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Geomorphology Part I

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Geography is the study of

1. the **physical features** of the earth and its atmosphere,
2. **human activity which affects and is affected by the physical features** of the earth and its atmosphere. (Definition from Oxford Dictionary)

- Human activity which affects and is affected by the physical features include the distribution of populations, distribution of resources and economic activities, and changes in the environment.

Geography, the natural science, is divided into two main branches:

1. **Physical geography:** deals with the study of processes and patterns in the natural environment like the atmosphere, hydrosphere, biosphere, and geosphere.
2. **Human geography:** deals with the environment shaped by human activity.

Physical Geography can be divided into several sub-fields, as follows:

- **Geomorphology** ('geo' meaning earth, 'morphe' meaning form and 'logos' meaning discourse) is the field concerned with understand-

ing the surface of the Earth and the processes by which it is shaped.
- **Climatology** is the study of the climate (weather conditions averaged over a long period).
- **Meteorology** focuses on weather processes and short-term forecasting (in contrast with climatology).
- **Oceanography** is the branch of physical geography that studies the Earth's oceans and seas.
- **Hydrology** is concerned with the amounts and quality of water moving and accumulating on the land surface and in the soils and rocks near the surface and is typified by the hydrological cycle.
- **Biogeography** deals with geographic patterns of species distribution and the processes that determine these patterns.
- **Environmental geography** analyses the spatial aspects of interactions between humans and the natural environment. The branch bridges the divide between human and physical geography.
- **Geomatics** is the field of gathering, storing, processing, and delivering geographic information.

There are many other sub-branches in physical geography.

1. Interior of The Earth

- Understanding the structure of the earth's interior (crust, mantle, core) and various forces (heat, seismic waves) emanating from it is essential to understand the evolution of the earth's surface, its current shape and its future.

1.1 The study of the earth's interior is essential

- to understand the earth's surface
- to understand the geophysical phenomenon like volcanism, earthquakes, etc.
- to understand the earth's magnetic field
- to understand the internal structure of various solar system objects
- to understand the evolution and present composition of the atmosphere
- for mineral exploration

Earth's surface

- Many different geological processes shape the Earth's surface.
- The forces that cause these processes come from both above and beneath the Earth's surface.
- Processes that are caused by forces from within the Earth are **endogenous processes** (Endo meaning "in").
- By contrast, **exogenous processes** (Exo meaning "out") come from forces on or above the Earth's surface.
- The major geological features of the earth's surface like mountains, plateaus, lakes are mostly a result of endogenous processes like folding, faulting that are driven by forces from inside the earth.

Geophysical phenomenon like volcanism, earthquakes

- The forces that cause catastrophic events like earthquakes, volcanic eruptions come from deep below the earth's surface.
- For example, earthquakes occur due to the movement of the tectonic plates and the energy required for this movement is supplied by the **conventional currents in the mantle**.
- Similarly, volcanism occurs through the vents and fissures created by the tectonic movements.

Earth's magnetic field

- Earth's magnetic field is a result of **convection currents in the outer core** of the earth.
- Life on earth would not have been possible if not for the earth's magnetic field which protects the earth's atmosphere from the harmful **solar wind**.

The internal structure of various solar system objects

- The entire solar system was formed from a single nebular cloud, and the process of the formation of every solar system object is believed to be similar to that of the earth.

Evolution and present composition of the atmosphere

- For life to flourish on the surface of the earth, the atmosphere needs to have essential components like oxygen for respiration, CO_2 and other greenhouse gases to maintain the temperature on the surface, ozone to protect life from ultraviolet radiation and the right atmospheric pressure.
- All these components of the earth's atmosphere owe their existence to the **volcanic eruptions** that unlock them from the earth's interior.

Mineral exploration

- Understanding volcanic activity and the nature of rocks is essential for mineral exploration.
- Most of the minerals like **diamonds (form at a depth of 150-800 km in the mantle)** that occur on the earth's surface are formed deep below the earth's surface. They are brought to the surface by **volcanic activity**.

1.2 Direct Sources of information about the interior

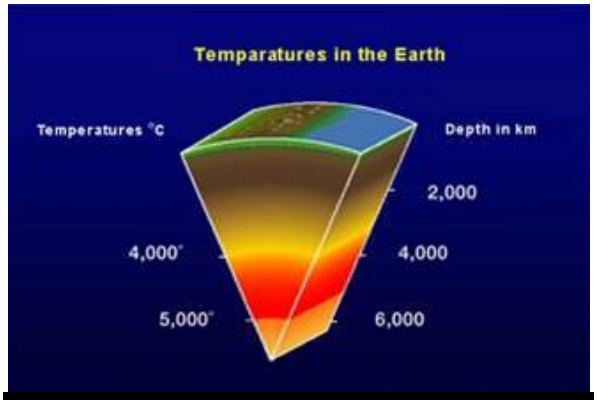
- Deep earth mining and drilling reveal the nature of rocks deep down the surface.
- But as mining and drilling are not practically possible beyond a certain depth, they don't reveal much information about the earth's interior.
- **Mponeng gold mine** (deepest mine in the world) and **TauTona gold mine** (second deepest mine in the world) in South Africa are deepest mines reaching to a depth of only 3.9 km.
- And the deepest drilling is only about 12 km deep hole bored by the Soviet Union in the 1970s over the **Kola Peninsula**.

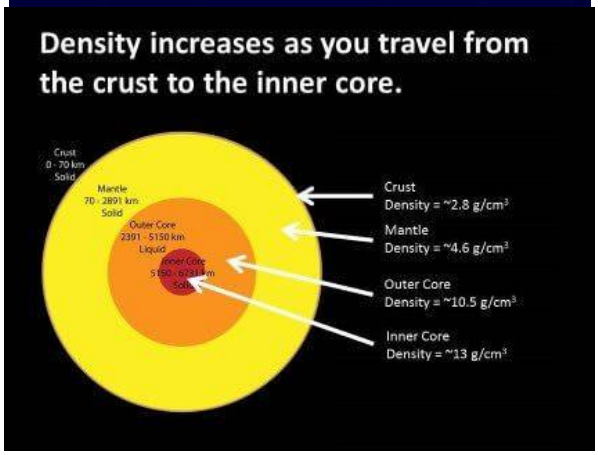
The Kola Peninsula in north-west Russia. (TUBS, from Wikimedia Commons)

- Volcanic eruption forms another source of obtaining direct information.

1.3 Indirect Sources of information about the interior

- Gravitation and the diameter of the earth help in estimating pressure deep inside.
- Volcanic eruptions and existence of hot springs, geysers etc. point to an interior which is very hot.





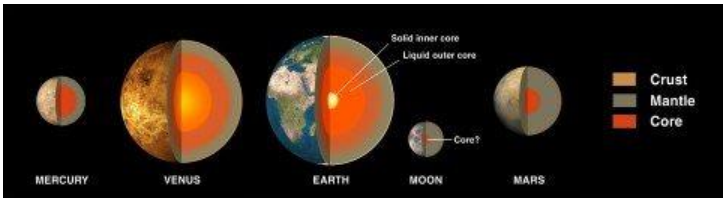
Seismic waves

- They are the most important source available to understand the layered structure of the earth.
- The velocity of seismic waves changes as they travel through materials with different **elasticity** and **density**.
- The **more elastic and denser the material is, the higher is the velocity**.
- They also undergo **refection or refraction** when they come across materials with different densities.
- Earth's internal structure can be understood by analysing the patterns of reflection, refraction

and change in velocity of the seismic waves when they travel through it.

Meteorites

- Meteorites and Earth are born from the same nebular cloud. Thus, they are likely to have a similar internal structure.
- When meteoroids they fall to earth, their outer layer is burnt during their fall due to extreme friction and the inner core is exposed.
- The heavy material composition of their cores confirms the similar composition of the inner core of the earth.



Gravitation

- The gravitation force differs according to the mass of material. The uneven distribution of mass of material within the earth influences this value. Such a difference is called **gravity anomaly**.
- Gravity anomalies give us information about the **distribution of mass** in the crust of the earth.

Magnetic field

- The geodynamo effect helps scientists understand what's happening inside the Earth's core. Shifts in the magnetic field also provide clues to the inaccessible iron core.

Sources of earth's heat

Radioactive decay

- The high temperature below the crust is attributed to the **disintegration of the radioactive substances**.
- **The nuclear decay happens primarily in the crust and the mantle**.
- Scientists believe that uranium could become sufficiently concentrated **at the base of Earth's mantle** to ignite self-sustained **nuclear fission**, as in a human-made reactor.
- The new measurements suggest **radioactive decay provides more than half of Earth's total heat**.

***Nuclear fusion doesn't occur inside the earth**. For nuclear fusion to occur there must be far more pressure and temperature inside the earth. The earth is not massive enough to cause such conditions.*

Primordial heat

- The rest is the heat left over from Earth's formation known as the **primordial heat**.
- Primordial heat is the kinetic energy transferred to Earth by external impacts of comets and meteorites and the subsequent effects (**friction** caused by sinking of heavy elements like Fe, rising light elements like Si) and **latent heat of crystallisation released as the core solidified**.

Tidal friction

- The ocean tides are not the only effect of tidal forces (gravitational influence of the moon and the sun on earth; tides are explained in oceanography). The solid body of the Earth also bulges slightly in this way.
- The daily flexing of the Earth (both solid body and the oceans) cause loss of energy of the Earth's rotation, due to friction.
- This energy goes into heat, leading to miniscule increase in the Earth's internal temperature.
- The loss of rotational energy means that the **Earth is slowing down in its rotation rate**, currently by about 0.002 seconds per century.

1.4 Seismic waves

- Seismic: relating to earthquakes or other vibrations of the earth and its crust.
- Seismic waves are waves of energy that travel through the Earth's layers and are a result of earthquakes, volcanic eruptions, magma movement, large landslides and large human-made explosions.
- The refraction or reflection of seismic waves is used for research into the structure of the Earth's interior.
- The terms seismic waves and earthquake waves are often used interchangeably.

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Geomorphology Part II

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1. Volcanism

- A volcano is a vent or a fissure in the crust from which lava (molten rock), ash, gases, rock fragments erupt from a magma chamber below the surface.
- Volcanism is the phenomenon of eruption of molten rock, pyroclastics and volcanic gases to the surface through a vent.

1.1 Causes of Volcanism

- There is a **huge temperature difference** between the inner layers and the outer layers of the earth due to the differential amount of radioactivity.
- This temperature difference gives rise to **convectional currents** in the mantle.
- The convection currents in the mantle create convergent and divergent boundaries (weak zones).
- At the divergent boundary, molten, semi-molten and sometimes gaseous material appears on earth at the first available opportunity.
- The earthquakes here may expose fault zones through which magma may escape (**fissure type volcano**).
- At the convergent boundary, the subduction of denser plate creates magma at high pressure which will escape to the surface in the form of violent eruptions.

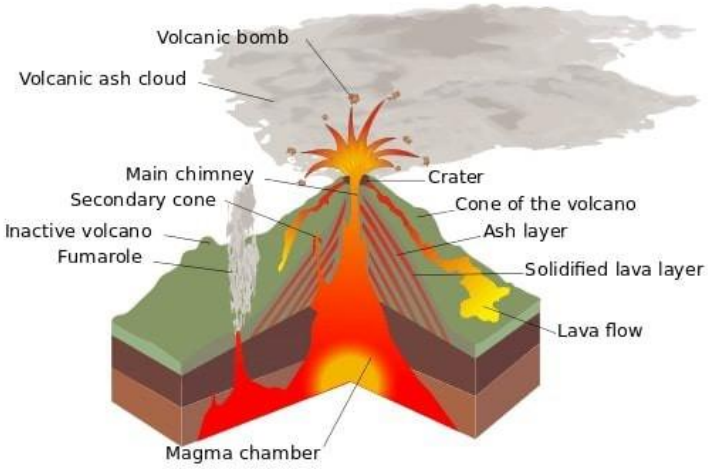
1.2 Lava types

- Magma is composed of molten rock and is stored in the Earth's crust. Lava is magma that reaches the surface through a volcano vent.

Andesitic or Acidic or Composite or Stratovolcanic lava

- These lavas are **highly viscous** with a high melting point.
- They are **light-coloured, of low density, and have a high percentage of silica**.
- They **flow slowly and seldom travel far** before solidifying.
- The resultant volcanic cone is therefore stratified (hence the name **stratovolcano**) and steep-sided.
- The **rapid solidifying of lava** in the vent obstructs the flow of the out-pouring lava, result-

ing in **loud explosions**, throwing out many volcanic **bombs or pyroclasts**.



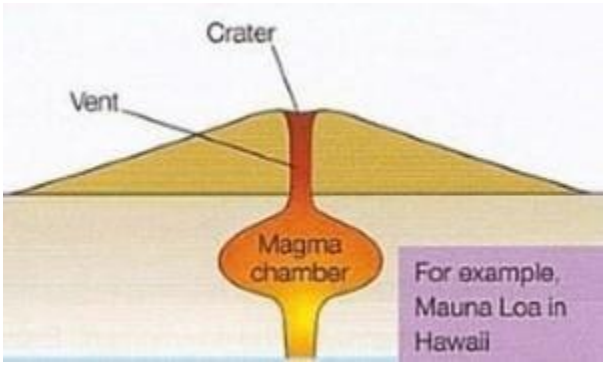
Volcano (Medium69.Cette William Crochot, via Wikimedia Commons)

- Sometimes the lavas are so viscous that they form a **lava plug** at the crater like that of **Mt. Pelée** in Martinique (an island in the Lesser Antilles, Caribbean Islands).
- Andesitic lava flow occurs mostly along the **destructive boundaries** (convergent boundaries).

Lava Plug at the crater

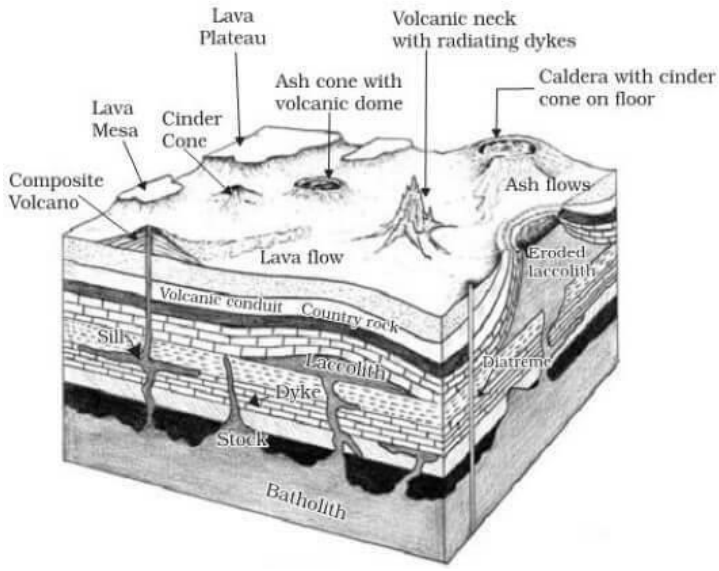
Basic or Basaltic or Shield lava

- These are the **hottest lavas**, about 1,000 °C and are **highly fluid**.
- They are **dark coloured basalt, rich in iron and magnesium but poor in silica**.
- They flow out of volcanic vent **quietly** and are **not very explosive**.
- Due to their **high fluidity**, they flow readily with a speed of 10 to 30 miles per hour.
- They affect extensive areas, spreading out as **thin sheets** over **great distances** before they solidify.
- The resultant volcano is **gently sloping** with a wide diameter and forms a flattened shield or dome.
- Shield type lava flow is common along the **constructive boundaries** (divergent boundary).



1.3 Volcanic Landforms

- Volcanic landforms are divided into **extrusive and intrusive landforms** based on whether magma cools within the crust or above the crust.
- Rocks formed by cooling of magma within the crust are called **Plutonic rocks.**
- Rocks formed by cooling of lava above the surface are called **Igneous rocks**.
- In general, the term 'Igneous rocks' is used to refer all rocks of volcanic origin.



Extrusive and Intrusive volcanic landforms

Extrusive Volcanic Landforms

- Extrusive landforms are formed from material thrown out to the surface during volcanic activity.
- The materials thrown out include lava flows, pyroclastic debris, volcanic bombs, ash, dust and gases such as **nitrogen compounds, sulphur compounds** and minor amounts of **chlorine, hydrogen** and **argon**.

Conical Vent and Fissure Vent

Fissure vent

- A fissure vent (volcanic fissure) is a narrow, linear volcanic vent through which lava erupts, **usually without any explosive activity**.
- The vent is often a few meters wide and may be many kilometres long.
- Fissure vents are common in **basaltic volcanism** (**shield type volcanoes**).

Conical vent

- A conical vent is a narrow cylindrical vent through which magma flows out violently.
- Conical vents are common in **andesitic volcanism** (**composite or stratovolcano**).

Mid-Ocean Ridges

- The system of mid-ocean ridges stretches for more than 70,000 km across all the ocean basins.
- The central portion of the mid-ocean ridges experiences frequent eruptions.
- The lava is **basaltic** (less silica and hence less viscous) and causes the **spreading of the seafloor**.

Composite Type Volcanic Landforms

- They are conical or central type volcanic landforms.
- Along with andesitic lava, large quantities of pyroclastic material and ashes find their way to the surface.
- **Andesitic lava** along with pyroclastic material accumulates in the vicinity of the vent openings leading to the formation of layers, and this makes the mounts appear as a **composite volcano or a stratovolcano** (divided into layers).

- The highest and most common volcanoes have composite cones.
- **Mount Stromboli (the Lighthouse of the Mediterranean)**, Mount Vesuvius, Mount Fuji are examples.

Shield Type Volcanic Landforms

- The **Hawaiian volcanoes** are the most familiar examples.
- These volcanoes are mostly made up of **basaltic lava** (very fluid).
- These volcanoes are not steep.
- They become explosive if somehow water gets into the vent; otherwise, they are less explosive.
- Example: Hawaiian volcanoes **Mauna Loa** (active shield volcano) and **Mauna Kea** (dormant shield volcano).

Fissure Type Flood Basalt Landforms (Lava Plateaus)

- Sometimes, a very thin magma escapes through cracks and fissures in the earth's surface and

flows after intervals for a **long time**, **spreading over a vast area**, finally producing a **layered, undulating (wave-like), flat surface**.

- Example: **Siberian Traps**, **Deccan Traps**, **Snake Basin, Icelandic Shield, Canadian Shield**.

Crater

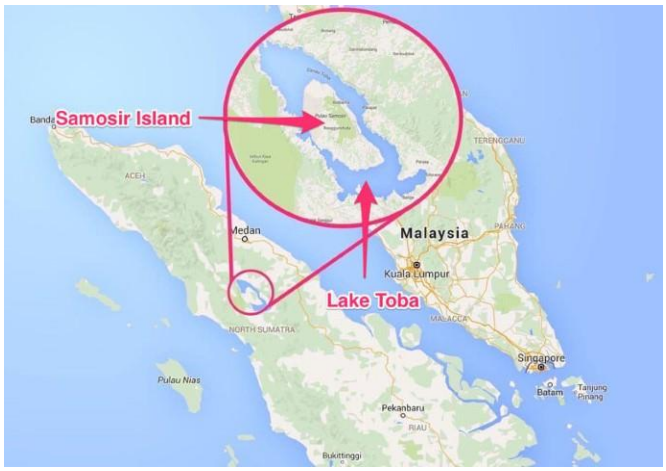
- A crater is an inverted cone-shaped vent through which the magma flows out. When the volcano is not active the crater appears as a bowl-shaped depression.

The crater of Mount Fuji, Japan

- When water from rain or melted snow gets accumulated in the crater, it becomes a **crater lake**.

Caldera

- In some volcanoes, the magma chamber below the surface may be emptied after volcanic eruptions.
- The volcanic material above the chamber **collapses** into the empty magma chamber, and the collapsed surface appears like a large cauldron-like hollow (tub shaped) called the caldera.
- When water from rain or melted snow gets accumulated in the caldera, it becomes a **caldera lake** (in general, the caldera lakes are also called crater lakes).
- Due to their unstable environments, some crater lakes exist only intermittently. Caldera lakes, in contrast, can be quite **large and long-lasting**.
- For example, **Lake Toba (Indonesia)** formed after its supervolcanic eruption around 75,000 years ago. It is the **largest crater lake in the world**.



- Mount Mazama (Cascade Volcanic Arc, USA) collapsed into a caldera, which was filled with water to form Crater Lake (the literal name of the lake formed by the collapse of Mount Mazama is 'Crater Lake'!).

Caldera lake of Mount Mazama

A crater lake, in general, could be of volcanic origin (volcanic crater lake, volcanic caldera lake) or due to a meteorite impact (meteor

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Climatology Part I

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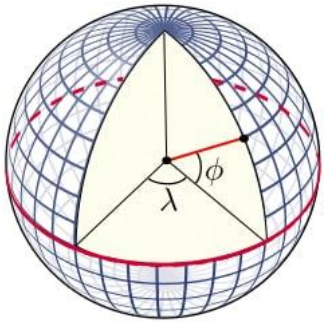
1. Latitudes and Longitudes

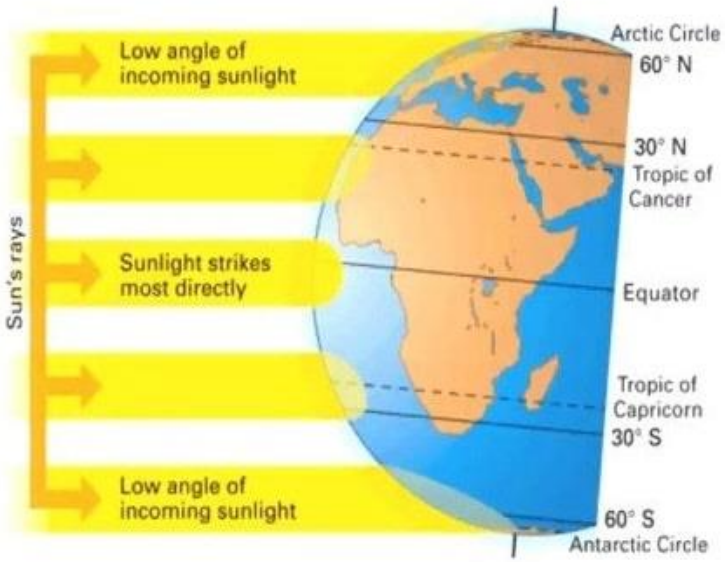
- Latitudes and Longitudes (coordinate system) are imaginary lines used to determine the location of a place on earth.
- Example: The location of New Delhi is 28° N Latitude, 77° E Longitude.



