- When dissolved or free oxygen is below a certain value the sewage is called *stale.*
- Anaerobic bacteria bring out putrefaction producing H_2S, NH_3, CH_4, $(NH_4)_2S$, etc. This type of oxidation is called *anaerobic* oxidation.

Biological Oxygen Demand (BOD)

- It is defined as the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days.
- Its unit is mg/*l* or ppm. An average sewage has BOD of 100 to 150 mg/*l*.

Chemical Oxygen Demand (COD)

- It is a measure of all types of oxidisable impurities present in the sewage.
- COD values are higher than BOD values.

Soil Pollution

The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil or land pollution.

Sources of soil pollution

(i) **Agricultural pollutants:** Chemicals like pesticides, fertilizers, bactericides, fumigants, insecticides, herbicides, fungicides.
(ii) Domestic refuge and industrial wastes.
(iii) Radioactive wastes from research centres, and hospitals.
(iv) Soil conditioners containing toxic metals like Hg, Pb, As, Cd, etc.
(v) Farm wastes from poultries, dairies and piggery farms.
(vi) Improper disposal of human and animal excreta.
(vii) Pollutants present in air from chemical works.

WHO IS DOING WHAT FOR CLIMATE?

GHG emission		Country
I	**24%**	**CHINA :** Envisages a peak in emissions by around 2030, and reducing carbon intensity (CO_2 emitted per unit of GDP) by 60-65% by 2030 compared with 2005 levels. The world's most populous nation will boost the share of non-fossil fuel in primary energy consumption from 11.2% in 2014 to 20%, and boost the volume of CO_2-absorbing forest by about 4.5 billion cubic metres.
II	**15.5%**	**UNITED STATES :** Has pledged a 26-28% reduction in emissions from 2005 levels by 2025. Power plants are to cut carbon dioxide pollution by 32% by 2030.

International conventions for climate change entered into force on 21 March 1994.

III	**10.8%**	**EUROPEAN UNION :** The 28-member bloc tends to cut emissions by at least 40% by 2030 from 1990 levels, and has set 27% targets for renewable energy supply and efficiency gains.
IV	**6.4%**	**INDIA :** Plans to reduce carbon intensity by 35% by 2030 from 2005 levels, and generates 40% of its electricity from renewable sources by the same date.
V	**4.9%**	**RUSSIA :** Has mooted cutting emissions by 70% by 2030 from 1990 levels, conditional on the pledges of other "major emitters".
VI	**2.9%**	**JAPAN :** Has pledged a 26% reduction in emissions from 2013 levels by 2030, with nuclear energy – offline since the 2011 Fukushima disaster – providing 20-22% of electricity by then. Renewable electricity production, including hydro power, would be expanded to a 22-24% share, from 11% in 2014.
VII	**2.1%**	**BRAZIL :** Will cut emissions by 37% by 2025 and 43% by 2030.
VIII	**1.6%**	**IRAN :** Iran has made an unconditional pledge to reduce its greenhouse gas emissions in 2030 by four per cent compared with a "business as usual" secnario. In addition, Tehran said it would reduce emissions by another 8% if it receives financial and technology support.
IX	**1.6%**	**INDONESIA :** A 29% cut in emissions by 2030 compared with what the level would have been without any action. With financial and other help, this could be raised to 41%.
X	**1.5%**	**CANADA :** Will seek to cut emissions by 30% from the 2005 levels by 2030. Canada has done its bit by cutting carbon emission and putting a curb on pollution in major cities in the country.