Latitude (ϕ) and longitude (λ) are defined on a perspective spherical modal (Wikipedia)

1.1 Latitude or Parallel

- Latitude is the angular distance of a place north or south of the equator measured in degrees from the centre of the earth.
- As the earth is **slightly flattened at the poles**, the **linear distance of a degree of latitude at the pole is a little longer than that at the equator**.
- For example, at the equator linear distance of a degree of latitude is 110.57 km (68.7 miles), at 45° it is 111.13 km (69 miles), and at the poles, it is 111.7 km (69.4 miles). The average is taken as **111 km (69 miles)**.



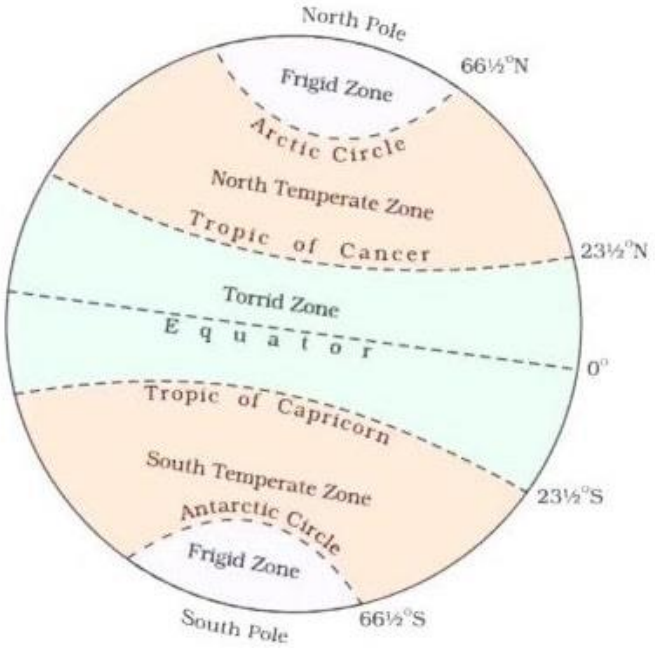
Latitudinal Heat zones of the earth

- The mid-day sun is exactly overhead at least once a year on all latitudes in between the Tropic of Cancer and the Tropic of Capricorn. This area, therefore, receives the maximum heat and is called the **torrid zone**.
- The mid-day sun never shines overhead on any latitude beyond the Tropic of Cancer and the Tropic of Capricorn. The angle of the sun's rays goes on decreasing towards the poles.
- As such, the areas bounded by the Tropic of Cancer and the Arctic circle, and the Tropic of Capricorn and the Antarctic circle, have moderate temperatures. These are, therefore, called **temperate zones**.
- Areas lying beyond the Arctic circle and the Antarctic circle are very cold. Here the sun does not rise much above the horizon. Therefore, its rays are always slanting. These are, therefore, called **frigid zones**.

Important parallels of latitudes

- Besides the **equator (0°)**, the **north pole (90° N)** and the **south pole (90° S)**, there are four important parallels of latitudes:
  1. The **Tropic of Cancer (23½° N)** in the northern hemisphere.
  2. The **Tropic of Capricorn (23½° S)** in the southern hemisphere.
  3. The **Arctic circle (66½° N)** in the northern hemisphere.
  4. The **Antarctic circle is (66½° S)** in the southern hemisphere.

Latitudinal Heat zones of the earth



1.2 Longitude or Meridian

- Longitude is an angular distance of a place east or west of the **Prime (First) Meridian** measured in degrees from the centre of the earth.

- On the globe, longitude is shown as a series of semi-circles that run from pole to pole passing through the equator. Such lines are also called **meridians**.
- It was decided in 1884 to choose the meridian which passes through the Royal Astronomical Observatory at **Greenwich, near London**, as the **zero meridian or prime meridian**.
- All other meridians radiate eastwards and westwards of the prime meridian up to 180°.
- Unlike the parallels of latitude, the meridians of longitude are of **equal length**.
- The meridians of longitude have one very important function; they determine local time in relation to **Greenwich Mean Time (GMT)**, which is sometimes referred to as **World Time**.

Longitude and Time

- Since the earth makes one complete rotation of 360° in one day or 24 hours, it passes through **15° in one hour** or **1° in 4 minutes**.
- The earth rotates from west to east, so **every 15° we go eastwards, local time is advanced by 1 hour**.
- Conversely, **if we go westwards by 15°, local time is retarded by 1 hour**.
- Thus, the **places east of Greenwich gain time**, whereas **places west of Greenwich lose time**.
- A traveller going eastwards gains time from Greenwich until he reaches the meridian 180° E when he will be 12 hours ahead of GMT (GMT+12).
- Similarly, in going westwards, he loses 12 hours when he reaches 180° W. There is thus a total difference of 24 hours or a whole day between the two sides of the 180° meridian.

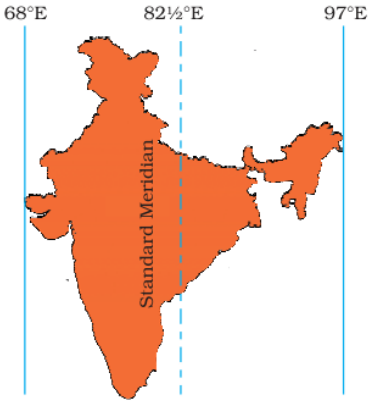
180° E and 180° W correspond to the same longitude. The difference is the direction of travel.

Standard Time and Time Zones

- Standard Time is the time corresponding to a certain longitude or longitudes as chosen by a country.
- Most countries adopt their standard time from the central meridian of their countries. E.g. **IST corresponds to the time at 82.5° E longitude**.
- In countries that have a very **large longitudinal extent** (**large east-west span**), such as Canada, USA, Russia, it would be inconvenient to have a single time zone. So, such countries have multiple time zones.
- For example, Russia has nine time zones, and Canada and USA have six time zones each.

Indian Standard Time

- Indian Standard Time (IST) is taken as the time at **82.5° E longitude** (passing close to the east of **Prayagraj or Allahabad**). Which means, **IST is 5 hours 30 mins ahead of GMT** (**IST = GMT+5:30**).



Longitudinal extent of India

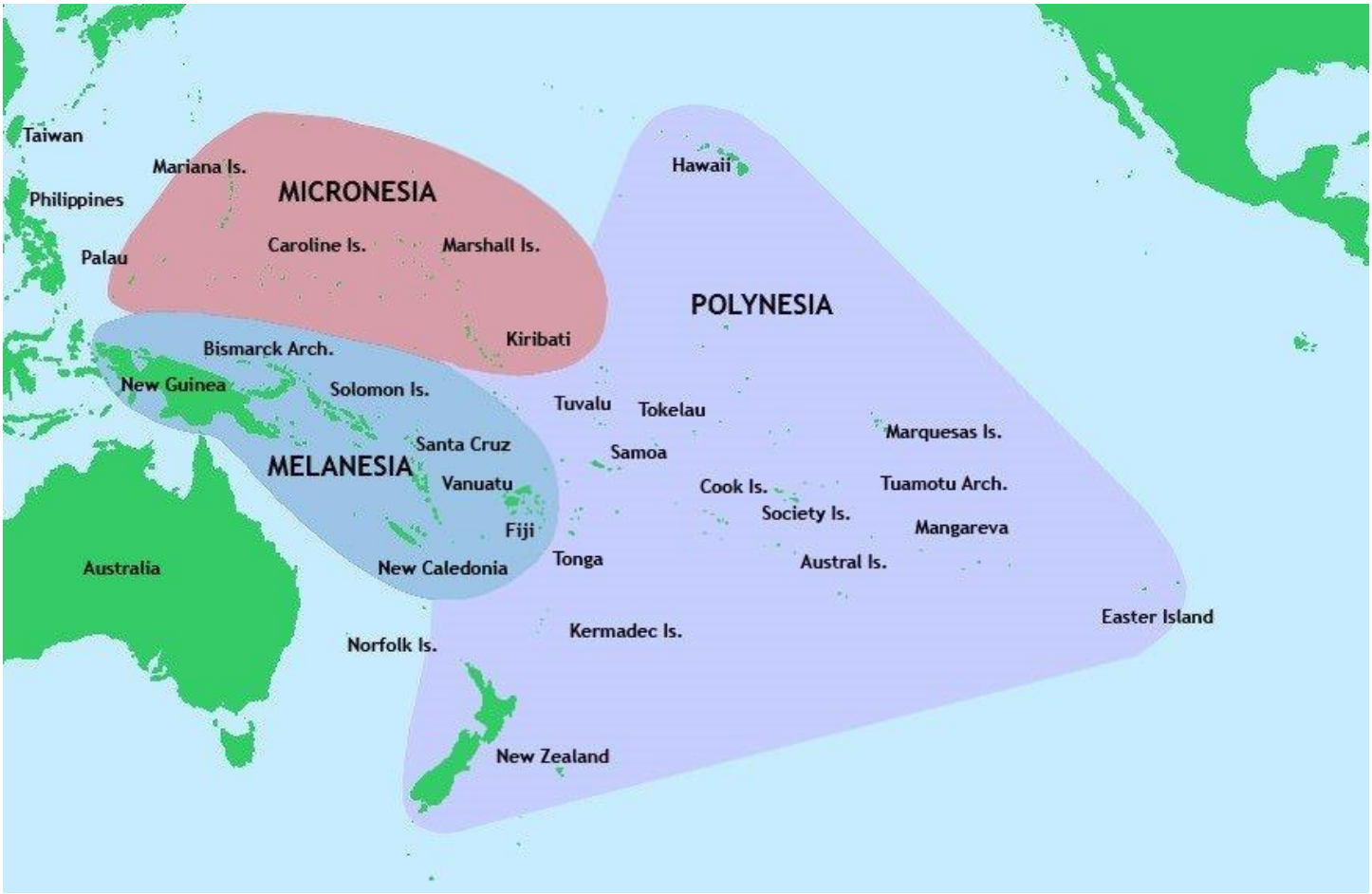
Chaibagaan Time

- One hundred fifty years ago, British colonialists introduced "Chaibagaan time" or "Bagaan time", a schedule observed by tea planters, which was **one hour ahead of IST**.
- This was done to improve productivity by optimising the usage of daytime.
- After Independence, Assam, along with the rest of India, has been following IST.
- The administration of the Indian state of Assam put forward a proposal to change its time zone back to Chaibagaan time to conserve energy and improve productivity.
- Indian government refused to accept such a proposal.

The International Date Line

- The International Date Line (IDL) an imaginary line that passes through the Pacific Ocean.

Time Zones and International Date Line



The Island Groups of Australia, Polynesia, Melanesia and Micronesia

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Climatology Part II

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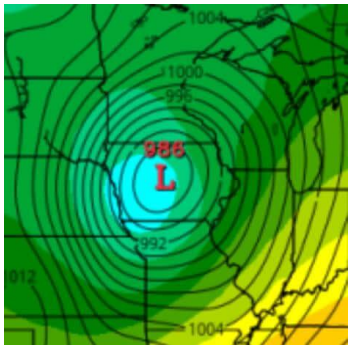
1. Tropical Cyclones

- Tropical cyclones originate over oceans in **tropical areas in late summers**.
- They are rapidly rotating violent storms characterised by
  - ✓ a **closed low-pressure centre with steep pressure gradients** (category 1 cyclones have a barometric pressure of greater than 980 millibars; category 5 cyclones can have central barometric pressure of **less than 920 millibars**),



Closed Isobars in a Tropical Cyclone

  - ✓ a **closed low-level atmospheric circulation** (winds converging from all directions — cyclonic circulation),
  - ✓ **strong winds** (squalls — a sudden violent gust of wind), and
  - ✓ a **spiral arrangement of thunderstorms** that produce very heavy rain **(torrential rainfall**).
- The low-pressure at the centre is responsible for the wind speeds.
- The closed air circulation (cyclonic circulation) is a result of **rapid upward movement of hot moist air** which is subjected to **Coriolis force**.

1.1 Conditions necessary for the Formation of a Tropical Cyclone

- **Large sea surface with temperature higher than 27° C.**
- **Presence of the Coriolis force enough to create a cyclonic vortex.**
- **A pre-existing weak low-pressure area or low-level-cyclonic circulation.**
- **Low wind shear.**
- **Upper-level divergence.**

Good Source of Latent Heat

- Ocean waters having temperatures of **27° C** and depth of warm water extending for **60-70 m** deep supply enough moisture, and hence **latent heat of condensation**, to generate and drive a tropical storm.
- Thick layer of warm water ensures that the deep convection currents within the water do not churn and mix the cooler water below with the warmer water near the surface.

Why tropical cyclones form mostly on the western margins of the oceans?

- Because of **warm ocean currents** (easterly trade winds drag ocean waters towards west) that flow from east towards west forming a thick layer of warm water with temperatures greater than 27°C.

Why are tropical cyclones very rare on the eastern margins of the oceans?

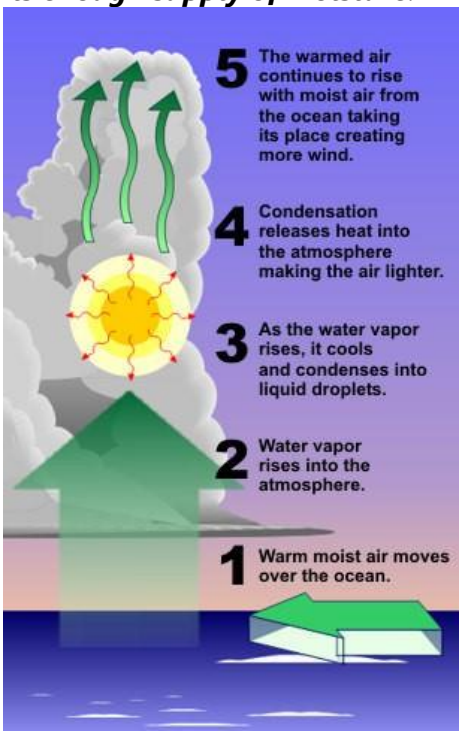
- The **cold currents** lower the surface temperatures of the eastern parts of the tropical oceans making them unfit for the breeding of cyclonic storms.

*Exceptional case: During **strong El Nino years**, strong hurricanes occur in the eastern Pacific. This is due to the accumulation of warm waters in the eastern Pacific due to **weak Walker Cell**.*

Why do tropical cyclones weaken on landfall?

- On landfall, the storm is cut-off from adequate moisture supply and hence it is deprived of latent heat of condensation. Thus, the storm dissipates (weakens or dies off) on landfall.

*Rising of humid air parcel ➔ ambient pressure on the air parcel decreases with altitude ➔ adiabatic lapse rate (fall in temperature of air parcel) ➔ condensation of moisture in air parcel due to low temperature ➔ **latent heat of condensation** is released in the process ➔ air parcel is heated further due to the release of latent heat of condensation and becomes less denser ➔ air parcel is further uplifted ➔ more air comes in to fill the gap ➔ new moisture is available for condensation ➔ latent heat of condensation is released. **The cycle repeats as long as there is enough supply of moisture**.*



Coriolis Force

- The **Coriolis force is zero at the equator,** but it increases with latitude.
- Coriolis force at 5° latitude is significant enough to create a storm (cyclonic vortex).
- About 65 per cent of cyclonic activity occurs between **10° and 20° latitude**.
- The cyclonic circulation is **anti-clockwise (counterclockwise) in the northern hemisphere** and **clockwise in the southern hemisphere**.

Why cyclones occur mostly in late summers?

1. Due to high specific heat of water, and mixing, the **ocean waters in northern hemisphere attain maximum temperatures in August** (in contract continents attain maximum temperatures in June-July).
2. Whirling motion (cyclonic vortex) is enhanced when the **doldrums** (region within ITCZ) over oceans are farthest from the equator (**Coriolis force increases with distance from the equator**).

Why do 'tropical cyclones' winds rotate counter-clockwise in the Northern Hemisphere?

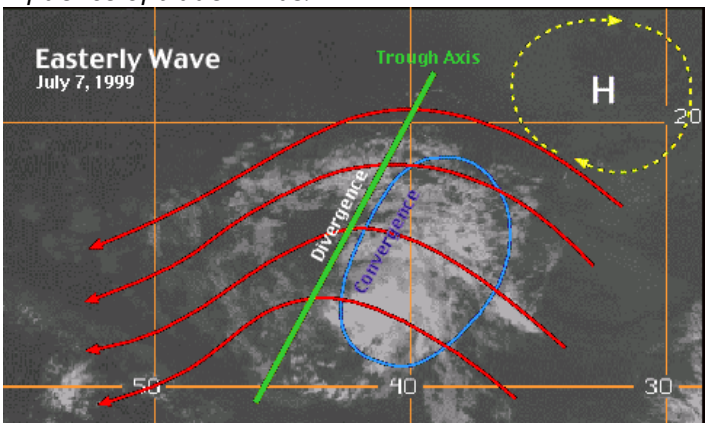
- As the earth's rotation sets up an apparent force (called the Coriolis force) that pulls the winds to the **right** in the Northern Hemisphere (and to the left in the Southern Hemisphere).
- So, when a low-pressure starts to form over north of the equator, the surface winds will flow inward trying to fill in the low and will be deflected to the right, and a **counter-clockwise rotation** will be initiated.
- The opposite (a deflection to the left and a clockwise rotation) will occur south of the equator.

Coriolis force is too tiny to effect rotation in water that is going down the drains of sinks and toilets. The rotation in those will be determined by the geometry of the container and the original motion of the water.

Low-level Disturbances

- Low-level disturbance is a **low-pressure trough (an extended region of low-pressure)** that moves from east to west in the form of **easterly wave disturbances** in the Inter-Tropical Convergence Zone (ITCZ).

A disturbance is a persistent group of thunderstorms with heavy rains and strong wind gusts.
Easterly wave disturbances: *it is a convective trough (thermal origin) — a persistent group of thunderstorms travelling together in east to west direction (westward traveling disturbances) under the influence of trade winds.*



Easterly wave disturbances

- Easterly wave disturbances act as **seedling circulations (birthplace)** for a large number of tropical cyclones. However, not all disturbances develop into cyclones.

Temperature Contrast Between Air Masses

- The convergence of air masses of different temperatures results in instability causing low-level disturbances which are a prerequisite for the origin and growth of violent tropical storms.
- Trade winds from both the hemispheres meet along the inter-tropical front (ITCZ). Temperature contrasts between these air masses must exist when the ITCZ is farthest from the equator so that the low-level disturbances can intensify into a depression (intensifying low-pressure cell).

Wind Shear

- Wind Shear is the difference between wind speeds at different altitudes.
- Tropical cyclones develop when the wind is uniform.

Why is convective cyclogenesis (tropical cyclogenesis) confined to tropics?

- **Because of weak vertical wind shear, cyclone formation processes are limited to latitude equatorward of the subtropical jet stream.**
- In the temperate regions, wind shear is high due to westerlies, and this inhibits convective cyclogenesis.

Why there are very few Tropical Cyclones during southwest monsoon season?

Large vertical wind shear

- The southwest monsoon is characterized by the presence of strong westerly winds (south-west monsoon winds) in the lower troposphere (below 3 km) and strong easterly winds in the upper troposphere (above 9 km). This results **in large vertical wind shear**. **Strong vertical wind shear inhibits cyclone development**.

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Oceanography

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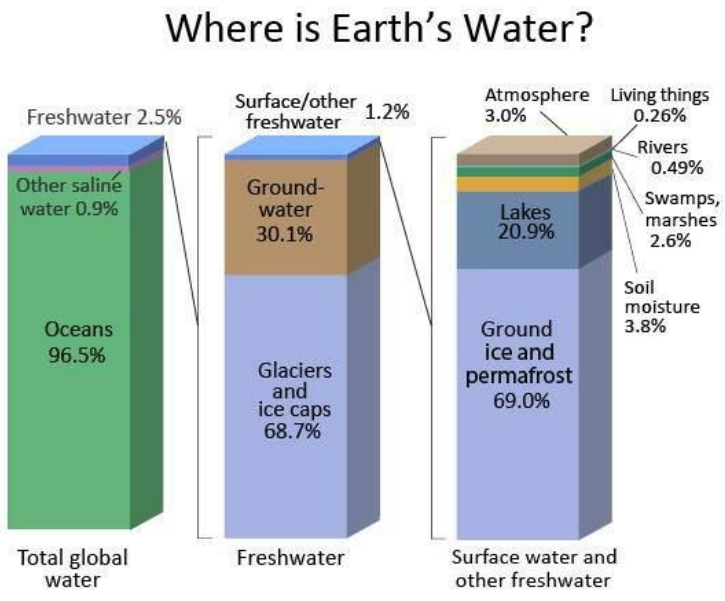
World Water Day – March 22

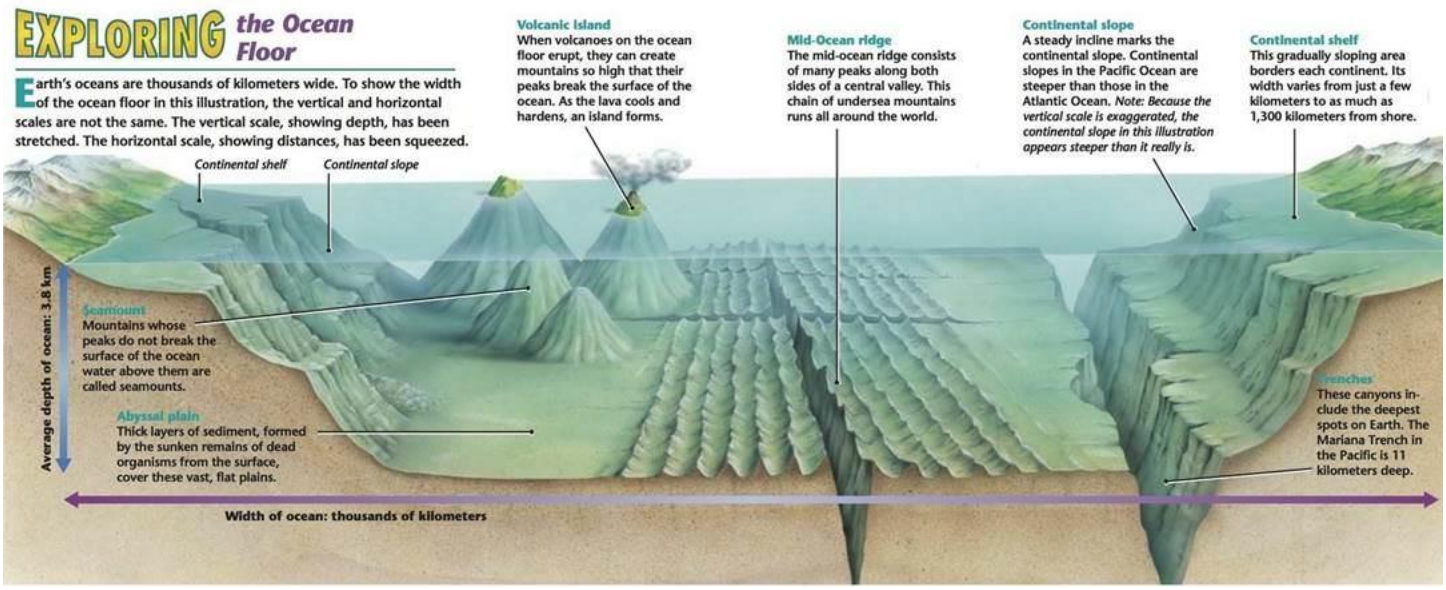
Water on the Earth's surface

Reservoir	Volume (Million Cubic km)	% of the Total
Oceans	1,370	97.25
Icecaps and Glaciers	29	2.05
Groundwater	9.5	0.68
Lakes	0.125	0.01
Soil Moisture	0.065	0.005
Atmosphere	0.013	0.001
Streams and Rivers	0.0017	0.0001
Biosphere	0.0006	0.00004

- Water on earth in liquid form came into existence in Hadean Eon (4,540 – 4,000 mya).
- During the Hadean Eon, temperature on earth was extremely hot, and much of the Earth was molten.
- **Volcanic outgassing** created the primordial atmosphere which consisted of various gases along with water vapour.
- Over time, the Earth cooled, causing the formation of a **solid crust**.
- The water vapour condensed to form rain and rainwater gradually filled the depressions on the newly solidified crust.
- The water in the depressions merged to give rise to mighty oceans.
- During the Hadean Eon, the atmospheric pressure was **27 times greater** than it is today and hence even at a surface temperature of close to 200° C water remained liquid in the oceans.
- Over time, both temperature and atmospheric pressure dropped, and water continues to stay as liquid in the oceans.



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.
NOTE: Numbers are rounded, so percent summations may not add to 100.



Ocean Relief Features

1. Ocean Relief

- Ocean relief is largely due to **tectonic, volcanic, erosional and depositional processes and their interactions.**
- Ocean relief controls the **motion of seawater.**
- The oceanic movement in the form of currents, in turn, causes many variations in both oceans and atmosphere.
- The bottom relief of oceans also influences **navigation and fishing.**

Ocean relief features are divided into major and minor relief features:

1.1 Major Ocean Relief Features

Four major divisions in the ocean relief are:

1. the continental shelf,
2. the continental slope,
3. the continental rise,
4. the Deep Sea Plain or the abyssal plain.

Continental Shelf

- Continental Shelf is the gently sloping (**gradient of 1° or less**) seaward **extension of a continental plate**.
- Continental Shelves cover **7.5%** of the total area of the oceans.
- **Shallow seas** and **gulfs** are found along the continental shelves.
- The shelf typically ends at a very steep slope, called the **shelf break.**
- Examples of continental shelves: Continental Shelf of South-East Asia (Sunda Plate), Grand Banks around Newfoundland, Submerged region between Australia and New Guinea, etc.

Formation

- The shelf is formed mainly due to
  1. **submergence of a part of a continent**
  2. **relative rise in sea level**
  3. **Sedimentary deposits brought down by rivers, glaciers**
- There are various types of shelves based on different sediments of terrestrial origin —
  1. **glaciated shelf (e.g. Shelf Surrounding Greenland),**
  2. **coral reef shelf (e.g. Queensland, Australia),**
  3. **shelf of a large river (e.g. Shelf around Nile Delta),**
  4. **shelf with dendritic valleys (e.g. shelf at the Mouth of Hudson River)**
  5. **shelf along young mountain ranges (e.g. Shelves between Hawaiian Islands).**

Various types of shelves

Width and depth of continental shelves

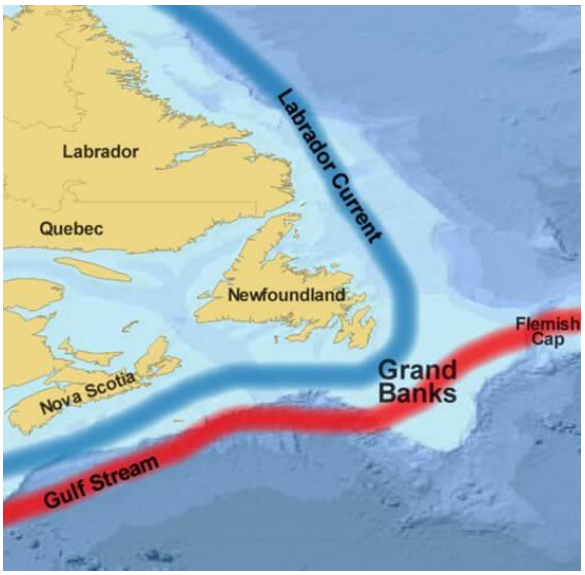
- Continental shelves have an average width of **70-80 km.**
- The shelves are almost absent or very narrow along a convergent boundary. E.g. coasts of Chile.
- The width of continental shelf of eastern coast of USA varies between 100-300 km.
- **Siberian shelf** in the Arctic Ocean is the largest in the world and stretches up to 1,500 km from the coast.

Width of various continental shelves

- Continental shelves may be as shallow as 30 m in some areas while in some areas it is as deep as 600 m.

Importance of continental shelves

- 20% of the world production of **petroleum** and gas comes from shelves.
- Continental shelves form the richest fishing grounds. E.g. Grand Banks around Newfoundland.



Grand Banks, the richest fishing grounds on earth

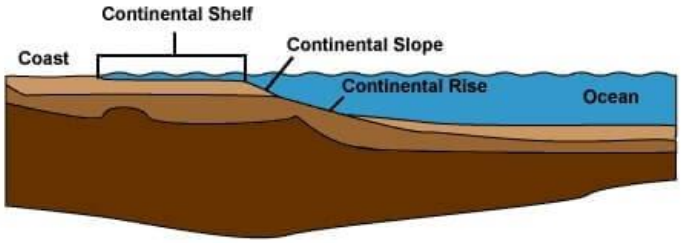
- Marine food comes almost entirely from continental shelves.
- They are sites for **placer deposits** and **phosphorites** (explained in Ocean Resources).

Continental Slope

- The gradient of the slope region varies between **2-5°.**
- The continental slope connects the continental shelf and the ocean basins.
- The depth of the slope region varies between 200 and 3,000 m.
- The seaward edge of the continental slope loses gradient at this depth and gives rise to **continental rise.**
- The **continental slope boundary indicates the end of the continents**.
- Canyons and trenches are observed in this region.

Continental Rise

- The continental slope **gradually** loses its steepness with depth.
- When the slope reaches a level of between **0.5° and 1°**, it is referred to as the continental rise.
- With increasing depth, the rise becomes virtually flat and merges with the **abyssal plain.**



Shelf, Slope and Rise (Wikipedia)

Deep Sea Plain or Abyssal Plain

- Deep sea planes are gently sloping areas of the ocean basins.
- These are the **flattest** and smoothest regions of the world because of **terrigenous** (marine sediment eroded from the land) **and shallow water sediments** that buries the irregular topography.
- It covers nearly **40%** of the ocean floor.
- The depths vary between 3,000 and 6,000 m.
- These plains are covered with fine-grained sediments like clay and silt.

1.2 Minor Ocean Relief Features

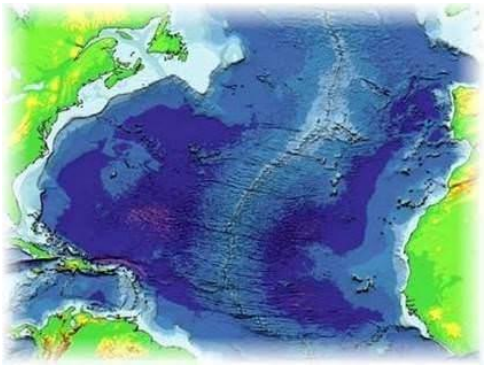
- Ridges (along a divergent boundary),
- Abyssal Hills (submerged volcanic mountains): Seamounts and Guyots,
- Trenches (along a convergent boundary),
- Canyons (erosional landform),
- Island arcs (formed due to volcanism along a convergent boundary or hotspot volcanism),
- Atolls and Coral reefs.

Oceanic Deeps or Trenches

- The trenches are relatively steep-sided, narrow basins (Depressions).
- These areas are the deepest parts of the oceans.
- They are of tectonic origin and are formed during ocean-ocean convergence and ocean-continent convergence.
- They are some 3-5 km deeper than the surrounding ocean floor.
- The trenches lie **along the fringes of the deep-sea plain** at the bases of continental slopes and along island arcs.
- The trenches run **parallel to the bordering fold mountains** or the **island chains**.
- The trenches are very common in the Pacific Ocean and form an almost continuous ring along the western and eastern margins of the Pacific.
- The **Mariana Trench off the Guam Islands** in the Pacific Ocean is the deepest trench with, a depth of more than **11 kilometres.**
- Trenches are associated with **active volcanoes** and **strong earthquakes** (like in Japan).
- Majority of the trenches are in the Pacific Ocean followed by the Atlantic Ocean and Indian Ocean.

Mid-Oceanic Ridges or Submarine Ridges

- A mid-oceanic ridge is composed of two chains of mountains separated by a large depression (divergent boundary).
- The mountain ranges can have peaks as high as 2,500 m and some even reach above the ocean's surface.
- Running for a total length of **75,000 km**, these ridges form the **largest mountain systems on earth.**



Mid Ocean Ridge

- The ridges are either broad, like a plateau, gently sloping or in the form of steep-sided narrow mountains.

Abyssal Hills

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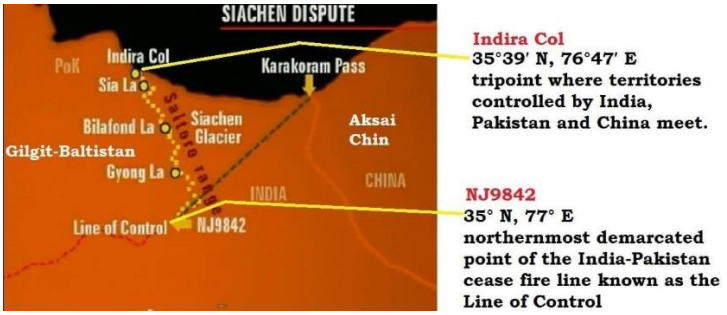
1. India as a Geographical Unit

Map of Jammu and Kashmir showing the occupied regions



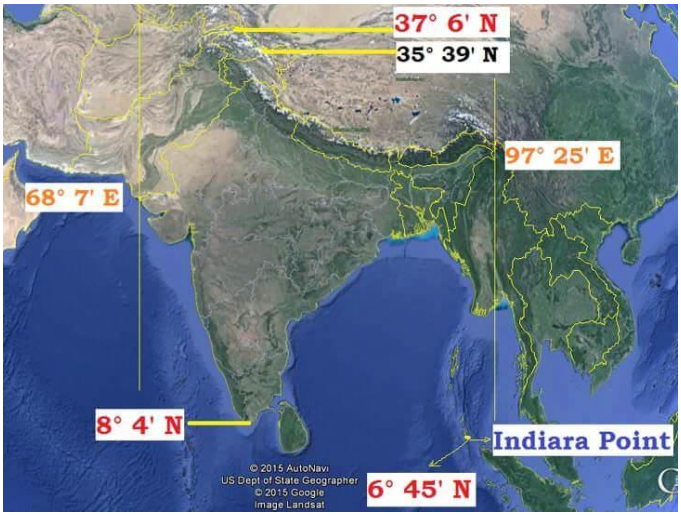
Location: Indira Col and NJ9842

- The southernmost point of the country is the **Pygmalion Point, or Indira Point** is located at **6° 45' N latitude**.
- North-south extent from **Indira Col** in Kashmir to Kanyakumari is **3,214 km**.
- East-west width from the Rann of Kutch to Arunachal Pradesh is **2,933 km**.

East-West Extent (~30°)	***68° 7' East to 97° 25' East longitude***
South-North Extent of mainland India (Including POK) (~29°)	***8° 4' North to 37° 6' North latitude***
South-North Extent of India (Including POK and the Andaman and Nicobar Islands) (~31°)	***6° 45' North to 37° 6' North latitude***

Top 10 Largest Countries in the World by Area

Rank	Country	Capital City	Continent	Area (km^2)
1	Russia	Moscow	Europe	1,70,98,242
2	Canada	Ottawa	North America	99,84,670
3	USA	Washington DC	North America	98,26,675
4	China	Beijing	Asia	95,96,961
5	Brazil	Brasilia	South America	85,14,877
6	Australia	Canberra	Oceania	77,41,220
7	**India**	**New Delhi**	**Asia**	**32,87,263**
8	Argentina	Buenos Aires	South America	27,80,400
9	Kazakhstan	Astana	Asia	27,24,900
10	Algeria	Algiers	Africa	23,81,741



Locational Extent of India

- With an area of **32,87,263 km^2**, India is the **seventh largest** country in the world.
- India accounts for about **2.4 per cent** of the total surface area of the world.
- The Tropic of Cancer passes through the middle of the country dividing it into two latitudinal halves.
- The area to the north of Tropic of Cancer is **near twice** the area which lies to the south of it.
- South of 22° north latitude, the country tapers off over 800 km into the Indian Ocean as a peninsula.
- East-West time difference is nearly **2 hrs**. (A difference of 1° longitude will make a difference of 4 minutes in time. ~30 x 4 = ~120 minutes or ~2 hours).

India, Tropical or Temperate Country?

- The temperate part (north of Tropic of Cancer) is twice the area of the tropical part.
- But India has always been treated as a tropical country for two different reasons – physical and cultural.

Physical Geographical (Climatic) Reasons

- The country is separated from the rest of Asia by the Himalayas.
- The tropical monsoons dominate its climate.
- Himalayas blocks the cold temperate air masses.
- Although winter night temperatures are low, yet clear skies and intense insolation raise the day temperatures to a tropical level.

Cultural Geographical Reasons

- Settlements, diseases, agricultural and primary economic activities are all tropical in nature.

It is primarily because of the Himalayas that India is a predominantly tropical country.

1.2 India's Frontiers

Data from the **Ministry of Home Affairs (Department of Border Management)**

- India has **15106.7 Km** of land border running through **17 States**.
- Indian has a coastline of **7516.6 Km (6100 km of mainland coastline + coastline of 1197 Indian islands)** touching 13 States and Union Territories (UTs).
- Barring Telangana, Madhya Pradesh, Chhattisgarh, Jharkhand, Delhi and Haryana, all other States in the country have one or more international borders or a coastline and can be regarded as **frontline States** from the point of view of border management.
- India's **longest border** is with **Bangladesh** while the shortest border is with Afghanistan.
- The length of India's land borders with neighbouring countries is given in the table below.

Neighbour	Length of the border (in Km)
1) Bangladesh	**4,096.7**
2) China	**3,488**
3) Pakistan	**3,323**
4) Nepal	1,751
5) Myanmar	1,643
6) Bhutan	699
7) Afghanistan	106
	15,106.7

Border with China

- This is the **second longest border of India**, next only to its border with Bangladesh.

- Five Indian states, namely Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh touch the Indian boundary with China.
- The Sino-Indian border is generally divided into three sectors namely: (i) the Western sector, (ii) the Middle sector, and (iii) the Eastern sector.

The Western Sector

- Separates Jammu and Kashmir state of India from the Xinjiang province of China.
- The western sector boundary is largely the outcome of the British policy towards the state of Jammu and Kashmir.
- China claims the **Aksai Chin, the Changmo valley, Pangong Tso and the Sponggar Tso area of north-east Ladakh**.
- China also claims a part of **Huza-Gilgit** area in **North Kashmir** (**ceded to it in 1963 by Pakistan**).

The Middle Sector

- Two Indian states of Himachal Pradesh and Uttarakhand touch this border.

The Eastern Sector

- The 1,140 km long boundary between India and China runs from the eastern limit of Bhutan to a point near **Diphu pass (Talu-Pass)** at the **tri-junction of India, Tibet and Myanmar**.

Diphu Pass *is a mountain pass around the area of the disputed tri-point borders of India, China, and Myanmar.*
It is ***Talu pass*** *on the Burmese side, and* ***Diphu pass*** *on the Indian (Tibetan) side.*

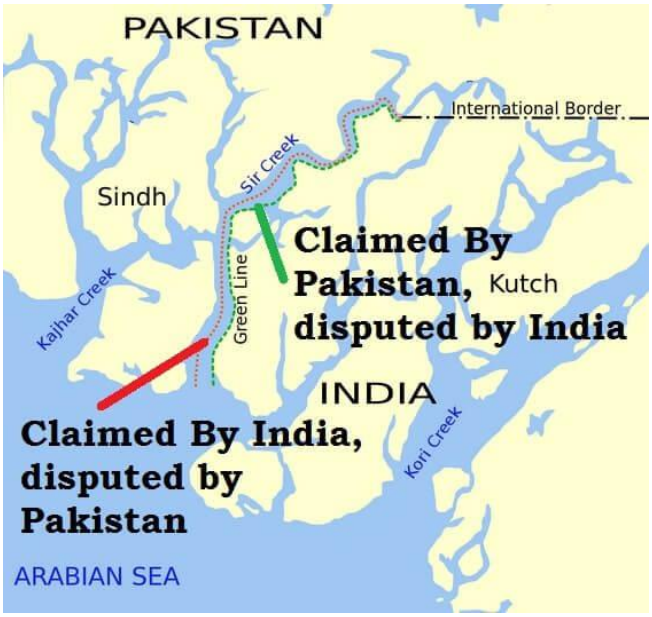
- This line is usually referred to as the **Mc Mahon Line** after Sir Henry Mc Mahon, then foreign secretary of British India, who negotiated the boundary agreement between Great Britain and Tibet at **Shimla accord in 1913-14**.

The India-Nepal Boundary

- Five states of India, namely Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Sikkim touch the Nepalese border with India.
- The border is a **porous** one with an unrestricted movement of goods and people between Indian and Nepal.
- Major portion of Indo-Nepalese border runs in the east-west direction almost along the foothill of the **Shiwalik Range**.

The Indo-Pakistan Boundary

- The Indo-Pakistan boundary is the result of the partition of the country in 1947 under the **Radcliffe award** of which Sir Cyril Radcliffe was the chairman.
- Jammu and Kashmir, **Sir Creek** are the major disputed regions.



Creeks in the Kutch Region

The India-Bangladesh Border

- India's 4,096 km long border with Bangladesh is the **longest**.
- This boundary has been determined under the **Radcliffe Award** which divided the erstwhile province of Bengal into two parts.

India-Myanmar Boundary

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Economic Geography Part I

Distribution of key natural resources across India and the World

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Economic Geography

- Economic geography is the study of patterns of humans' economic activities ranging from production to consumption of various goods and services across the world.
- By 'human economic activities' we mean, production, location, distribution, consumption, exchange of resources, spatial organization of economic activities, etc.
- Different subject matters of economic geography include the distribution of mineral resources, location of industries, economies of agglomeration (economies of urbanization), transportation, international trade, the relationship between the environment and the economy, etc.

Importance of studying economic geography:

- It allows us to understand an area's economy and its economic relationship with other areas around the world.
- It helps us understand the reasons and methods of development of a region or lack of development thereof.
- It helps us find solutions to economic developmental challenges.

GS1 Syllabus:

1. **Distribution of key natural resources across the world (including South Asia and the Indian sub-continent); {Economic Geography Part I}**
2. **factors responsible for the location of primary, secondary, and tertiary sector industries in various parts of the world (including India). {Economic Geography Part II}**

GS3 Syllabus:

1. **Major crops cropping patterns in various parts of the country, different types of irrigation and irrigation systems storage. {Indian Agriculture}**
2. **Infrastructure: Energy, Ports, Roads, Airports, Railways etc. {Will be covered as a separate topic}**

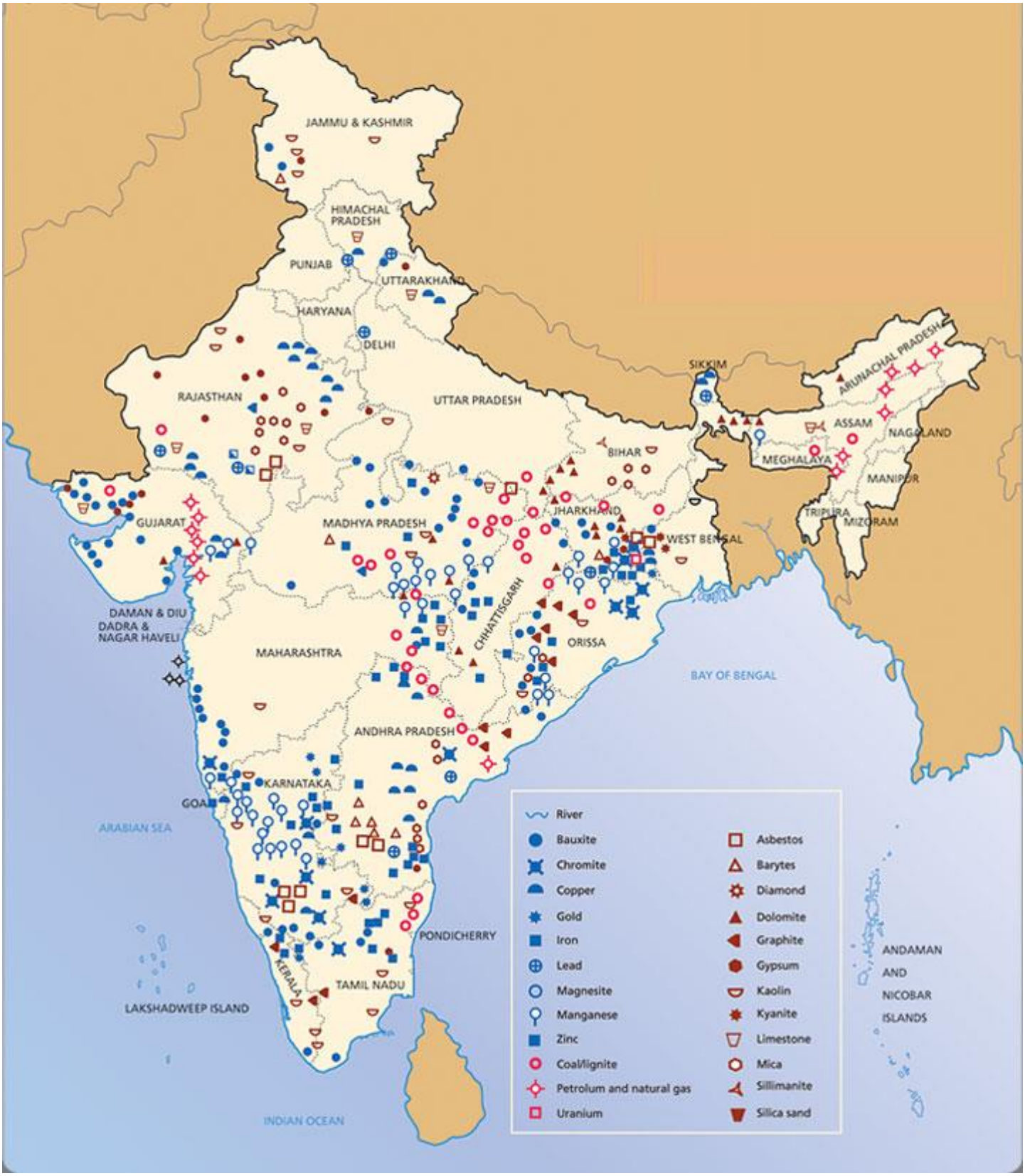
Natural Resources Classification	
Biotic	**Abiotic**
Renewable (Non-conventional): biomass, solar energy, wind energy, etc.	**Non-renewable (Conventional):** coal, oil, iron, etc.
Metallic: Iron, copper, tin, zinc, uranium (heavy metal), etc.	**Non-metallic:** graphite, diamond, mica, limestone, etc.