Source: *TOI*

CARBON BUDGET

- A carbon budget is the maximum amount of carbon that can be released into the atmosphere while keeping a reasonable chance of staying below a given temperature rise.
- The concept of carbon budget was first time adopted by Intergovernmental Panel on Climate Change (IPCC) in its 2013 report.
- In its most recent synthesis report, published in early 2014 states that the Intergovernmental Panel on Climate Change (IPCC) laid out estimates of how much CO2 we can emit and still keep global average temperature rise to no more than 1.5°C, 2°C or 3°C above pre-industrial levels.
- The first four carbon budgets, leading to year 2027, have been set in law. The UK is currently in the second carbon budget period (2013-17).
- Meeting the fourth carbon budget (2023-27) will require that emissions be reduced by 50% from 1990 levels in 2025.
- As Carbon dioxide is increasing day by day in the atmosphere the three major sink (atmosphere, ocean and land) are absorbing more carbon.
- The carbon sink are increasing alarmingly due to deforestation, fossil fuel emission and industrialization.
- Although we tend to focus on growing atmospheric carbon concentrations, ocean acidification is also hugely worrying.
- As the world continues to warm the future function of ocean and land sinks may come under strain.

The existing Tiger Reserves represent around one-third of India's high density forest area.

Global Share of CO_2

In recent years, there has been a tremendous surge in carbon dioxide (CO_2) levels in the atmosphere.

- These atmospheric carbon dioxide rises are believed to be the result of industrialization.
- China was the biggest emitter of carbon dioxide; the country accounted for around 28.03 percent of global CO2 emissions that year.
- In 2014 five largest CO2 producers includes United States of America, Brazil, Russia, India and China out of which China is at the top position in carbon dioxide emission.
- Today, there are a number of measures to reduce carbon dioxide emissions.
- These measures include reforestation, the introduction of a price for carbon emission, a reduction of livestock and a decreased use of fossil fuels in energy generation.

INTERNATIONAL CONVENTIONS FOR CLIMATE CHANGE

Convention	Place	Crucial Documents
International Whaling Commission (1946)	Washington, D.C., United States.	• To keep under review and revise as necessary the measures laid down in the Schedule to the Convention which govern the conduct of whaling throughout the world.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)	Washington, U.S.A.	• Help in conservation of species
Ramsar Convention on Wetland (1971)	Ramsar, Iran	• Halt the worldwide loss of wetlands and • To conserve, use and manage, those that remain. • This requires international cooperation, policy making, capacity building and technology transfer.
World Heritage Convention, 1972	Paris	• Recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. • Defines the kind of natural or cultural sites which can be considered for inscription on the World Heritage List under UNESCO.
Convention on the Conservation of Migratory Species of Wild Animals (1979)	Bad Godesberg, Germany	• It is an intergovernmental treaty • Should promote, cooperate in and support research relating to migratory species • Endeavour to provide immediate protection for migratory species • Conservation and management of migratory species included in Appendix II
MARPOL Convention (73/78)	—	• To minimize pollution of the oceans and seas, including dumping, oil and air pollution.

Hemis National Park in Jammu and Kashmir is the largest national park in India.

Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	Helsinki, Finland	• Play role in controlling the ozone depletion
Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal (1989)	Basel, Switzerland	• To reduce hazardous waste generation and promote environmental sound management system for their disposal. • Restrict trans boundary movement of such wastes and • Provide regulatory system applying to cases where such movement is allowable.
Convention on Biological Diversity (1993)		• The conservation of biological diversity • The sustainable use of the components of biological diversity • The fair and equitable sharing of the benefits arising out of the utilization of genetic resources
The United Nations Framework Convention on Climate Change (1994)	Kyoto, Japan	• Gather and share information on greenhouse gas emissions, national policies and best practices • Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing c ountries • Cooperate in preparing for adaptation to the impacts of climate change
Global Tiger Forum (1994)	New Delhi, India	• Set up to embark on a worldwide campaign to save the wild tiger
United Nations Convention to Combat Desertification (1994)		• Promotes a global response to desertification, land degradation and drought
Kyoto Protocol (1997)	Kyoto, Japan	• Set targets on greenhouse-gas emissions for developed countries. • Fight global warming by reducing greenhouse gas concentrations in the atmosphere. • Reduce greenhouse gases by 18% below the emission levels of 1990.
United Nations Forum on Forests (2000)		• Implementation of agreements and foster a common understanding on sustainable forest management; • To provide policy development and dialogue among Governments and international organizations, • To enhance cooperation • To foster international cooperation and • To monitor, assess and report on progress of the above functions and objectives • To strengthen political commitment to the management, conservation and sustainable development.
Stockholm Convention on Persistent Organic Pollutants (2001)	Stockholm, Sweden	• It develops a risk management evaluation • Determines whether the substance fulfills POP screening. • Manage and dispose of POPs wastes in an environmentally sound manner
Rotterdam Convention (2004)	Rotterdam, Netherlands	• Convention promotes open exchange of information • Calls on exporters of hazardous chemicals to use proper labeling • Inform purchasers of any known restrictions or bans