Renewable and Non-renewable energy resources will be covered as a part of General Science and Science and Technology.

1. Iron

1.2 Types of Iron Ore

- Based on the amount of ore and iron content, iron ore is classified into various types.



- Magnetite (Fe_3O_4) and Haematite (Fe_2O_3) are fine quality ores.
- Limonite, siderite, etc. are inferior ores that have their own unique characteristics.

Magnetite (Fe_3O_4)

- Magnetite has excellent **magnetic qualities**, hence the name.

- It is black in colour and has **very high content of Iron – upto 72 per cent (best quality iron ore)**.
- Magnetite has higher iron content than hematite (60-70 per cent); therefore, its **quality is higher**.
- However, unlike haematite ore, magnetite ore is **not found in high grades**.
- That is, while hematite ore generally contains large concentrations of hematite, magnetite ore generally holds low concentrations of magnetite.
- Hence the ore needs to be **beneficiated** (treat to improve its properties) for magnetite recovery.
- End products (e.g. steel) made from magnetite ore are typically of **higher quality** than those made from hematite ore. That's because **magnetite has fewer impurities than hematite**.
- Magnetite with less iron content (25% to 30%) is known as **Taconite**.
- A naturally magnetized content of magnetite is called **lodestone**.
- Distribution of magnetite ore in India: Dharwad and Cuddapah systems – **Karnataka (73%), Andhra Pradesh (14%), Tamil Nadu (5%), Rajasthan (5%)**, etc.

Haematite (Fe_2O_3)

- Reddish ore with naturally high iron content – **60 to 70 per cent**.
- Because of its high iron content, hematite ore can be used in steel production **without benefaction**.
- Hematite is the most abundantly available ore in India.
- Distribution: **Odisha, Jharkhand, Chhattisgarh, Andhra Pradesh, Karnataka, Maharashtra and Goa**.

Limonite

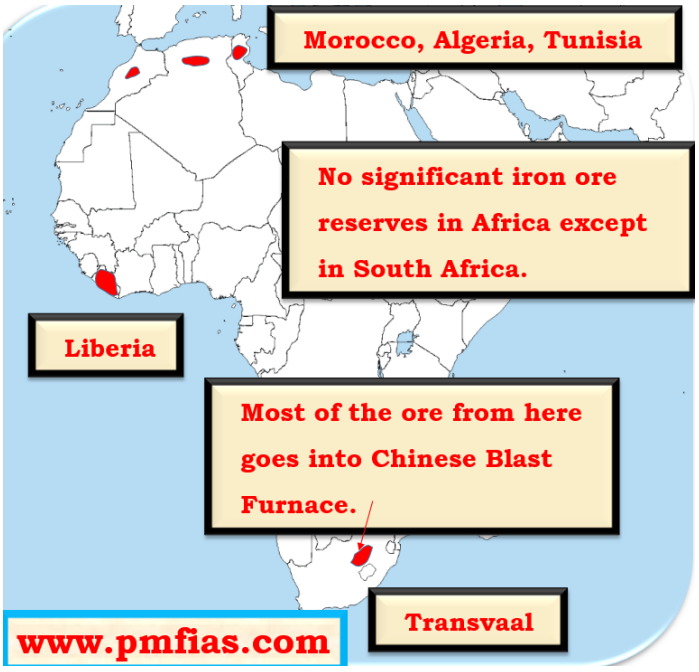
- Limonite is inferior iron ore that is yellowish in colour with **40 to 60 per cent iron content**.
- Limonite mines are **open cast mines**; hence mining is **easy and cheap**.
- Distribution: **Damuda series in Raniganj coal field**, Garhwal in Uttarakhand, Mirzapur in Uttar Pradesh and Kangra valley of Himachal Pradesh.

Siderite ($FeCO_3$)

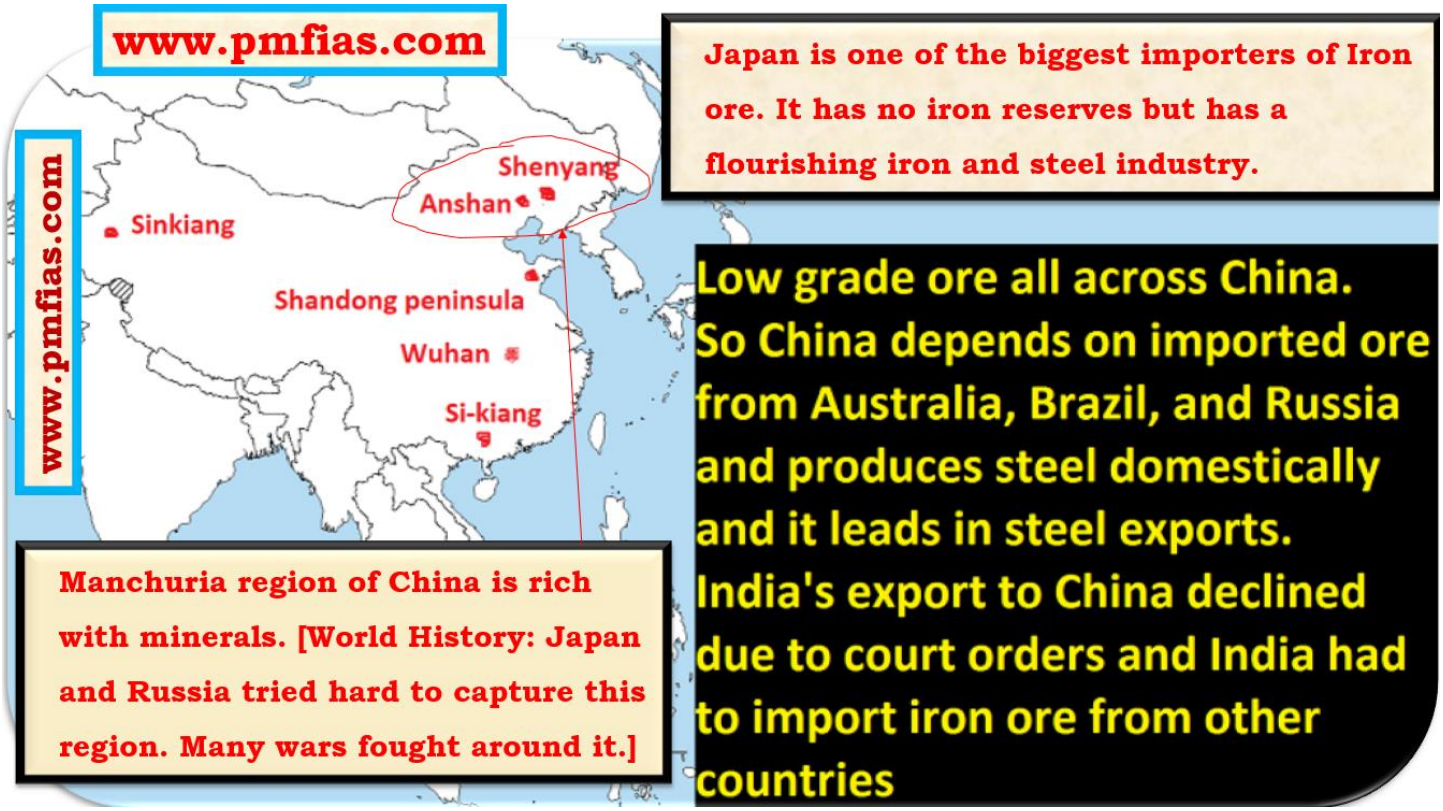
- It is **iron carbonate ore** of inferior quality with **less than 40 per cent iron content**.
- It contains many impurities and hence mining, in many places, is economically unviable.
- However, one good quality of the ore is that it doesn't contain sulphur or phosphorus.
- And also, it is **self-fluxing** due to the presence of lime.

1.3 Iron Ore Distribution Across the World

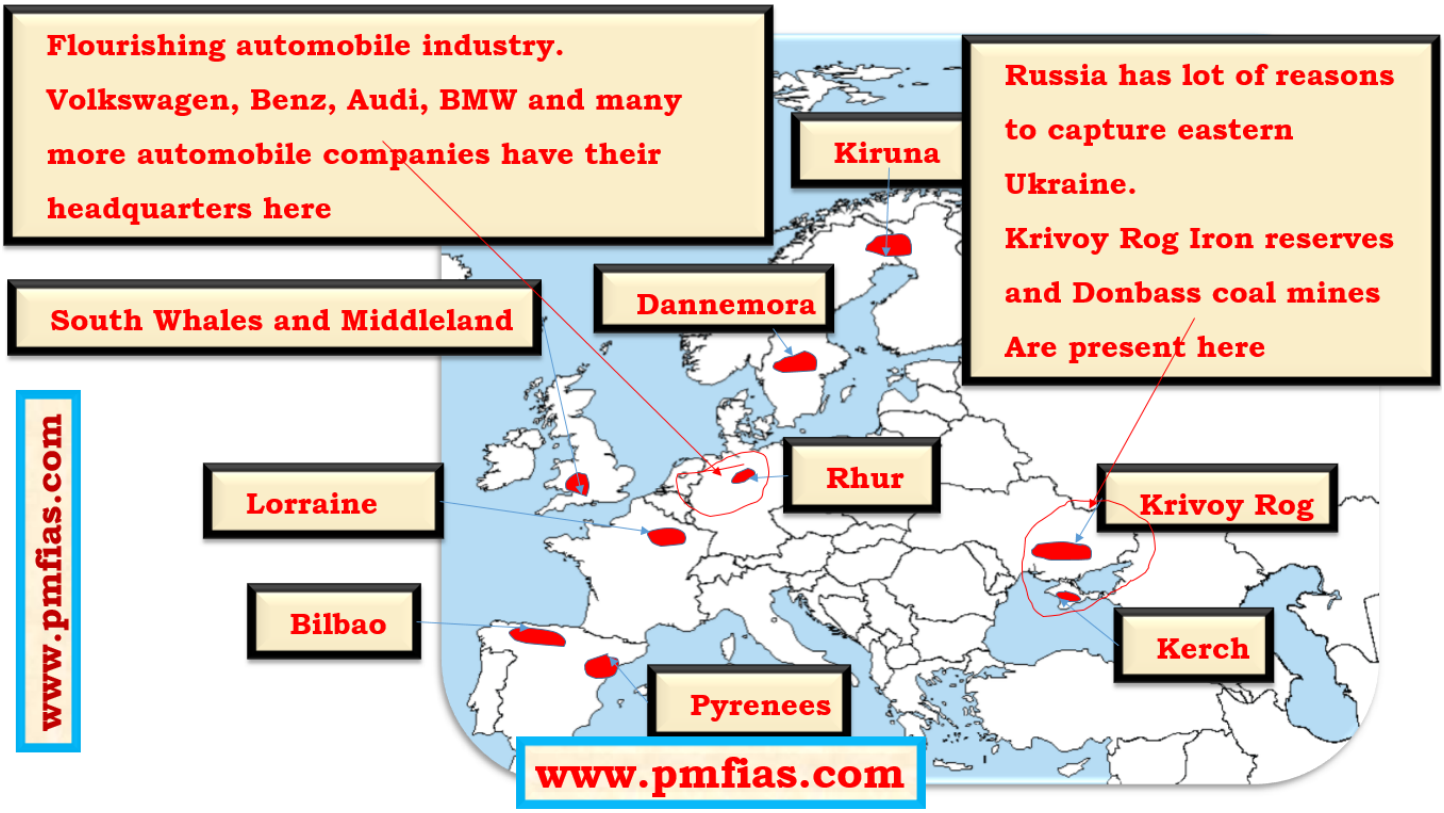
Iron ore in Africa: Transvaal, Liberia



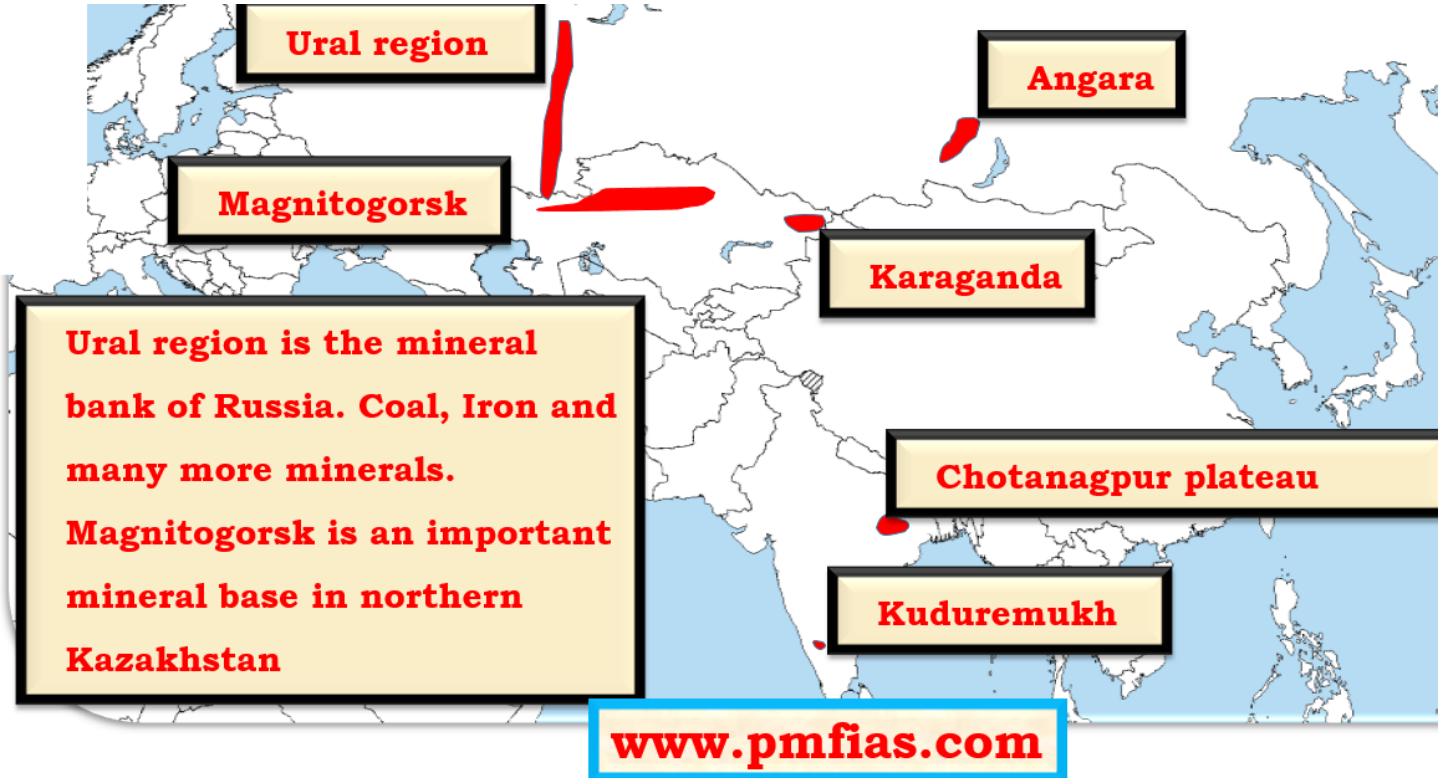
Iron Ore in China: Manchuria, Sinkiang, Si-kiang, Shandog Peninsula



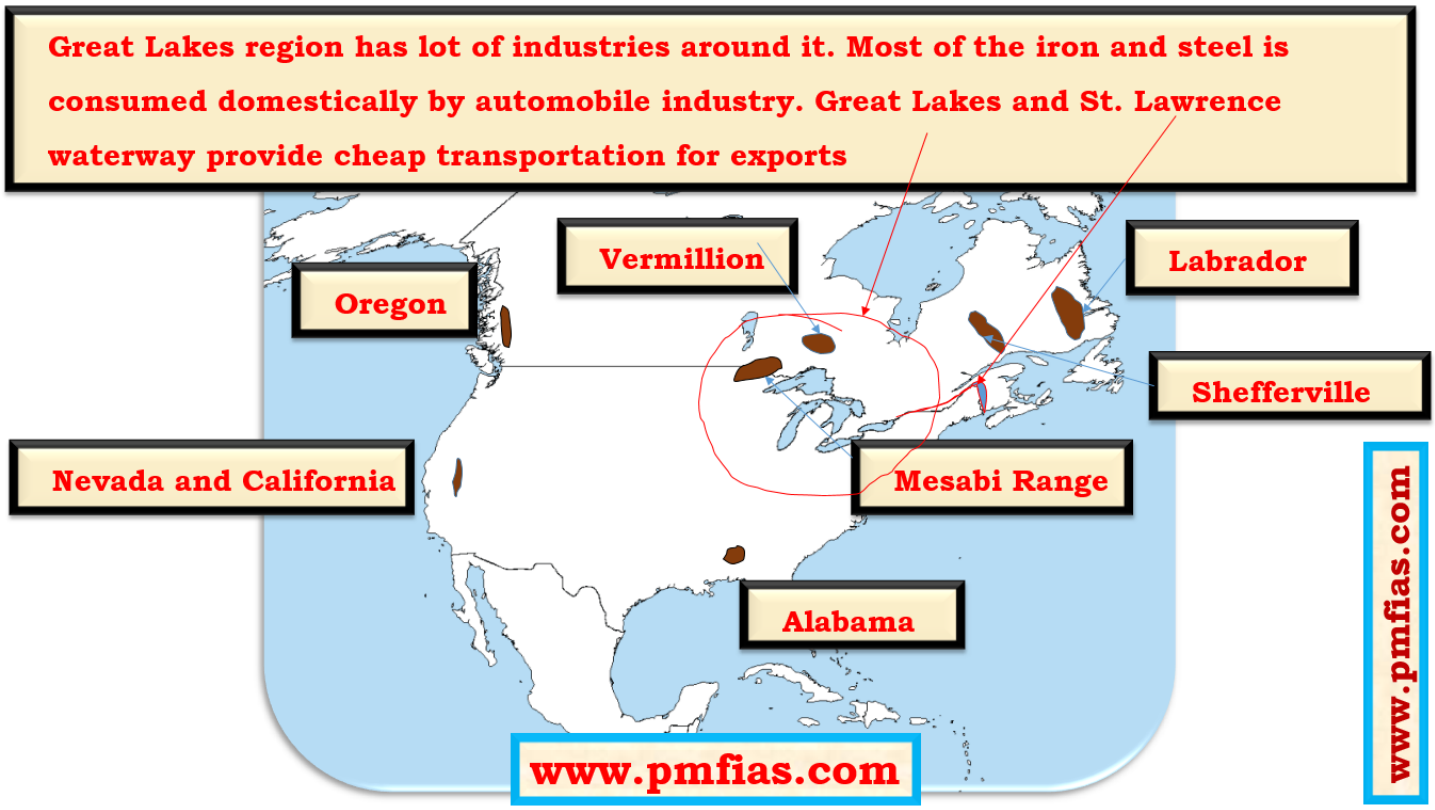
Iron Ore in Europe: Ruhr, South Whales, Krivoy Rog, Bilbao, Lorraine



Iron ore in Russia, Kazakhstan: Ural region, Magnitogorsk



Iron Ore in North America: Great Lakes (Mesabi Region), Labrador



Iron Ore in South America: Carajas, Itabira, Minas Geriais

- The main concentration of Sillimanite is found in Tamil Nadu, Orissa, Kerala, Andhra Pradesh.
- Orissa is the largest producer of sillimanite in India. Ganjam is an important sillimanite producing district.
- Kerala is the second largest producing state.

13.4 Gypsum

- Gypsum is a **hydrated sulphate of calcium**.
- It is a white opaque or transparent mineral.
- It occurs in sedimentary formations such as limestones, sandstones and shales.
- It is mainly used in making **ammonia sulphate fertilizer** and in **cement industry**.
- It makes upto 4-5 per cent of cement.
- It is applied in agriculture for conserving moisture in the soil and for aiding nitrogen absorption.
- **Rajasthan** is by far the largest producer of gypsum in India (99 per cent of the total production of India).
- The main deposits occur in Jodhpur, Nagaur and Bikaner.
- The remaining gypsum is produced by Tamil Nadu (Tiruchirapalli district), Jammu and Kashmir.

14. Atomic Minerals

- **Uranium, Plutonium** and **Thorium** are the main atomic minerals.
- Other atomic minerals are **beryllium, lithium and zirconium**.
- Zirconium is found along the Kerala coast & in alluvial rocks of Ranchi & Hazaribagh districts of Jharkhand.
- India has sufficient reserves of beryllium to meet her requirement of atomic power generation.
- Plutonium has occurred naturally, but except for trace quantities it is now not found in the Earth's crust.
- Plutonium is formed **in nuclear power reactors** from **uranium-238** by neutron capture.
- The most common plutonium isotope formed in a typical nuclear reactor is the fissile Pu-239.
- Pu-239 is the principal fuel in a **fast neutron reactor**.

14.1 Uranium

- Uranium is a silvery-grey metallic radioactive chemical element.
- It is only naturally formed in supernova explosions.
- **Uranium, thorium**, and **potassium** are the main elements contributing to natural terrestrial radioactivity.
- Uranium has the chemical symbol U and atomic number 92.
- Uranium isotopes in natural uranium are **^{238}U (99.27%)** and **^{235}U (0.72%)**.
- All uranium isotopes are **radioactive and fissionable**.
- But only **^{235}U** is **fissile** (will support a **neutron-mediated chain reaction**).
- Traces of Uranium are found everywhere.
- Commercial extraction is possible only in locations where the proportion of Uranium is adequate.

Uranium Reserves and Production across the World

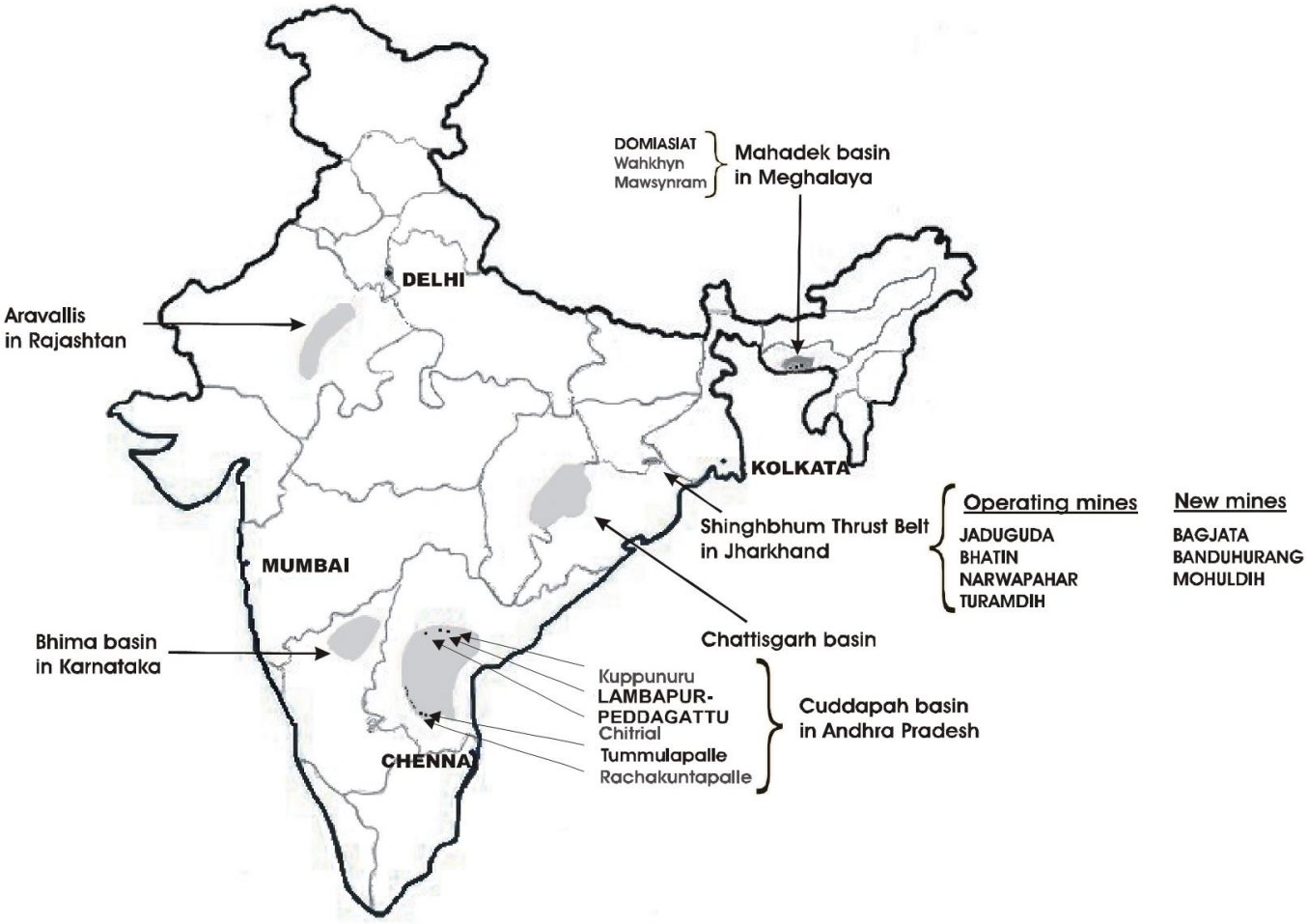
World's Uranium (U) Reserves (TT)			World's Uranium (U) Production (TT) in 2017		
Country	**Reserves as of 2015**		**Country/Region**	**Production**	
1. Australia	1780	23%	1. Kazakhstan	23.3	39.2%
2. Kazakhstan	941	12%	2. Canada	13.1	22.1%

3. Canada	**703**	**9%**	**3. Australia**	**5.8**	**9.9%**
4. Namiba	463	6%	4. Namibia	4.2	7.1%
India	**139**	2%	**India**	**0.4**	**0.7%**
Total	7641 TT		World	59 TT	

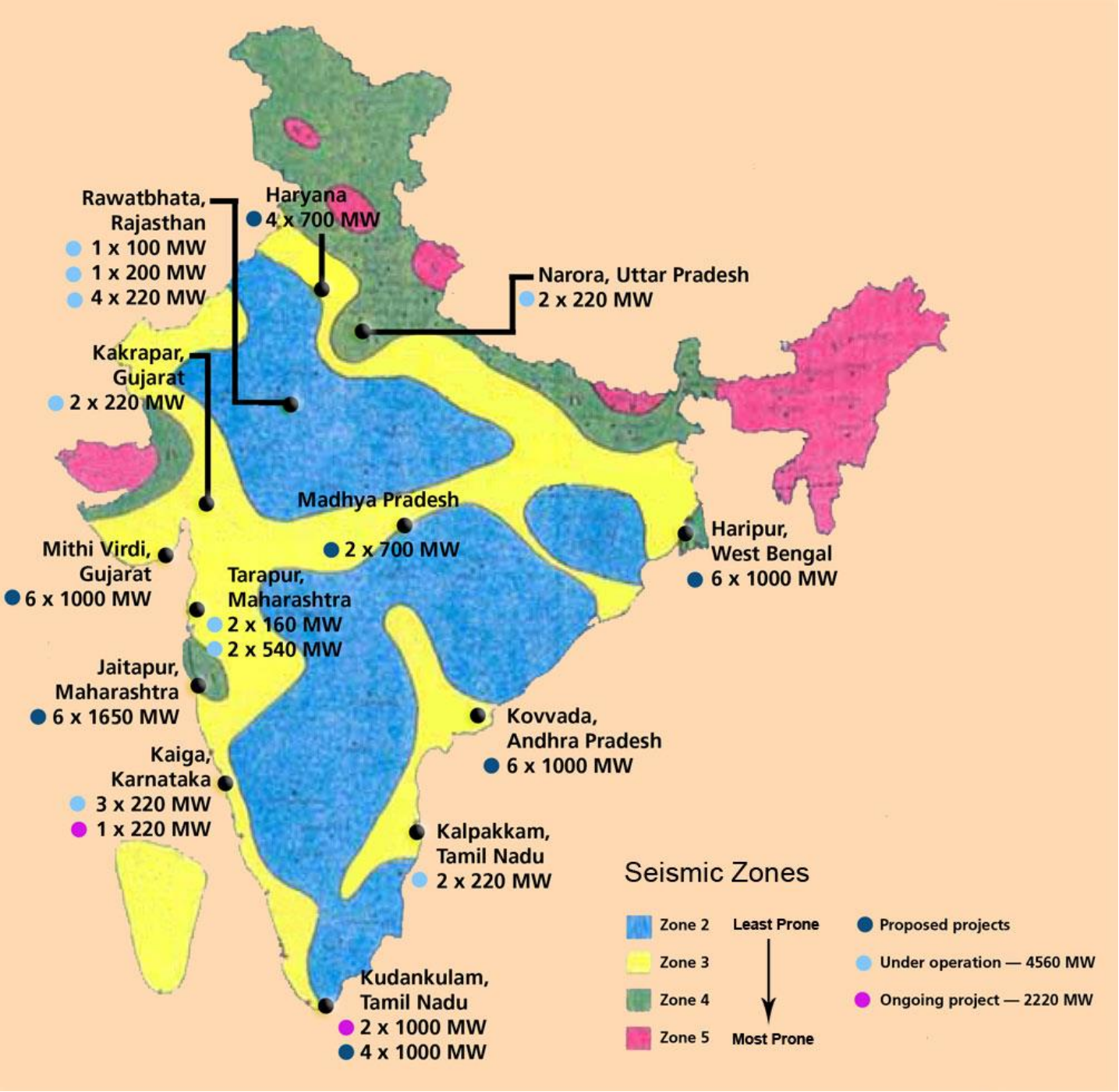
- **Olympic Dam** and the **Ranger mine** in Southern Australia are important mines in Australia.
- High-grade deposits are only found in the **Athabasca Basin** region of Canada.
- The **Chu-Sarysu basin** in central Kazakhstan alone accounts for most of the country's uranium resources

Uranium in India

- **Monazite sands** comprises the largest source of uranium.
- Monazite sands occur on **east and west coast**s and in some places in Bihar.



- But the largest concentration of monazite sand is on the **Kerala coast**.
- Over 15,200 tonnes of uranium is estimated to be contained in monazite.
- Some uranium is found in the copper mines of Udaipur in Rajasthan.
- Uranium deposits occur in **Jaduguda in Singhbhum Thrust Belt** and **Hazaribagh districts of Jharkhand**, **Gaya district of Bihar**, **Cuddapah basin of Andhra Pradesh**, **Aravallis**, & **Mahadek basin of Meghalaya**.
- Singhbhum Copper belt is known for a number of copper deposits with associated nickel, molybdenum, bismuth, gold, silver etc.
- The state of **Andhra Pradesh** is the largest producer of uranium in India.
- Tummalapalle village located in the **Kadapa (Cuddapah) district of Andhra Pradesh** is considered as one of the largest uranium reserves in India.



- India has no significant reserves of Uranium. All needs are met through imports.
- India imports thousands of tonnes of uranium from **Russia, Kazakhstan, France,** and **Uzbekistan.**
- India is trying hard to import uranium from Australia and Canada.
- However, there are some concerns regarding nuclear proliferation and other related issues.

14.2 Thorium

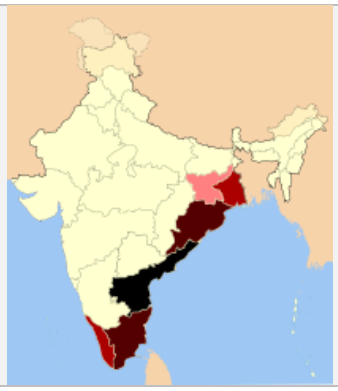
- Thorium is a chemical element with symbol Th and atomic number 90.
- **Uranium and thorium** are the only radioactive elements that occur **naturally** in large quantities.
- Thorium is **weakly radioactive**: all its known isotopes are **unstable**, with the seven naturally

occurring ones (thorium-227, 228, 229, 230, 231, 232, and 234).
- **Thorium-232** is the most stable isotope of thorium and accounts for nearly all natural thorium, with the other five natural isotopes occurring only in traces.

Thorium Distribution

- Thorium is estimated to be about **three to four times more abundant than uranium** in the Earth's crust and is chiefly refined from **monazite sands.**
- Monazite contains 2.5% thorium **and is scattered along the Kerala Coast**.
- The other mineral carrying thorium is **thorianite**.
- Thorium is predicted to be able to replace uranium as nuclear fuel in nuclear reactors, but only a few thorium reactors have yet been completed.
- The known reserves of thorium in India are estimated to be between 457,000 and 508,000 tonnes.
- **Kerala**, Jharkhand, Bihar, Tamil Nadu and Rajasthan are the main producers.
- **United States, Australia, and India** have particularly large reserves of thorium.

World's Thorium Reserves (2011)		India's Thorium Reserves (2016)	
Country	**Reserves in TT**	**State**	**Reserves**
1. India	**963**	**1. Andhra Pradesh**	**31%**
2. United States	**440**	2. Tamil Nadu	21%
3. Australia	**300**	3. Odisha	20%
4. Canada	100	4. Kerala	16%
5. South Africa	35	5. West Bengal	10%



Related topics:

- Nuclear Fission, Components of Nuclear Reactor, Types of Nuclear Reactors
- India's Three-Stage Nuclear Power Programme

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Economic Geography Part II (Industrial Locational Factors Part I)
Factors responsible for the location of primary, secondary, and tertiary sector

Print-Friendly PDF

1. Primary, Secondary and Tertiary Sectors

- Economic activities are broadly grouped into **primary, secondary, tertiary** and **quaternary activities**.

1.1. Primary Activities

- Primary activities are **directly dependent on the environment** as these refer to utilisation of earth's resources such as land, water, vegetation, building materials, minerals, etc.
- It thus includes hunting, gathering, pastoral activities, fishing, forestry, agriculture, **mining, quarrying, etc**.
- Industries that are involved in primary economic activities are called as primary industries.

1.1.1 Hunting and Gathering

- Gathering is practised in regions with harsh climatic conditions.
- It involves primitive societies that extract from both plants and animals to satisfy their basic needs.
- The yield per person is meagre and little, or no surplus is produced.
- Gathering is practised in:
  - ✓ high latitude zones which include northern Canada, northern Eurasia and southern Chile.
  - ✓ Low latitude zones such as the Amazon Basin, tropical Africa, Northern fringe of Australia and the interior parts of Southeast Asia.
- They use various parts of the plants, e.g., the bark is used for **quinine, tanin** extract and tree trunk yield rubber, gums and resins.
- The chewing gum after the flavour is gone is called Chicle — it is made from the juice of **zapota tree**.
- In modern times some gathering is market-oriented and has become commercial.
- However, synthetic products often of better quality and at lower prices have replaced many items supplied by the gatherers in tropical forests.
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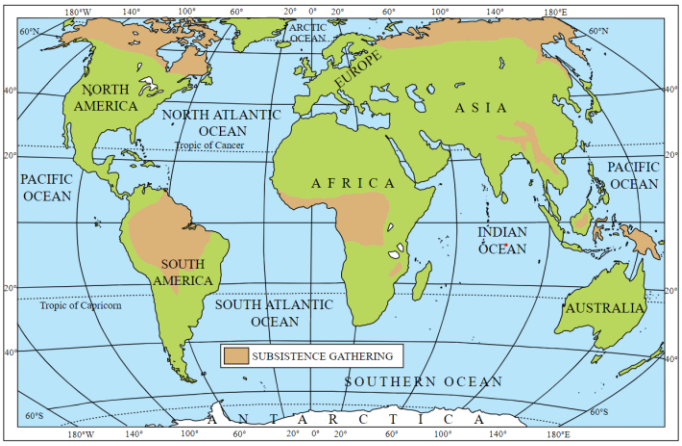


Image Source: NROER

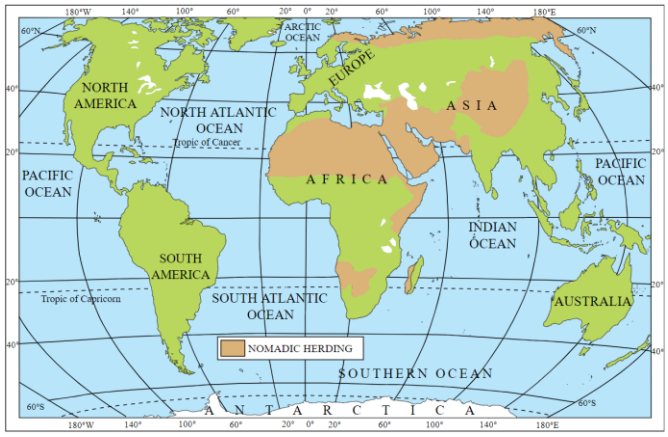
1.1.2 Pastoralism

- At some stage in history, as hunting was unsustainable, humans began the domestication of animals.
- People living in different climatic conditions selected and domesticated animals found in those regions.

Nomadic Herding (pastoral nomadism)

- Nomadic herding is a primitive subsistence activity.

- They move from place to place along with their livestock, depending on the availability of pastures & water.
- A wide variety of animals is kept in different regions.
- In tropical Africa, cattle are the most important livestock, while in Sahara and Asiatic deserts, sheep, goats and camel are reared.
- In the mountainous areas of Tibet and Andes, yak and llamas and in the Arctic and sub-Arctic regions, reindeer are the most important animals.
- Pastoral nomadism is associated with three important regions.
- The core region extends from the Atlantic shores of North Africa eastwards across the Arabian Peninsula into Mongolia and Central China.
- The second region extends over the tundra region of Eurasia.
- In the southern hemisphere there are small areas in South-west Africa and on the island of Madagascar.



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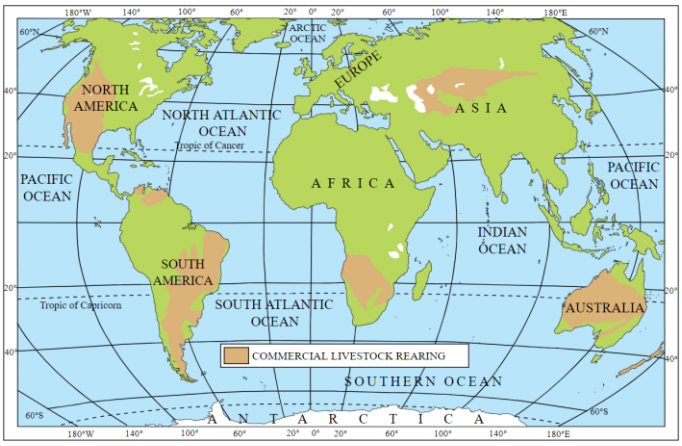
- The process of migration from plain areas to pastures on mountains during summers and again from mountain pastures to plain areas during winters is known as **transhumance**.
- In mountain regions, such as Himalayas, **Gujjars, Bakarwals, Gaddis** and **Bhotiyas** migrate from plains to the mountains in summers and to the plains from the high altitude pastures in winters.
- The number of pastoral nomads has been decreasing due to the imposition of political boundaries.

1.1.3 Commercial Livestock Rearing

- Commercial livestock rearing is more organised and capital intensive.
- Commercial livestock ranching is associated with western cultures and is practised on permanent ranches.
- These ranches (a large farm where cattle are bred) cover large areas and are divided into a number of parcels, which are fenced to regulate the grazing.
- When the grass of one parcel is grazed, animals are moved to another parcel.
- This is a specialised activity in which **only one type of animal is reared**.
- Essential animals include sheep, cattle, goats and horses.
- Meat, wool, hides and skin are processed and packed scientifically and exported world markets.
- Rearing of animals in ranching is organised on a scientific basis.
- The main emphasis is on breeding, genetic improvement, disease control and health care of the animals.



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- **New Zealand, Australia, Argentina, Uruguay** and **the United States of America** are important countries where commercial livestock rearing is practised.

1.1.4 Subsistence Agriculture

- In subsistence agriculture, almost all the production is consumed locally with little or nothing left for trade.
- Primitive Subsistence Agriculture and Intensive Subsistence Agriculture are the two types.

Primitive Subsistence Agriculture

- Primitive subsistence agriculture or **shifting cultivation** is widely practised by many tribes in the tropics.
- The vegetation is usually cleared by fire, and the ashes add to the fertility of the soil.
- Shifting cultivation is thus, also called **slash and burn** agriculture.
- It is prevalent in the tropical region in different names, e.g. **Jhuming** in Northeastern states of India, **Milpa** in Central America and Mexico and **Ladang** in Indonesia and Malaysia.

Intensive Subsistence Agriculture

- This type of agriculture is largely found in **densely populated regions of monsoon Asia**.
- There are two types of intensive subsistence agriculture.

Intensive subsistence agriculture dominated by wet paddy cultivation

- Landholdings are very small due to the high density of population.
- Farmers work with the help of family labour leading to intensive use of land.
- Use of machinery is limited, and most of the agricultural operations are done by manual labour.
- Farmyard manure is used to maintain the fertility of the soil.
- In this type of agriculture, the **yield per unit area is high but per labour productivity is low**.

Intensive subsidence agriculture dominated by crops other than paddy

- Due to the difference in relief, climate, soil, etc. it is not practical to grow paddy in parts of monsoon Asia.
- Wheat, soyabean, barley & sorghum are grown in northern China, North Korea and North Japan.
- In India wheat is grown in plains and millets are grown in dry parts of western and southern India.
- Most of the characteristics are similar to that of wet paddy cultivation except that **irrigation is often used**.

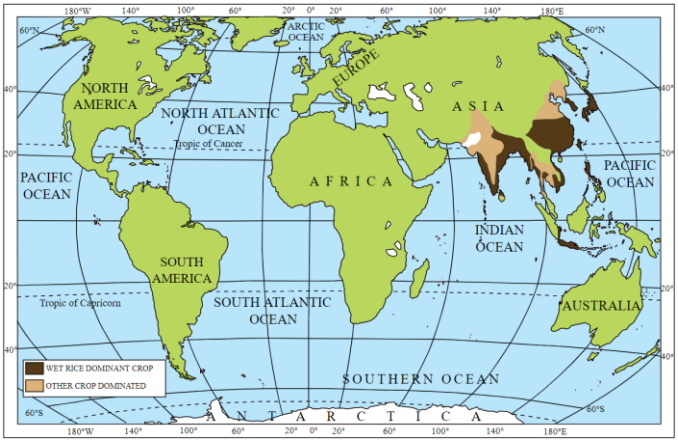


Image Source: NROER

1.1.5 Plantation Agriculture

- Plantation agriculture was introduced by the Europeans in colonies situated in the tropics.
- Plantations are mainly profit-oriented large scale production systems.
- E.g. **tea, coffee, cocoa, rubber, cotton, palm, sugarcane, banana** & **pineapple**.
- The characteristic features of this type of farming are

- ✓ **large estates or plantations,**
- ✓ **large capital investment**,
- ✓ managerial and technical support,
- ✓ scientific methods of cultivation,
- ✓ single crop specialisation,
- ✓ cheap labour, and
- ✓ **a good system of transportation** which links the estates to the factories and markets.

- The **French** established **cocoa** and **coffee** plantations in **west Africa**.
- The **British** set up large
  - ✓ **tea gardens** in **India** and **Sri Lanka**,
  - ✓ **rubber plantations** in **Malaysia** and
  - ✓ **sugarcane** and **banana** plantations in **West Indies**.
- Spanish and Americans invested heavily in **coconut** and **sugarcane** plantations in the **Philippines**.
- The Dutch once had a monopoly over **sugarcane** plantation in **Indonesia**.
- Some **coffee** fazendas (large plantations) in **Brazil** are still managed by Europeans.