Rann of Kutch, also known as the Indian Wild Ass sanctuary is the largest wildlife sanctuary in India.

INTERNATIONAL TREATIES/AGREEMENTS ON ENVIRONMENT

Agenda-21

- It is a product of the Earth Summit (UN Conference on Environment and Development) held in Rio de Janeiro, Brazil, in 1992.
- The Agenda emphasizes on issues like poverty, health consumption patterns, natural resource use, financial resources and human settlements.

Paris Agreement, 2016

- It is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gases emissions, mitigation, adaptation and finance starting in the year 2020.
- It was opened for signature on 22 April 2016 (Earth Day) at a ceremony in New York. As of December 2016, 194 UNFCCC members have signed the treaty, 131 of which have ratified it.

Cartagena Protocol on Biosafety

- It is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health.
- It was adopted on 29th January, 2000 and entered into force on 11 September 2003.

ENVIRONMENTAL POLICIES/ PROGRAMMES OF INDIA

Programmes/ Policies	Launch Date	Objective
National Water Mission	—	• To put comprehensive water data base in public domain and assessment of impact of climate change on water resource. • Promotion of citizen and state action for water conservation, augmentation and preservation. • Focused attention to vulnerable areas including over-exploited areas.
Paryavaran Vahini Scheme	1992	• To create environmental awareness and involve people through active participation and reporting of illegal acts pertaining to forests, wildlife, pollution, environmental degradation and cruelty to animals.
National River Conservation Plan	1995	• To improve the water quality of major rivers which are the major fresh water source in the country, through the implementation of pollution abatement scheme.
National Environment Policy, 2006	2006	• Conservation of Critical Environmental Resource. • Integration of environmental concerns in economic and social development. • Intra-generational equity.
National Action Plan on Climate Change	2008	• To sustain economic growth while dealing with the global threat of climate change.

In India the first biosphere reserve, Nilgiri was declared in 1986.

National Mission for Sustaining the Himalayan Ecosystem	—	• To conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.
National Mission for Green India	2014	• To protect, restore and enhance India's diminishing forest cover and responding to climate change by a combination of adaptation and mitigation measures. • To take a holistic view of greening and focuses on multiple ecosystem services, especially, biodiversity, water, biomass, preserving mangroves, wetlands, critical habitats etc. along with carbon sequestration as a co-benefit.
National Solar Mission	2010	• To reduce the cost of solar power generation in the country through long term policy. • Domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022.
National Mission for Sustainable Habitat	2010	• Formulation of National Sustainable Habitat Standards, which would get integrated with relevant regulations to ensure that future developments are aligned in accordance with concerns related to climate change.
National Mission for Enhanced Energy Efficiency	2010	• To promote the market for energy efficiency by fostering innovative policies and effective market instruments.
National Mission for Sustainable Agriculture	2013	• To define strategies for climate mitigation and adaptation within the agriculture sector. • To promote sustainable agriculture through a series of adaptation measures focusing on ten key dimensions encompassing Indian agriculture
National Mission for Clean Ganga	2016	• To clean the Ganga and its tributaries in a comprehensive manner.
National Wildlife Action Plan for 2017-2013	2017	• Integration of climate change into wildlife planning, conservation of coastal and marine ecosystem, mitigation of human-wildlife conflict.
Wood is Good Campaign	2017	• To promote wood as climate-friendly resource and substitute to materials like steel and plastic as it is carbon neutral unlike others materials.
SECURE Himalaya Project	2017	• Conservation of locally and globally significant biodiversity, land and forest resources in high Himalayan ecosystem spread over four states viz. Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Sikkim.