1.1.6 Extensive Commercial Grain Cultivation

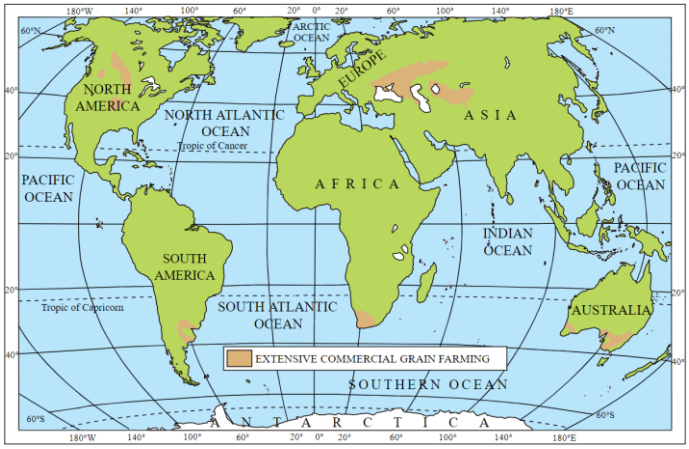
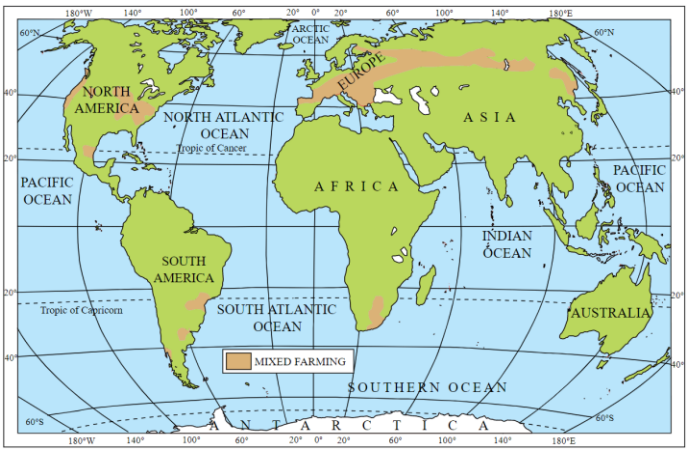


Image Source: NROER

- Commercial grain cultivation is practised in the interior parts of semi-arid lands of the midlatitudes.
- **Wheat** is the principal crop, though other crops like **corn, barley, oats** and **rye** are also grown.
- The size of the farm is very large. Therefore entire operations of cultivation are **mechanised**.
- There is a **low yield per acre but high yield per person**.
- This type of agriculture is best developed in the **Eurasian steppes**, the **North American Prairies**, **Pampas of Argentina**, **Velds of South Africa**, the **Australian Downs** and the **Canterbury Plains of New Zealand**.

1.1.7 Mixed Farming

- This form of agriculture is found in the highly developed parts of the world, e.g. **Northwestern Europe, Eastern North America**, and the temperate latitudes of Southern continents.
- Mixed farms are moderate in size & the crops grown are **wheat, barley, oats, maize, fodder & root crops**.



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- **Animal husbandry** is an essential component of mixed farming.
- Animals like cattle, sheep, pigs and poultry provide the primary income along with crops.
- **Crop rotation** and **intercropping** play an essential role in maintaining soil fertility.
- Mixed farming is characterised by **high capital expenditure** on farm machinery and building, **extensive use of chemical fertilisers** and

green manures and also by the **skill and expertise of the farmers**.

1.1.8 Dairy Farming

- Dairy is the most advanced and efficient type of rearing of milch animals.
- It is **highly capital intensive**.
- Animal sheds, storage facilities for fodder, feeding and milking machines add to the cost of dairy farming.
- Special emphasis is laid on cattle breeding, health care and veterinary services.
- It is **highly labour intensive** as it involves rigorous care in feeding and milking.
- There is no offseason during the year as in the case of crop raising.
- It is practised **near urban centres** which provide a neighbourhood market for fresh milk & dairy products.
- The development of transportation, refrigeration, pasteurisation and other preservation processes have increased the duration of storage of various dairy products.
- There are three main regions of commercial dairy farming.
- The largest is **North Western Europe** the second is **Canada,** and the third belt includes **South Eastern Australia, New Zealand and Tasmania**.

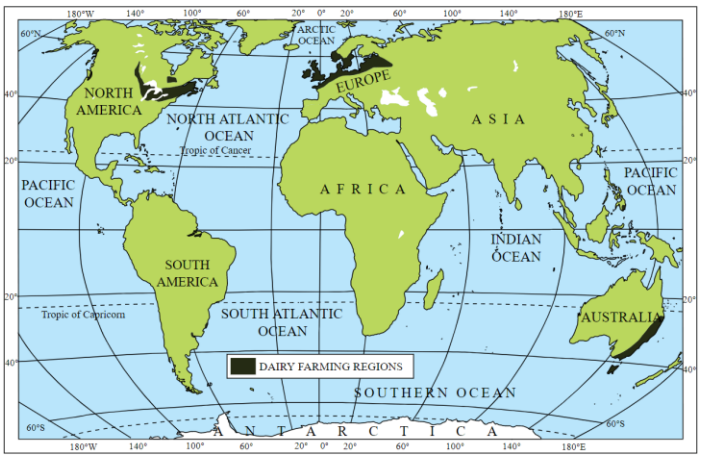


Image Source: NROER

1.1.9 Mediterranean Agriculture

- Mediterranean agriculture is highly specialised commercial agriculture.
- It is practised in the countries on either side of the Mediterranean Sea, southern California, central Chile, southwestern parts of South Africa and south and southwestern parts of Australia.
- This region is an important supplier of **citrus fruits**.
- **Viticulture or grape cultivation** is a speciality of the Mediterranean region.
- Best quality wines in the world are produced from high-quality grapes in various countries of this region.
- The inferior grapes are dried into raisins and currants. This region also produces olives and figs.
- The advantage of Mediterranean agriculture is that more valuable crops such as fruits and vegetables are grown in **winters** when there is a great demand in European and North American markets.

1.1.10 Market Gardening and Horticulture

- Market gardening and horticulture specialise in the cultivation of high-value crops such as vegetables, fruits and flowers, solely for the **urban markets**.
- Farms are small and are located where there are **good transportation** links with the urban centre.
- It is **both labour and capital intensive** and lays emphasis on the use of irrigation, HYV seeds, fertilisers, insecticides, greenhouses and artificial heating in colder regions.
- This type of agriculture is well developed in densely populated industrial districts of **north-west Europe, northeastern United States of America and the Mediterranean regions**.

- The farming where farmers specialise in vegetables only is known as **truck farming**.
- The distance of truck farms from the market is governed by the distance that a truck can cover overnight.
- The modern development in the industrial regions of Western Europe & North America is **factory farming**.
- Livestock, particularly poultry and cattle rearing, is done in stalls and pens.
- They fed on manufactured feedstuff and carefully supervised against diseases.
- This requires **heavy capital investment**, veterinary services and heating and lighting.

1.1.11 Co-operative Farming

- A group of farmers form a co-operative society voluntarily for more efficient and profitable farming.
- Individual farms remain intact, and farming is a matter of cooperative initiative.
- Co-operative societies help farmers, to procure all valuable inputs of farming, sell the products at the most favourable terms and assist in the processing of quality products at cheaper rates.
- The co-operative movement has been successful in many western European countries like **Denmark, Netherlands, Belgium, Sweden, Italy** etc.

1.1.12 Collective Farming

- It is based on social ownership of the means of production and collective labour.
- Collective farming or the model of **Kolkhoz** was introduced in erstwhile USSR to improve upon the inefficiency of the previous methods of agriculture and to boost agricultural production for self-sufficiency.
- The farmers used to pool in all their resources like land, livestock and labour.
- They were allowed to retain very small plots to grow crops in order to meet their daily requirements.

1.1.13 Mining

- The actual development of mining began with the industrial revolution.
- Mining is of two types: surface mining (**open-cast mining**) and underground mining.
- Surface mining is the easiest and the cheapest way of mining minerals that occur close to the surface.
- The output is both large and rapid.
- When the ore lies deep below the surface, the underground mining (**shaft method**) has to be used.
- In this method, underground galleries from vertical shafts radiate to reach the minerals.
- Minerals are extracted and transported to the surface through these passages.
- It requires specially designed lifts, drills, haulage vehicles, ventilation system for safety and efficiency.
- This method is risky — poisonous gases, fires, floods, and caving lead to fatal accidents.
- The developed economies are retreating from mining, processing and refining stages of production due to high labour costs, while the developing countries with large labour force are becoming more important.
- Several countries of Africa and Asia have over fifty per cent of the earnings from minerals alone.

1.2. Secondary Activities

- Secondary activities transform raw materials into valuable products by the processes of processing, manufacturing, and construction.
- In each of these processes, the common characteristics are the **application of power, mass**

production of identical products and **specialised labour** in **factory settings** for the production of commodities.

1.2.1 Modern Manufacturing Industry

- Modern large scale manufacturing undertakes mass production of standardised parts by each worker or robot performing only one task repeatedly.

Mechanisation

- Mechanisation refers to using gadgets which accomplish tasks.
- **Automation** (manufacturing without the aid of human thinking) is the advanced stage of mechanisation.

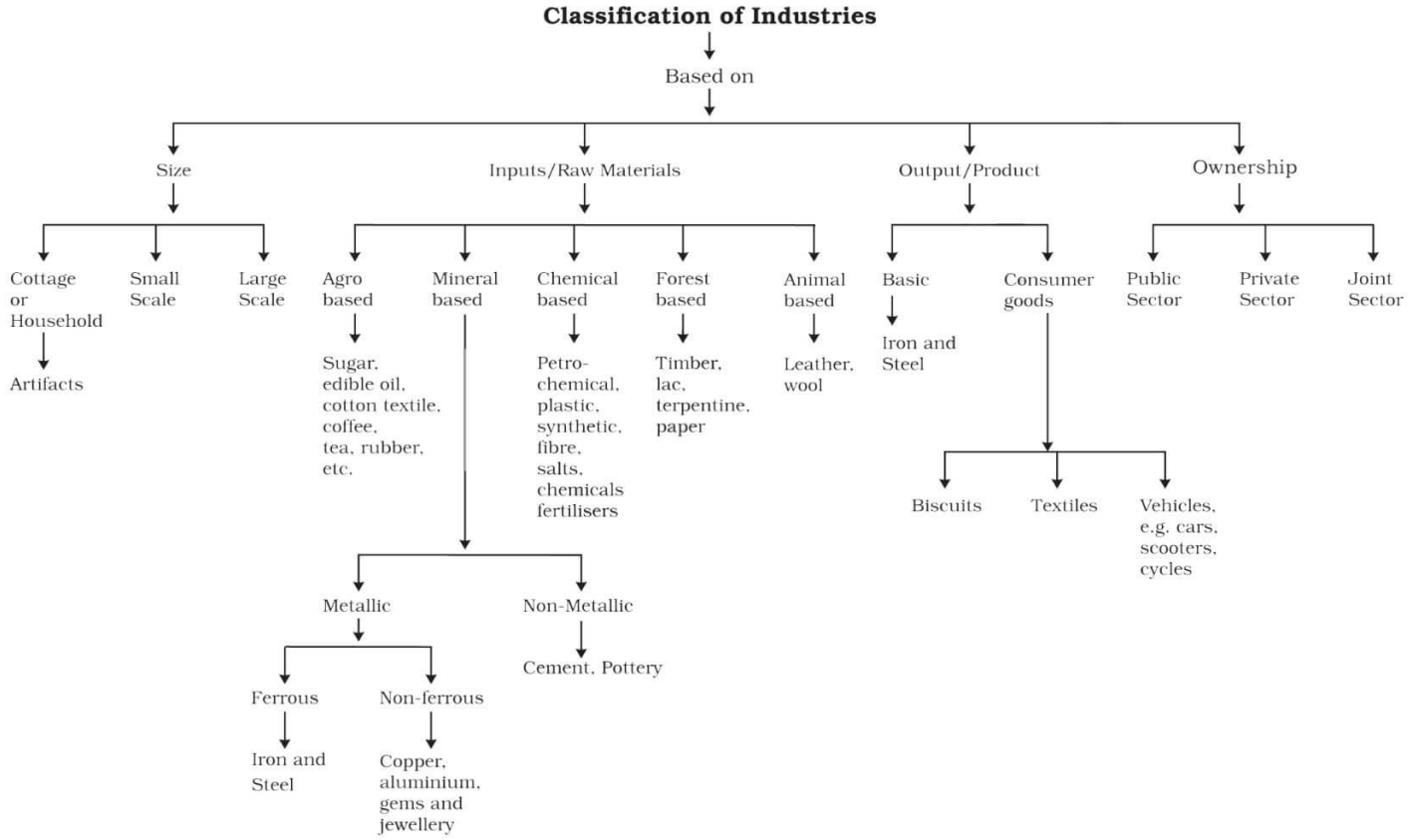
Technological Innovation

- Technological innovations through research and development strategy are an important aspect of modern manufacturing for quality control, eliminating waste and inefficiency, and combating pollution.

Organisational Structure and Stratification

- Modern manufacturing is characterised by:
  1. a complex machine technology
  2. extreme specialisation and division of labour for producing more goods with less effort, and low costs
  3. vast capital
  4. large organisations
  5. executive bureaucracy.

1.2.2 Classification of Manufacturing Industries



Industries based on Size

- The amount of capital invested, number of employees, and volume of production determine the size of industry.
- Accordingly, industries may be classified into household or cottage, small-scale and large-scale.

Household industries or cottage manufacturing

- It is the smallest manufacturing unit.
- The artisans use local raw materials and simple tools to produce everyday goods in their homes with the help of their family members or part-time labour.
- Finished products may be for consumption in the same household or, for sale in local markets.
- Some common everyday products produced in this sector of manufacturing include foodstuffs, fabrics, mats, tools, furniture, leather, pottery, bricks from clays, etc.
- Goldsmiths make jewellery of gold, silver and bronze.

Small Scale Manufacturing

- Small scale manufacturing is distinguished from household industries by its production techniques and place of manufacture (a workshop outside the home/cottage of the producer).
- This type of manufacturing uses local raw material, simple power-driven machines and semi-skilled labour.
- It provides employment and raises local purchasing power.
- Therefore, countries like India, China, Indonesia and Brazil, etc. have developed labour-intensive small scale manufacturing in order to provide employment to their population.

Large Scale Manufacturing

- Large scale manufacturing involves a large market, various raw materials, enormous energy, specialised workers, advanced technology, assembly-line mass production and large capital.
- This kind of manufacturing developed in the last 200 years, in the United Kingdom, north-eastern U.S.A. and Europe. Now it has diffused to almost all over the world.
- On the basis of the system of large scale manufacturing, the world's major industrial regions may be grouped under two broad types, namely
  1. traditional large-scale industrial regions which are thickly clustered in a few more developed countries.
  2. high-technology large scale industrial regions which have diffused to less developed countries.

Industries based on Inputs/Raw Materials

- On the basis of the raw materials used, the industries are classified as: (a) agro-based; (b) mineral based; (c) chemical-based; (d) forest-based: and (e) animal-based.
- Major agro-processing industries are food processing, sugar, pickles, fruits juices, beverages (tea, coffee and cocoa), spices and oils fats and textiles (cotton, jute, silk), rubber, etc.
- Agro-processing includes canning, producing cream, fruit processing and confectionery.
- Timber for the furniture industry, wood, bamboo and grass for the paper industry, lac for lac industries come from forests.
- Leather for the leather industry and wool for woollen textiles are obtained from animals.

Industries Based on Output/Product

- The industries whose products are used as raw material to make other goods are called **basic industries**.
- E.g. **Iron and steel**, copper smelting and aluminium smelting industries.
- The consumer goods industries produced goods which are consumed by consumers directly.
- E.g. industries producing bread, tea, soaps, paper, etc. are consumer goods or **non-basic industries**.

1.2.3 Foot Loose Industries

- However, domestic production is simply not enough to satisfy the demand of Indian jute mills.
- **The constant increase in rice** cropped area in the delta region further complicates the situation.
- **India imports significant quantities of jute fibre from Bangladesh to meet the shortfall**.
- Antiquated technology and machinery, shortage of power and industrial sickness affect production.
- Newly established factories in **Bangladesh** are posing a tough competition.
- Adoption of **synthetic alternatives** (polythene, nylon) has resulted in the decline of demand for jute.

5.3. Future positives for the jute industry

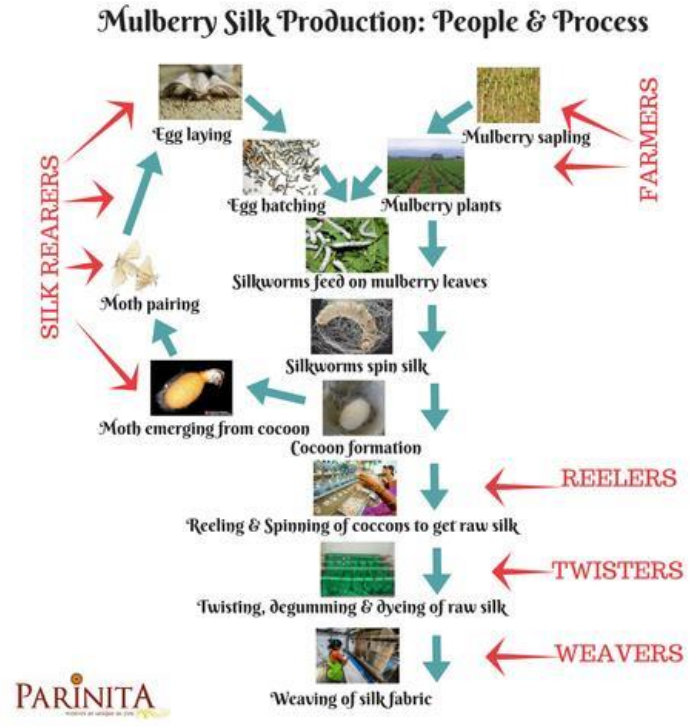
- Emerging environment consciousness can turn the fortunes of jute as it meets all the standards of safe packaging (natural, renewable, biodegradable).
- Some advanced countries are already switching to jute.
- The main buyers of Indian jute products are the USA, EU, Canada, Russia, etc.

5.4. Top jute producing, exporting and importing countries

- Top producers of jute: India and Bangladesh.
- Top consumers of jute: India, Bangladesh and Pakistan.
- Top exporters of jute: Bangladesh and India.
- Top importers of jute: Pakistan and India.

6. Silk Textile Industry

- Silk is a fibre made up two different proteins – **sericin** and **fibroin**.
- A layer of sericin surrounds the fibroin core (80% of silk fibre).
- The pigments in the sericin layer impart colour to the silk.
- Silk is used to make silk fabric, **parachutes, teeth braces (Italy)** and **fishing nets** around the world.
- Sericulture is the process of breeding silkworms and extracting silk from them.
- The production of mulberry silk involves the following processes.
    1. **Moriculture**: the cultivation of mulberry leaves.
    2. Silkworm rearing: promoting the growth of the silkworm by feeding mulberry leaves.
    3. Silk reeling: the extraction of silk filaments from the silkworm cocoons.
    4. Silk yarn: the silk filaments are woven together to form a thread. These threads are often plied together to form a yarn.



- Mulberry plant that can be **grown under varied climatic conditions** ranging from **temperate to tropical**.
- The pant grows well in slightly acidic soils that receive an annual rainfall ranging from 60 to 250 cm.
- Today, **China accounts for over 70% of the global silk production** and **90% of the world's silk exports**.
- **India is a distant second with 18% of the world's silk production**.

6.1. Silk Industry in India

- There are mainly four types of silk varieties produced by different species of silkworms.
- **Mulberry silk (white)** is secreted by the caterpillar of ***Bombyx mori*** which feeds on mulberry leaves.
- Wild Silks — Tussar (creamy), Eri (coppery) and **Muga Silk (golden)** — are secreted by wild silkworms.
- India is the only country producing all known commercial varieties of silk.
- Mulberry silk (80 per cent of the country's total silk; Eri silk is second) is of superior quality and is produced in the states of **Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu** and **Jammu and Kasmir**.
- Wild silks are mostly produced in the forests of Jharkhand, Chhattisgarh, Madhya Pradesh, Bihar, Odisha, Assam, Meghalaya, Manipur and Nagaland.
- Muga silk (golden silk) is exclusively obtained from the Brahmaputra valley of **Assam**.
- Assam has received a **geographical indication (GI)** for the production of **Muga silk**.

State	Production of silk in Tonnes (2016-17)		Silk producing regions
1. Karnataka	9571	31.5 %	**Mulberry silk in Mysuru (Ramanagara), Kolar**, Bengaluru Rural (Devanahalli) and Chikkaballapura districts in the Old Mysore region
2. Andhra Pradesh	5971	19.7 %	Anantapur, Chittoor Districts (Rayalaseema region)
3. Assam	3810	12.6 %	Muga silk in Brahmaputra Valley region
4. Jharkhand	2631	8.7 %	**Tussar (tasar) silk** in Singhbhum District
5. West Bengal	2565	8.5 %	**Murshidabad** and Birbhum district
6. Tamil Nadu	1914	6.3 %	Coimbatore, Dharmapuri and Salem district
Total	30348		

- Important centres of silk industry are
  - ✓ **Mysore** in Karnataka;
  - ✓ **Varanasi** in Uttar Pradesh;
  - ✓ **Dharmavaram**, Pochampalli, Venkatagiri, Narainpet in Andhra Pradesh;
  - ✓ Kashmir division;
  - ✓ **Bhagalpur** in Bihar and
  - ✓ **Murshidabad** in West Bengal.
- **Varanasi, Kanchipuram, Murshidabad** (W.B.), **Dharmavaram** (Anantapur District) in Andhra Pradesh and **Bhagalpur** in Bihar are famous for **silk sarees.**
- There is a massive demand for these sarees in the local market.
- Silk and silk products are exported to USA, U.K., Kuwait, Russia, Oman, Saudi Arabia, Singapore, and UAE.

6.1.1 Factors Responsible for the Localization of the Silk Industry in Karnataka

- Silk textile industry in Karnataka is concentrated in the Old Mysore regions and Belagavi district.

Historical aspects	• Tipu Sultan was the first to import silk cocoons from China in the 18th century. • He sent craftsman to Bengal to learn sericulture. • More impetus was provided by the demand for Mysore silk for the manufacturing of parachutes during WW II.
Raw material	• **Karnataka is the largest raw silk producing state in India**. • It produces only mulberry silk and accounts for over 50 per cent of India's mulberry silk. • Sericulture is concentrated around Mysuru (Ramanagara), Kolar, Bengaluru Rural (Devanahalli) and Chikkaballapura districts in the Old Mysore region.
Labour	• Cheap labour is readily available.
Technology	• The **Central Sericultural Research & Training Institute (CSRTI)** is located in Mysore. • The institute has developed many high yielding varieties of mulberry and silkworms. • GOI has set a goal of making the nation self-sufficient in **bivoltine silk, a high-grade variety** made with silkworms that **lay two batches of eggs per year**. • In response, the **Japan International Cooperation Agency** has provided technical co-operation to the country since 1991. • Karnataka, Andhra Pradesh, and Tamil Nadu saw the widespread adoption of bivoltine production techniques since then.
Water	• **Cauvery** and **Arkavathi rivers** provide water for washing, bleaching and dyeing.
Market	• The crepe silk saris (made of pure silk interwoven with **gold zari threads**) have market throughout India. • Silk and silk fabric produced in Karnataka are exported to famous silk saree making centres like Varanasi, Kanchipuram, Bhagalpur, Jammu and Kashmir, etc.
Government support	• **Mysore Silk**, crafted under the aegis of the Karnataka Silk Industries Corporation, now has the additional distinction of a **GI tag**.

6.1.2 Factors Responsible for the Localization of the Silk Industry in Varanasi

- Banarasi silk sarees are famous for intricate weaving and craftsmanship with a tinge of **Mughal** and Indian cultures.
- The sarees are worked on both handlooms (85% of the silk consumption) and power looms.

Historical aspects	• The Mughals heavily patronized the Banarasi silk industry. • Muslim craftsman are involved in weaving silk sarees in Banarasi since the Mughal era.
Labour	• Highly skilled Muslim craftsman (Muslim weaver community known by the name of Ansari) are involved in weaving silk sarees in Banarasi since the Mughal era.
Raw material	• Silk is obtained from Karnataka. (Silk Industry is not a weight losing industry) • Fine quality silk is also imported from China. • **Zari thread (thread made of fine gold or silver)** is obtained from Gujarat
Water	• Varanasi is located on the left bank of the Ganges (provides water for washing and dyeing of silk).
Market	• Banarasi saris are very popular all across India.

Government recognition	• In 2009, weaver associations in Uttar Pradesh secured **Geographical Indication** (GI) rights for the '**Banaras Brocades and Sarees**'. • This means, saree or brocade made in the six districts of Uttar Pradesh, that is **Varanasi, Mirzapur, Chandauli, Bhadohi, Jaunpur** and **Azamgarh districts**, can be legally sold under the name of Banaras saree and brocade.

6.1.3 Factors Responsible for the Localization of the Silk Industry in Kanchipuram

Historical aspects	• During the reign of Krishnadevaraya (Vijayanagara Dynasty) two weaving communities from Andhra Pradesh, the **Devangas** and the **Saligars** moved to Kanchipuram and started their hereditary profession there.
Labour	• Highly skilled weavers with generations of experience are available throughout the region. • The sarees are handwoven.
Raw material	• Silk is obtained from Karnataka. Cotton yarn is available in the vicinity. • Zari thread (thread made of fine gold or silver) is obtained from Gujarat.
Water	• Kanchipuram is located close to the left bank of the **Palar river**.
Market	• Kanchipuram saris are worn as bridal & special occasion saris by most South Indian women.
Government recognition	• Kanchipuram saris have been recognized as a **Geographical indication** by GOI.

6.1.4 Factors Responsible for the Localization of Silk Industry in Jammu and Kashmir

Historical aspects	• Jammu and Kashmir was one of the centres of the ancient silk route.  • The modern silk industry was started in Srinagar in the 1890s under the patronage of British.
Labour	• The famous shawl industry of Kashmir which had provided means of livelihood to a sizeable section of the population had started to decline. • In order to compensate for this decline, the state took several measures for the development of the silk industry.
Raw material	• Jammu and Kashmir produces the **best quality bivoltine mulberry silk** because of conducive climatic conditions.
Technology	• Reeling machinery was imported from Europe early on.
Market	• Kashmiri Silk Saree has a good market in India.

6.1.5 Issues faced by Indian Silk Industry

- India imports a considerable amount of silk **(bivoltine mulberry silk) from China** as the domestic raw silk is nowhere near the quality of the Chinese silk. Chinese silk can be easily worked on power looms.
- Domestic raw silk is not of uniform thickness due to poor quality of cocoon, and our producers use obsolete reeling machines to make yarn.
- The **synthetic fibres (nylon) and artificial silk** being less expensive and easy to maintain, have been responsible for reducing the popularity of silk.
- Investment is had to find as most of the silk industry operates in the unorganized sector at the household level.

6.2. Factors Responsible for the Localization of the Silk Industry in China

- China has dominated the global silk industry as the world's largest silk producer, exporter, and consumer.

Historical aspects	• Silk was discovered around 3500 BC in China. It was a closely guarded secret for centuries.
Labour	• Low-cost labour for producing silk are readily available. • Highly skilled labour force with generations of experience in weaving silk fabric is also available.
Raw material	• **China is the world's largest silk producer**. • Chinese silk is of high quality and is easy to be worked on power looms. • Silk is mainly produced in the **south of the Yangtze River Delta** (Jiangsu, Zhejiang and Guangdong provinces).
Climate	• China's climate is highly favourable for cultivating multiple varieties of silk. • Unvoltine (hatch once a year), **bivoltine (hatch twice a year)** and polyvoltine (hatch more than twice a year) mulberry silk cocoons are successfully reared.
Economic Linkages	• Cities such as **Hangzhou** and **Nanjing** are well known for their silk industries. • Their proximity to the **Shanghai** textile industries has been an advantage.
Technology	• The Chinese scientists have developed hybrid varieties using European and Japanese silkworms, which makes it possible to rear silkworms up to seven times a year.
Innovation	• In Pearl River valley, additional income is obtained by combining sericulture with fisheries (dead silkworm and their wastes are fed to fishes) for higher income.
Water	• Yangtze River provides water for washing, bleaching and dyeing.
Market	• India, Europe and the U.S. import a large quantity of Chinese silk and silk fabric.
Government support	• The Chinese government encourages the formation of silk cooperatives (**silk communes**) for greater efficiency. • It also provides various incentives for the modernization of the industry.

- As the land cost and workforce cost is increasing on the east coast, business is shifting to the west.
- Western parts are more focused on raw silk production due to its natural weather and soil conditions.

6.3. Silk Industry Outside India and China

- Sericulture outside India and China was not successful.
- Several textile industries in Europe import Chinese silk and cotton to cater to the nearby markets.

6.3.1 Japan

- During the medieval times, poor peasants in Japan used silk production as a secondary source of income.
- After the Meiji Restoration of 1868, the port of **Yokohama** (South of Tokyo) was developed for trading silk.
- By the early 20th century, rapidly industrializing Japan was producing as much as 60% of the world's raw silk.
- The Japanese silk fabric was in demand in Britain and the U.S.
- Post-WW II, the continued rise of synthetic fibres (nylon in the U.S.), high labour costs, competition from shipping, automobile & semiconductor industries contributed to the decline of Japan's silk industry.
- For example, in **Toyota in Aichi Prefecture near Nagoya** (previously, Koromo town), the less profitable silk industry was replaced by Toyota Motor Corporation's manufacturing plants.
- The demand for silk fabric in the domestic market also fell due to westernization of Japan.
- By 1975, Japan was no longer a net exporter of silk.

6.3.2 The U.S.

- There was some limited silk production in Virginia and Georgia from 1600s to 1760s.
- A blight on mulberry trees in the 1840s forced American factories to switch to importing Chinese raw silk.
- America's silk experiment finally failed as the **comparative advantage** of sericulture in the Gulf region (that had suitable climatic conditions) was never higher than that of tobacco (Virginia), soybean (Virginia) and cotton (Georgia).

6.3.3 Europe

- Sericulture was even introduced in Europe (France & Italy) in the early 19th century.
- Several epidemics in silkworms across Europe in the 1840s wiped out most of the sericulture industry.
- Due to high labour costs, the sericulture industry never took off after the epidemics.

Cotton Textile Industry in Italy (Lombardy and Prato) and Silk Textile Industry in France (Lyon)

- In the world of high fashion, the "Made in Italy" and "Made in France" tags have a distinct brand value.
- Some of the finest fashion designers and textile companies are based in France and Italy.
- Hence, apparel and other fashion goods with these tags command a higher price across the world.
- The Italian and French fabric producers are closer to high-value markets (Europe, U.S. and rich royal families in the Middle East), and in the fast-paced world of high fashion, this matters.
- These factors along with the **Chinese capital, raw material and workforce** have given rise to modern
  - ✓ **cotton textile industry in Lombardy and Prato (Italy)** and
  - ✓ **silk textile industry in Lyon (France)**, even though these regions have no raw material base.
- To accommodate the Chinese workforce, direct flights are run between China & Italy (Go Corona Go!).

7. Sugar Industry

You must first read GS3: Major Crops and Cropping Patterns > Major Cash Crops of India > Sugarcane

- Producing sugar involves the following steps:
  1. extracting the juice from the **sugarcane (in tropical regions)** or **sugar beet (a tuber crop in the temperate areas —** used as an alternative to expensive sugar imports from tropical countries**)**,

  2. removing the impurities from the juice,
  3. crystallizing the **sucrose** content in the juice to obtain raw brown sugar.
  4. refining raw sugar to obtain refined white sugar.
- The production of raw sugar is done in a sugar mill.
- The refining (removal of impurities) of the raw sugar is done in a sugar refinery.

	Sugar mill	**Sugar refinery**
Inputs	• Raw sugarcane, water, power	• Brown sugar, water, power
Output	• **Brown sugar** that contains impurities like molasses. • **Molasses:** provides the raw material for manufacturing **alcohol (ethanol)**. • **Bagasse (cane residue):** used for manufac-	• White refined sugar

	turing **paper** and also as **fuel in the mills**. • **Pressmud:** used as soil amendment (compost) to increase fertility.	
Most determining locational factor	• Sugarcane (and also sugar beet) is bulky, **highly perishable** and significantly **weight losing** (sugar accounts for only ~10% of the bulky sugarcane). • **Sugar mills can be operated only during the cane harvesting period**. • **Hence a sugar mill must be located close to the cane growing areas**.	• Brown sugar is neither perishable nor weight losing. • Sugar refining can be done year-round. • Hence a sugar refinery can be set up near or relatively at a distant location (**near ports for export — Mumbai port, Kolkata and Haldia ports, etc.**) from a sugar mill. • **Markets** are the most determining factor.

7.1. Major Factors that influence the location of sugar industry

Raw material	• The quality of sugarcane plays the most important role in production costs. • Fifty per cent cost of production is accounted for by sugarcane alone. • Hence the sugarcane mills are confined to the **sugarcane growing regions of the tropics (hot, humid, less windy areas)**.
Transportation	• Sugarcane is **highly perishable** and **significantly weight losing** raw material. • Once the sugarcane is harvested, the cane starts to **dry up, and the sucrose content starts to decline rapidly**. • It is prohibitively expensive to transport sugarcane over long-distances. • Hence the sugar mills are always located close to the cane growing areas (Hence the cane is always grown close to the mills — usually within a 100 km radius).
Water	• Sugarcane is a water-intensive crop with a crop season of 12 to 18 months. • The germination to ripening phase is itself close to a year. • Hence the availability of water year-round is a critical factor for cane cultivation.
Labour	• Sugarcane is not harvested year-round & the crushing season varies from 4 to 8 months. • Hence the availability of **seasonal labour** is critical for both harvesting and processing. • In India, harvesting and milling is done by migrant workers.
Capital	• Sugarcane processing is a capital intensive industry. Financial services and policy support are critical for the industry to remain competitive.
Policy	• In India, lack of proper policy support and timely financial services have severely hampered the modernization of the industry.
Power	• Power is readily available in the form of bagasse. • Hence sugar mills can be set up far away from coal and other power sources.

7.2. Major Sugar Producers

- Approximately 80% of the world's sugar is produced from sugarcane in tropical and subtropical climates with the remaining 20% derived from sugar beet.
- In the 2018-2019 crop year, sugar production was 179 million metric tons (MT).

- **India (33 MT)** became the world's largest sugar producer in 2018/2019.
- It overtook **Brazil (29.5 MT)** for the first time in 16 years.
- **Brazil**, Thailand, Australia, India are the leading exporters of sugar.
- **Uttar Pradesh** is the leading sugarcane producing State.
- Sugar production in U.P. in 2018-19 is estimated to be around 13.5 MT.
- Sugar production in **Maharashtra** in 2018-19 is estimated to be around 11.5 MT.
- In Feb 2020, for better use of surplus sugar stock, GOI approved an increase in the price of ethanol to be procured by public sector oil marketing companies (OMCs) from sugar mills for blending with petrol.

- The decision will help in further increasing the ethanol blend levels in petrol from the current 6%.
- For 2019/2020, India expects sugar production to drop to 26%.
- This is because of droughts in 2018 and floods in 2019 in Maharashtra.
- Sugar mills in India are concentrated in the sugarcane growing regions.
- Uttar Pradesh: The western belt includes Meerut, Saharanpur, Muzaffarnagar, Bijnor and Moradabad, and the eastern belt includes Gorakhpur, Deoria, Basti and Gonda.
- Bihar: extension of the eastern UP belt, which includes Darbhanga, Saran, Champaran and Muzaffarpur.
- Maharashtra: Ahmednagar, Kolhapur, Solapur, Satara, Pune and Nashik districts.
- Tamil Nadu: Coimbatore, Tiruppur, Karur and Tiruchchirappalli districts.
- Karnataka: Belgaum, Mandya and Mysore districts.
- Andhra Pradesh. East Godawari West Godavari, Krishna, Vishakhapatnam, and Chittoor districts.

7.2.1 The rise and fall of Cuban Sugar Industry

- Cuba is known as the sugar-bowl of the world. But it is nowhere in the list of top exporters.

The rise

- In the 18th century, Cuba became a prosperous sugar-producing colony of Spain.
- Just like cotton in the American South, the Cuban sugar industry benefited greatly from slavery.
- Cuba's independence from Spain in 1898 led to financial and technological investments in the Cuban sugar economy from the USA.
- The USA remained the biggest importer of Cuban sugar.
- Cuba remained unchallenged as the world's largest sugar producer until the 1960s.

The fall

- Cuba's sugar production suffered greatly at the outset of the industrialization drive in 1962.
- The industrial restructuring (formation of collectives) created a severe labour shortage.
- The fragmentation of landholding due to Castro's policy of redistribution of the confiscated American owned plantations among workers led to higher production cost per unit area.
- USA's embargo against Cuba restricted sugar imports and export of machinery.
- The loss of the single largest market – the USA – meant that Cuba had to rely heavily on USSR.
- After the collapse of the Soviet Union in 1991, the Cuban sugar industry collapsed.

7.3. Sugar Industry in Peninsular India vs Sugar Industry in North India

North India (Sutlej-Ganga plain from Punjab to Bihar)	**South India** (Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh)
• Low yield and productivity. • High summer temperatures ranging from 30° to 35°C and Loo (dry, scorching wind in May and June with a desiccating effect) leads to low growth and fibrous crop. • In winter months (December and January) the crop is likely to be damaged by **severe cold and frost**. • Hence it must be harvested before frost season.	• The tropical climate gives a higher yield per unit area as compared to north India. • No winds like 'loo' during summer. • Reasonably high temperature during winter. • Frost-free climate throughout the year. • High maritime influence = moderate climate = decreased crop duration and **higher sucrose content**.
• Perennial rivers and large scale irrigation facilities.	• Non-perennial rivers. • Irrigational facilities have improved over time.
• The crushing season ranges from 4 to 8 months.	• **Yearlong crushing** (factories keep running throughout the year)
• Has more mills than the south but they are of comparatively smaller size and use antiquated technology.	• Mills are comparatively large and modern.
• The co-operative sugar mills are under the pressure of undue political & social interferences.	• The co-operative sugar mills are better managed in the south than in the north.
Uttar Pradesh • Vast alluvial plains with soils rich in lime and potash. • Abundant water for washing and processing. • Seasonal labour is readily available.	**Maharashtra** • The regur soils (black clayey soils) of the Deccan Plateau are good at soil retention. • The major sugar belt lies along the river valleys of Western Maharashtra which is close to the Mumbai port. **Tamil Nadu and Andhra Pradesh** • Maritime influence (moderate climate) and fertile soils — high yield per hectare, higher sucrose con-

	tent, high recovery rate and long crushing season

- As a result of better conditions prevailing in peninsular India, the sugar industry is gradually shifting from north India to peninsular India.

7.3.2 Mains Question

Mains Practise: South India offers more favourable climatic conditions for the growth of sugarcane, but the most important sugarcane belt is in north India. What is the reason for this paradoxical situation?

- Before World War I, the northern plain area was mainly used for growing indigo.
- With the introduction of cheap aniline dyes, indigo lost its market by the time of WW I.
- Consequently, indigo's place was taken by sugarcane cultivation in the north.

Other factors

- Sugarcane needs good irrigational facilities throughout the year.
- Such facilities were available in the north due to perennial river systems.
- On the other hand, south has only non-perennial rivers.
- Also, irrigational facilities were previously non-existent in most parts of the south.
- In the southern states, sugarcane faces tough competition from cotton, tobacco, groundnut, coconut, etc.
- The peninsular sugarcane is not grown in compact blocks (close to mills), as in Uttar Pradesh and Bihar.

Mains 2013 Question: Do you agree that there is a growing trend of opening new sugar mills in the southern states of India? Discuss with justification (5 marks) (100 words)

- Previously, north India used to produce about 90 per cent of India's sugar.
- It has now reduced to around 40%.

More sugarcane cultivation = More sugar mills.

- Most favourable weather conditions (free from loo and frost).
- Development of extensive irrigational facilities in the past few decades.
- Yearlong crushing season. (In the north, the crushing period is restricted to 4-8 months)
- High maritime influence = moderate climate = does not reduce sugar content (extremely high temperature and low rainfall lead to fibrous crop).

7.4. Challenges faced by the sugar industry in India

- The Indian sugarcane has low sucrose content and gives poor yields compared to the global average.
- The production cost of sugar in India is one of the highest in the world.

Issues faced by mills

- Since the harvesting can be done only in a particular season, the crushing is confined to a limited period, and the sugar factories remain idle for the rest of the period.
- Most of the machinery used in Indian sugar mills, particularly those of UP and Bihar are old and obsolete.
- Due to low profitability, the industry is unwilling to modernize.
- Low rate of recovery: the average rate of recovery in India is less than 10 per cent compared to other major sugar-producing countries (14- 16 per cent).

Fluctuating availability of sugarcane for mills

- Sugarcane requires **10 to 18 months** to mature.

- This makes it extremely vulnerable to vagaries of the monsoons.
- **Too heavy rainfall results in low sugar content** & **deficiency in rainfall produces a fibrous crop**.
- Two-thirds of the total sugarcane produced in India is used for making jaggery and khandsari, and the rest goes to sugar factories.
- Since khandsari industry is free from excise duty, it can offer higher prices of cane to the cane growers.
- Sugarcane has to compete with several other crops like cotton, oilseeds, rice, etc.

Government apathy

- GOI imposes high excise duty on sugar exports.
- GOI has made it mandatory to use jute bags instead of synthetic bags to store 20% of the produced sugar.
- Through it is done to save the jute industry, it has turned out into a problem for the sugar industry as jute bags lead to more spillage.

8. Tea Industry

You must first read GS3: Major Crops and Cropping Patterns > Plantation Crops in India > Tea & Coffee

Major steps involved in the cultivation and processing of tea leaves:

- Plantation: tea plantations are managed as large estates with a dedicated labour force.
- Pruning: tea plants will grow into a tree if left undisturbed. Hence, they must be **pruned** (trimming away dead or overgrown branches) for ease of plucking of leaves by women labourers from the ground.
- It also enables the growth of new shoots bearing soft leaves.
- Plucking: hand picking is done by **skilled women labour**. Proper picking is essential to maintain the quality of the leaves and for enabling the quick growth of new leaves.
- **Fermentation**: The tea leaves are placed in a controlled humid atmosphere allowing the leaves to oxidize.
- The duration of exposure to oxygen affects the degree of fermentation, resulting in darkened leaves.
- **Black tea leaves** (consumed with milk in India) are fermented leaves whereas **green tea leaves** (consumed without mixing with milk in countries like Japan where dairying is absent) are unfermented.
- Drying: the leaves are dried with hot air to prevent further fermentation. The flavour, aroma and character of the tea are controlled at this stage.
- Auctions: The various grades produced by the tea estates are tasted and auctioned by traders.
- Blending: The tea leaves are blended at this stage to create many varieties of tea.

8.2. Factors that determine the location of the tea industry

Climate	• Tea bush requires warm (20°-30°C), moist (150-300 cm), frost-free climate through the year. • Tea plantations in India are rarely above **1,800 meters**. Above this height, low temperatures and frost become the detrimental factors. • Frequent showers **evenly distributed over the year** ensure continuous growth of tender leaves. E.g. Darjeeling tea. • **High humidity, heavy dew,** and **morning fog** favour rapid development of young leaves.

	E.g. Darjeeling tea.
Vegetation	• Tea is a shade-loving plant and develops more vigorously under shade.
Topography	• Waterlogging is detrimental to its roots. • Hence good soil drainage is a must for tea cultivation. • The undulating topography of hilly areas with virgin soils is ideal for teal cultivation.
Soil	• Virgin forest soils rich in humus and iron content are considered to be the best. E.g. Darjeeling tea. • A relatively large proportion of **phosphorus and potash** in the soil gives a special flavour to the tea. E.g. Darjeeling tea.
Capital	• Tea cultivation and processing is a capital intensive industry. • Tea plants take about four years to mature. • Labour costs have accounted for around 45-60% of the total cost of production. • In the initial stages, the tea plantations were entirely financed by the British. • At present, the formal banking sector is playing a crucial role in supporting the organized tea industry.
Labour	• Tea has to be processed within the tea garden to preserve its freshness and quality. • Everything from fermentation to auctions occur at the tea estate itself. • Mechanization is not feasible as the tea cultivation is carried out **on undulating topography of hilly areas**. • This makes tea cultivation a labour-intensive industry that requires abundant, cheap, and skilled labour at every stage (from plantation to blending).

8.3. Major tea producing areas in India

- **Upper Assam (upper Brahmaputra valley), Lower Assam and Darjeeling, Nilgiri Hills of South India**.

8.3.1 Tea industry of the Darjeeling district

- **Climate:** frequent showers, heavy dew, and morning fog **improve tea quality**.
- Cold winters retard plant growth and result in low yield compared to other regions in the NE.
- **Soil:** deep clayey soils rich in potash and phosphorous give the tea a distinctive flavour.
- **Topography:** Less steep hills (low gradients) is an added advantage.
- **Labour:** large estates with permanent labour force thrived since the time of the British.
- The Plantation Act permitted bonded labourers from Bihar & Bengal to work and settle on the plantations.
- **Capital:** initially, in the 1830s, it was the British that infused the capital and created a thriving tea industry in Darjeeling. The tea industry is now self-reliant.
- **Market:** Darjeeling tea, because of its distinctive aroma, is highly valued in the international markets.
- Initially, the British had a full monopoly over the Darjeeling tea trade. With India gaining independence, the Darjeeling tea thrived in the international market.
- **Transport:** Kolkata port for exports.