Tiger census added 295 tigers and total estimated population reaches to 1706. In the latest census, Karnataka has surpassed Madhya Pradesh for the number of tigers.

ENVIRONMENTAL CONFERENCES/ SUMMITS

Conference	Date	Venue	Highlights
United Nations Conference on Environment and Development (Earth Summit)	3-14 June, 1992	Rio de Janeiro	Resulted in the documents like Rio Declaration on Environment and Development, Agenda 21, and Forest Principles
World Summit on Sustainable Development	26 August to 4 September 2002	Johannesburg, South Africa	Reviewed progress in the implementation of Agenda 21 since its adoption in 1992
United Nations Conference on Sustainable Development	20-22 June, 2012	Rio de Janeiro, Brazil	Securing renewed political commitment for sustainable development
International Conference on Land Use and Water Quality	29 May - 1 Jun 2017	Hague, Netherlands	Discussion on 'policy cycle' to enable enhancing the quality of the water environment, which includes problem recognition, formulation of technical options, policy formulation, interaction between policy makers and stakeholders
3rd World Conference on Environment	5th June, 2017	New Delhi	Discussion on issues like air pollution, water pollution, economics and clean technology, and the role of courts and tribunals for environmental protection
CEM India 2017 - Conference on Emissions Monitoring	26-28 September, 2017	New Delhi	Provide guidelines for continuous emission monitoring system
UN Summit on Conservation of Migratory Species	23-28 October, 2017	Manila, Philippines	Discussion on sustainable development for wildlife and people

National Air Quality Index

- The national AQI is published every month by CPCB along with a numerical value and a colour code which helps in comparing air pollution levels in cities.
- It is determined on the basis of concentration of 8 pollutants, including Particulate Matter (PM 2.5, PM 10), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) ozone (O_3), ammonia (NH3) and lead (Pb).
- The colour are classified into 6 categories depending upon numerical value as Good (0-50), Satisfactory (51-100), Moderately polluted (101-200), Poor (201-300), Very poor (301-400) and Severe (401-500).

In 2016, forest fire, have been noted in pine forest of Uttarakhand and according to forest department 3,500 hectares of forest had been burnt.

INDIA INITIATIVES TOWARDS ANIMAL PROTECTION

Project Tiger

- Project Tiger is a tiger conservation programme launched in 1973 by the Government of India.
- The project aims at ensuring a viable population of Bengal tigers in their natural habitats and also to protect them from extinction, and preserving areas of biological importance
- The project's task force visualized these tiger reserves as breeding nuclei, from which surplus animals would migrate to adjacent forests.
- The government has set up a Tiger Protection Force to combat poachers and funded relocation of villagers to minimize human-tiger conflicts.

Project Rhino

- It was joint venture of the Assam Forest Department and Wildlife Trust of India - International Fund for Animal Welfare (WTI-IFAW) and initiated in February 2006 with the trans location of a hand-raised rhino calf to Manas Wildlife Sanctuary.
- The projects aims at repopulating the one horn rhino by displacing them to Manas Wild Life Sanctuary from Kaziranga National Park.
- The whole project is supported by Bodoland Territorial Council and the Assam Forest Department.

Project Crocodile Conservation

- It was launched in 1975 in different States for protecting the endangered crocodile species like Gharial, Gavialis gangeticus; Mugger crocodile, Crocodylus palustris and Saltwater crocodile.
- The funds and technical support for the project came from UNDP/ FAO through the Government of India.

Project Elephant (PE)

- It is a Central Government initiative to provide financial and technical support to major elephant bearing states of India.
- It was launched in February 1992. It aims at protecting the elephants, their habitat and corridor. It is implemented in 13 States / UTs, viz. Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Orissa, Tamil Nadu, Uttranchal, Uttar Pradesh and West Bengal.

SAVE

- Saving Asia's Vultures from Extinction (SAVE) is a consortium of regional and international organization to co-ordinate conservation, campaigning and fundraising activities to help the plight of south Asia's vultures.
- The key strategies of vulture conservation SAVE is involved in a wide range of conservation activities across South Asia including:
  (i) breeding vultures in captivity so that their offspring can be released back in to the wild when the environment is free from diclofenac
  (ii) an active advocacy programme targeting the vets and farmers using diclofenac
  (iii) legislation controlling the manufacture and sale of veterinary drugs
  (iv) in-situ conservation actions focused around the small but key remaining vulture populations
  (v) an active research programme that underpins these activities and monitors their effectiveness

Project Dolphin

- Gangetic river dolphins is India's national aquatic animal and is often known as the **'Tiger of the Ganges'.**
- This dolphin species is an indicator animal which represent healthy river ecosystem in a same position as a tiger in a forest. Their population is estimated to be less than 2,000 in the country.

Ecology term was coined by the German biologist Ernst Haeckel.

- Some of the major threats are habitat fragmentation due to construction of dams and barrages, direct killing, indiscriminate fishing and pollution of rivers.
- For conservation of dolphins, India's first Dolphin Community Reserve will be established in West Bengal to protect the endangered mammal, Gangetic river dolphins.
- The reserve would be set up in the Hooghly River between Malda and Sundarbans as per provisions of Wildlife Protection Act, 1972.
- State Forest department also has announced that it would also conduct a census to estimate the population of dolphins.

ENVIRONMENTAL BILLS/ACTS

- The Water (Prevention and Control of Pollution) Act, 1974
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- The Water (Prevention and Control of Pollution) Cess Rules, 1978
- The Air (Prevention and Control of Pollution) Act, 1981
- The Air (Prevention and Control of Pollution) Rules, 1982
- The Environment (Protection) Act, 1986
- The Environment (Protection) Rules, 1986
- Hazardous Wastes (Management and Handling) Rules, 1989
- Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
- The Forest (Conservation) Act, 1980
- The Forest (Conservation) Rules, 1981
- The Wildlife Protection Act, 1972
- The Wildlife (Transactions and Taxidermy) Rules, 1973
- The Wildlife (Stock Declaration) Central Rules, 1973
- The Wildlife (Protection) Licensing (Additional Matters for Consideration) Rules, 1983
- The Wildlife (Protection) Rules, 1995
- The Wildlife (Specified Plants - Conditions for Possession by Licensee) Rules, 1995
- The Public Liability Insurance Act, 1991
- The Public Liability Insurance Rules, 1991
- The National Environment Tribunal Act, 1995
- The National Environment Appellate Authority Act, 1997
- Municipal Solid Wastes (Management and Handling) Rules, 2000
- Ozone Depleting Substances (Regulation and Control) Rules, 2000
- The Biological Diversity Act, 2002
- Noise Pollution (Regulation and Control) (Amendment) Rules, 2002
- The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006
- The National Green Tribunal Act, 2010
- Wild Life Protection (Amendment) Bill, 2013

ENVIRONMENTAL ORGANIZATIONS/AUTHORITIES

Organizations	Headquarter	Objective
National Biodiversity Authority (2003)	Chennai	• To implement the provisions under the National Biological Diversity Act, 2002. • To ensure conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources

Around 25,000 trees are cut down each day to produce toilet paper.