Mains 2014 Question

Whereas the British planters had developed tea gardens all along the Shivaliks and Lesser Himalayas from Assam to Himachal Pradesh, in ef-

- The small size of the manufacturing units with obsolete technology makes them uneconomic.
- The cost of imported wood pulp and wastepaper is ever increasing.
- The production of paper, paper board and above all, newsprint has always fallen short of the demand.
- This has forced the country to resort to heavy imports. Pulp, paper, paper board, newsprint and wastepaper are imported from **Norway, Sweden, Canada**, etc.
- Effluents released by the paper mills into open drains and rivers cause severe environmental issues.

11.9. International lumber, pulp and paper imports and exports

Major exporters of forest products (2018)

- Sawn wood: Russia (20%); Canada (19%); Sweden (8%); Germany (6%); Finland (6%); U.S.A. (5%).
- Pulp for paper: Brazil (24%); Canada (15%); U.S.A. (11%); Chile (8%); Indonesia (7%); Finland (6%).
- Recovered paper: U.S.A. (34%); United Kingdom (8%); Japan (7%); Netherlands (5%); Germany (5%).
- Paper and paperboard: Germany (12%); U.S.A. (10%); Finland (9%); Sweden (8%); Canada (6%); China (4%).

Major importers of forest products (2018)

- Sawn wood: China (25%); U.S.A. (18%); United Kingdom (5%); Japan (4%); Germany (4%).
- Pulp for paper: China (35%); U.S.A. (9%); Germany (7%); Italy (6%).
- Recovered paper: China (31%); India (12%); Germany (9%); Indonesia (6%).
- Paper and paperboard: Germany (10%); U.S.A. (8%); China (5%); Italy (5%); United Kingdom (4%).

Source

12. Commercial Marine Fishing Industry

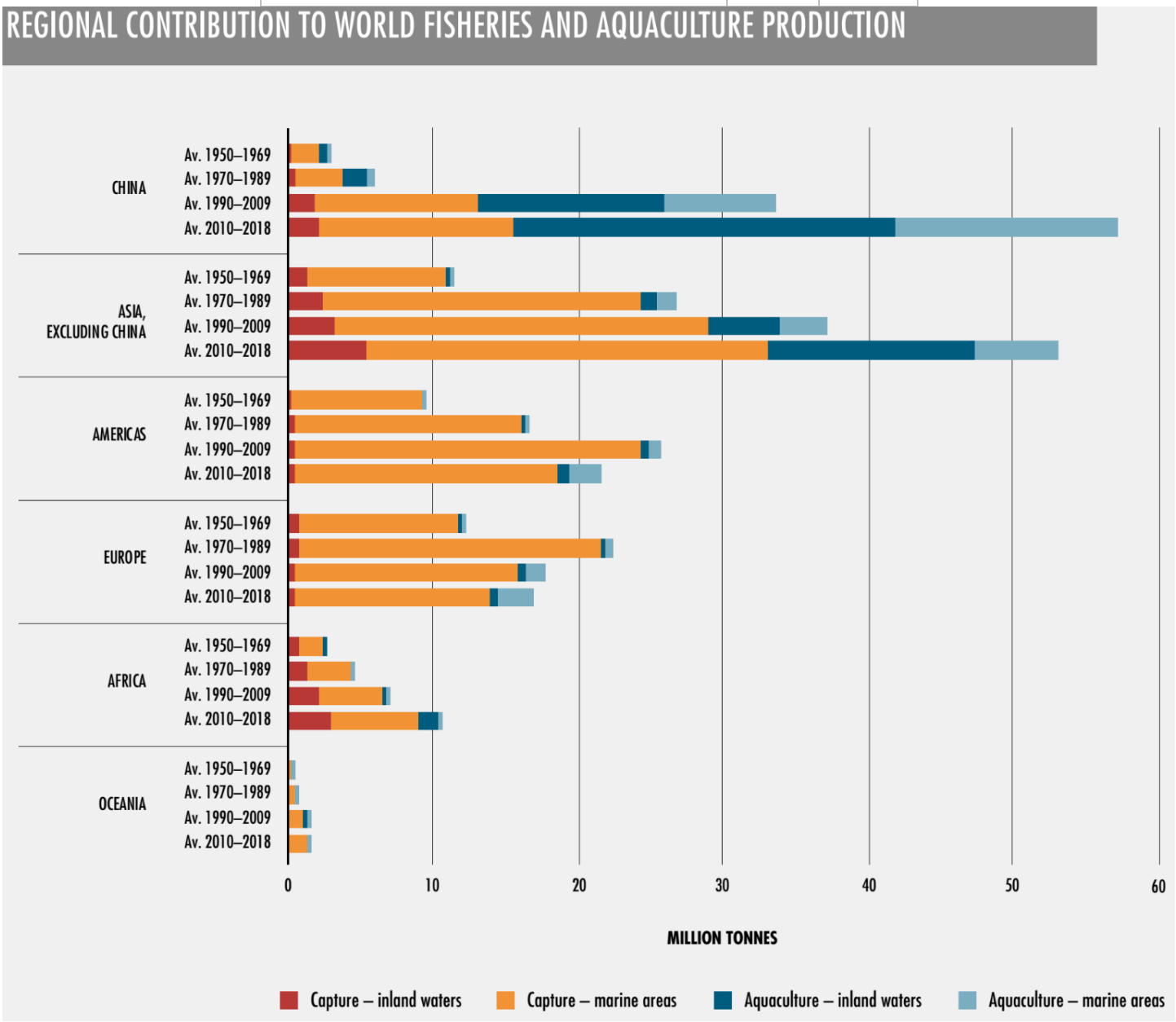
- **Aquaculture** involves cultivating aquatic (freshwater and saltwater) populations (fish, crustaceans, molluscs, shrimp, crab, etc.) under controlled conditions, and can be contrasted with **commercial fishing**, which is the harvesting of wild fish (fish, whales, seals, etc.).
- In 2018, an estimated 59.5 million people were engaged in the primary sector of fisheries and aquaculture.
- In total, about 20.5 million people were employed in aquaculture and 39.0 million in fisheries.
- World aquaculture production of farmed aquatic animals has been dominated by **Asia** (89 per cent share).
- **China, India, Indonesia**, Vietnam, Bangladesh, etc. are the major aquaculture producers.

12.1. Marine Capture Fisheries

- Commercially, marine fisheries are a lot more important than freshwater (inland) fisheries.

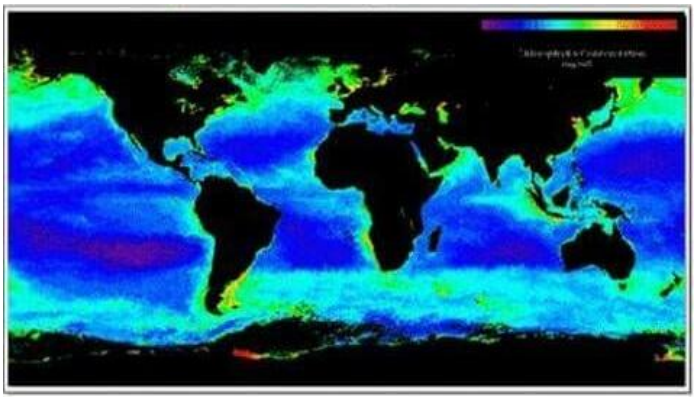
Production of fisheries & aquaculture	2017	2018
Capture		
Inland	11.9	12.0
Marine	81.2	84.4
Total capture	93.1	**96.4**
Aquaculture		

Inland	49.6	51.3
Marine	30.0	30.8
Total aquaculture	79.5	**82.1**
Total world fisheries and aquaculture	**172.7**	**178.5**



- **China, Indonesia, India, U.S.A., Russia, Peru, Japan, Vietnam, Norway**, Denmark, Canada, etc. are the major marine fishing nations.
- Tropical countries like Indonesia, India, Vietnam, etc. are mostly involved in intensive **inshore (near the shore)** fishing by small fishers and small to medium scale fishing trawlers.
- **China, U.S.A., Russia, Japan, Norway, Denmark**, etc. are focused on **both inshore and deep-sea fishing**.
- The deep-sea fishing operations are carried out by highly mechanized trawlers.
- Modern canning and **refrigeration** facilities have greatly helped the fish export trade of these countries.
- Canada, the U.S.A., Greenland, Norway, South Africa and Argentina are the major sealing nations.
- Japan, Norway & Russia are the leading whaling nations. Most of the whaling happens in the North Pacific.
- In recent years, whaling and sealing have decreased due to pressure from conservationists.

12.2. Factors that create the most fertile marine fishing grounds

Water temperature	• Marine life is best developed in oceans of the **high latitudes** whose waters are at temperatures lower than 20 °C. • This is because the fish feed on minute marine organisms called **plankton**, and the plankton multiplies best in **colder waters**. • **In the tropics, the warmer waters significantly inhibit the growth rate of the plankton population**. • Hence the **temperate and sub-polar seas (seas in the higher latitudes)** offer better fishing grounds compared to the tropics.
Ocean topography	• Plankton of all kinds are abundantly available in **shallow waters (continental shelves)** where they have **access to both sunlight as well as nutrients** (brought by rivers). • Hence the most exceptional fishing grounds are found above **continental shelves in the higher latitudes**.
Ocean water mixing and upwelling zones	• Plankton need both sunlight and nutrients (such as **nitrate** and **phosphate**) to be able to photosynthesize. • Sunlight is only available in the uppermost layers. • During photosynthesis, the nutrients are quickly used up by phytoplankton, so they are not available for long periods in the upper layers under normal circumstances. • To escape this problem, the seawater needs to be **mixed regularly** to bring the **nutrient-rich deep waters** up to the sunlight zone.  *Phytoplankton production is highest at high latitudes* • Furthermore, in surroundings where atmospheric temperatures are often colder than oceanic temperatures, the top layers of the ocean are cooled by the atmosphere. • This increases the density of the surface waters and causes them to sink and therefore causes mixing (nutrient-deficient water sinks and nutrient-rich water is upwelled). • Hence the **cold & warm current mixing zones (e.g. Grand Banks)** and **nutrient-rich cold water upwelling zones (e.g. upwelling near Peruvian coast)** form fertile fishing grounds.

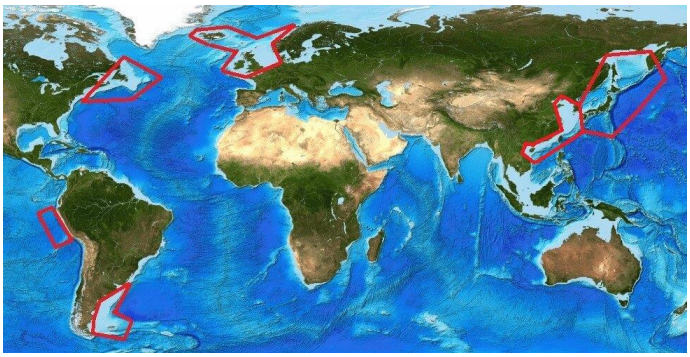
12.3. Factors that determine the location of the commercial fishing industry

Proximity to the fishing grounds	• Proximity to the fishing grounds reduces refrigeration and transportation costs. • However, with the highly mechanized modern trawlers, proximity to the fishing grounds is no longer a significant factor. • For example, Japanese trawlers venture into waters as far as Antarctica & Grand Banks.
Climate	• The cold climate of the higher latitudes makes refrigeration (preservation and storage of fish) economical. • Whereas in tropics, the **warmer climate and higher humidity** (fungal and bacterial attacks) make preservation and storage (refrigeration) more expensive. • Hence the commercial marine fishing industry is less viable in tropics.
Ports	• Sheltered inlets and estuarine coasts make ideal sites for **fishing ports** and villages. • Both the **Atlantic and Pacific coastlines** of the middle and high latitudes in the northern hemisphere are very much **indented** and are backed by strong relief. • Here, ports exclusively for fishing industry are developed. The fishing ports have all the necessary infrastructure from processing to canning units. • Fishing ports make the fishing industry efficient and cost-effective.
Capital	• The commercial success of marine fishery depends on the cost optimization with the help of efficient technology. • Hence a lot of capital is required for R&D, mechanization and infrastructure. • Europe, Japan, U.S.A. and Canada have the requisite capital and well established financial services for the cost-intensive and risky marine fishery industry.
Market	• Fish are used as food, and raw material for fertilizers, lubricants, cosmetics, etc. • Seals and whales are hunted for meat, fur and oil. • Fish, fish meal, and fish waste are widely used as **animal feed and feed for aquaculture** and as **fertilizer** for paddy fields. • **Fish oil** represents the richest available source of **long-chain polyunsaturated fatty acids (PUFAs)**, which perform a wide range of critical functions for human health. **Fish as a primary food source** • Europe is a **net exporter of horticulture products** and a **net importer of food grains and meat**. • Fish meat is the most affordable option in many countries like **Norway** (hilly terrain; ice-covered land; little scope for agriculture and dairying; **most of the population living along the coast**). • Just like **Norway, Japan** has very few dietary alternatives to fish. **Fish as an essential part of the diet** • There is a great demand for fish along the North American coasts which are mostly inhabited by European settlers. • With the rapid economic development in Asia since the 1990s, fish is gaining a lot of importance as an inexpensive alternative to meat in the densely populated coastal re-

	gions. **The insignificant market in the southern hemisphere** • On the other hand, commercial fishing is not of prime importance in the southern hemisphere (**Peru, Falkland Islands are an exception**) where cattle rearing and dairying are more economical options. • (**Cattle rearing in Pampas of South America and Eastern Australia**, **dairying in New Zealand** and agriculture in South Africa).
Employment	• Lack of viable alternate employment opportunities in the primary sector since time immemorial has played a significant role in high dependence of **Japan** and **Norway** on the fishing industry. • Japan has high population pressure, hilly terrain & forests and very little cultivable land. • Norway is mostly hilly and experiences long, harsh winter months. • Hence, venturing into deep-sea fishing has remained the most practical and feasible primary economic activity for these countries.

12.4. The major commercial marine fishing grounds of the world

- The **continental shelves** of **North-East Atlantic, North-West Atlantic** and **North-West Pacific** are the most important global commercial fishing grounds.
- The **continental shelf around the Falkland Islands** and **upwelling zones** along the **Peruvian and Chilian coast** are other major fishing regions.



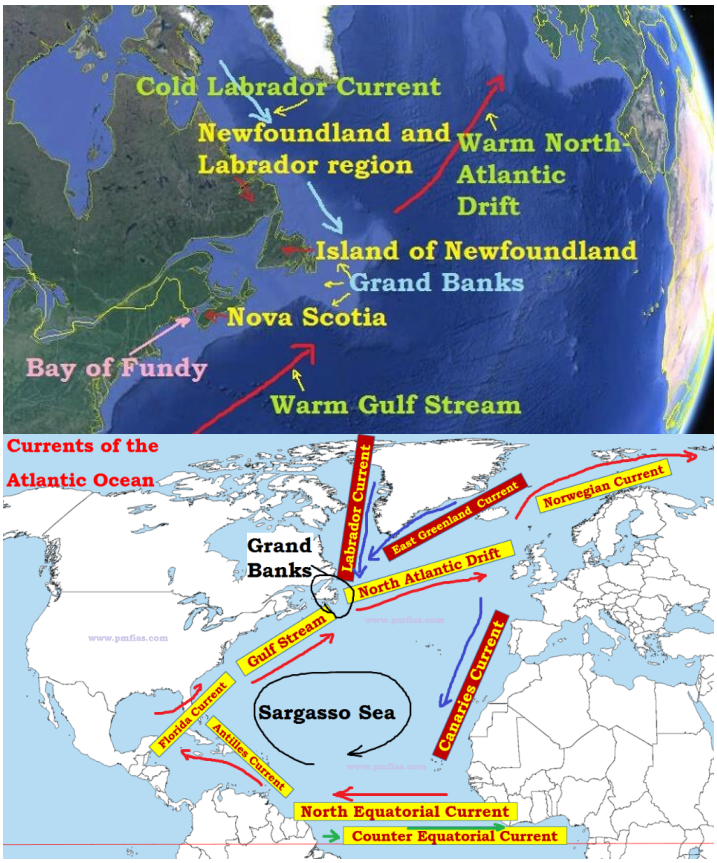
12.4.1 North-East Atlantic Region

- Colder atmospheric temperatures, and warmer oceanic temperatures (influenced by warm **North Atlantic Drift**), cause mixing and nutrient upwelling in the North-East Atlantic Region.
- This explains the abundant fish resources in the region (**Iceland continental shelf & North Sea continental shelf**).
- Fishing is done on a highly organized basis by **Norway, Denmark, Spain, Iceland and the U.K**.
- Fishing goes on all round the year in the shallow waters of the North Sea.
- **Dogger Bank** is the most vigorously exploited region.

12.4.2 North-West Atlantic Region

- The North-West Atlantic Region extends from Newfoundland to the New England states of the U.S.A.
- Mixing of **warm Gulf Stream** and **cold Labrador currents** and **gently sloping continental shelves** makes the region around the **Grand Banks of Newfoundland** the **world's largest fishing ground.**
- The gently sloping continental shelves stretch for over 200 miles south-east of Newfoundland.

- Fish of all types and sizes feed and breed here and support a **thriving fishing industry.**
- In Newfoundland, the fishing industry employs almost the entire population.
- All the fishing activities are carried out by highly mechanized trawlers which can store fish in refrigerated chambers for months.
- **St. John's, chief port of Newfoundland** is the headquarters of the Grand Banks fishing industries.



- All processing activities like cutting, gutting, cleaning, packing (canning) are done at the ports itself.
- Along with Canada and U.S.A., countries like Norway, U.K., Portugal, Denmark, Russia and Japan, also send fishing fleets to the Grand Banks.

12.4.3 North-West Pacific Region

- The North-West Pacific Region extends from the **Bering Sea** to the **East China Sea**.
- **China** leads in the catch, followed by **Russia, Japan**, South and North Koreas.
- Within the enclosed seas — the **Sea of Okhotsk, Sea of Japan, Yellow Sea** and the **East China Sea** — intensive forms of inshore (close to the shore) as well as deep-sea fishing are carried out.
- In the case of inshore fishing, processing (gutting to meat cuts) and canning is done at the fishing ports.
- In deep-sea fishing, processing happens on the vessel, and the meat is **refrigerated** for canning at the ports.
- Commercial fishing is best developed in **Japan**, where the industry is very highly organized.

Pearl Fishery in Japan

- Natural pearls are derived mainly from oysters.
- It was the Japanese that invented cultured pearls in 1913.
- Young oysters are first collected, and grains of mother-of-pearl (the inner lining of oyster shells) are inserted into them. They are then placed in wire cages and lowered into shallow coastal waters.
- After about two to five years, these oysters will be collected, and the artificial pearls will be extracted.
- **Japan** is the leader in the production of artificial pearls.

Why is fishing the dominant primary sector occupation of Japan?

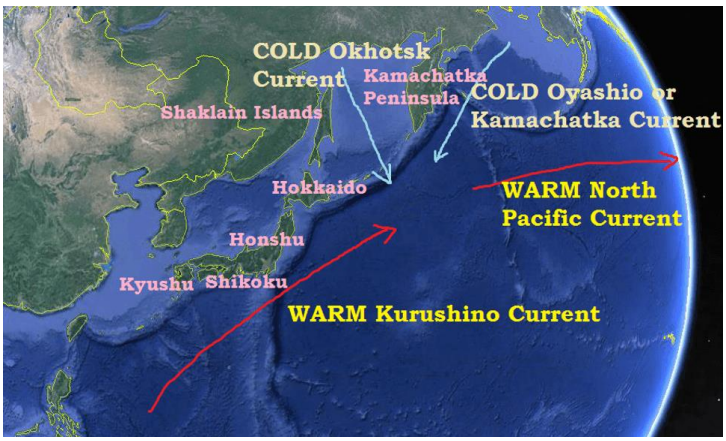
Fishing is the only reliable primary sector activity

- The **rugged (mountainous) nature of Japan** and parts of mainland eastern Asia support little agricultural activity (80 per cent land in Japan is classified as 'non-agricultural'. Around 50% is covered by forests).
- Japan is **not well endowed with natural resources**.

- Hence fishing forms a dominant aspect of the primary economy.

Geographical advantage

- The continental shelves around the islands of Japan are rich in plankton, due to the meeting of the **warm Kuroshio** and the **cold Oyashio currents** and provide excellent breeding grounds for all kinds of fish.



Cold and warm ocean current mixing zone off Japan

- The **indented coastline of Japan** provides **sheltered fishing ports**, calm waters and safe landing places, ideal for the fishing industry.
- **Hakodate** and **Kushiro** are large fishing ports with complete refrigeration facilities.

Ready market

- The scarcity of meat (there is little pasture in Japan for livestock farming of any kind) popularised fish as the principal item of diet and the chief protein food of the Japanese and the Chinese as well.
- There exists a great demand for fish and fish products in the nearby countries where the fishing industry is under-developed.
- The Japanese make use of fish wastes, fish meal and seaweeds as fertilizers in their farms.

Capital, technology and infrastructure

- Japan has huge stakes in international fishing enterprises, and her advanced fishing techniques give her an edge over competitors.
- The Japanese fishing trawlers venture far and wide into the **Arctic, Antarctic and the Atlantic waters**.
- Advanced financial services, encouraging government policy, an advanced technology at hand, skilled workforce with decades of experience in fishing make Japan a leader in the fishing industry.

Whaling

- Hunting and eating whales is a part of Japanese culture.
- Whale meat consumption became widespread after World War II when other food was scarce.
- In 2018 **Japan withdrew** from the **International Whaling Commission** (I.W.C.) for banning whale hunting.
- This means Japan will **no longer hunt whales in the Antarctic**, as it did earlier under the guise of research.
- The whaling will be conducted within Japan's territorial waters and Exclusive Economic Zone.

12.4.4 China, India and South-East Asia

China

- **China** and **India** are the world's leading producers of **inland fish and aquaculture**.
- When it comes to commercial marine fishing, China was nowhere in the scene until the 1980s.
- Opening up of the economy in the 1980s, the inflow of foreign capital and the subsequent rise in income levels has made China one of the major marine (inshore) fishing countries.
- It is now far ahead of Japan in marine fish production.
- However, for China, **aquaculture and inland fisheries are far more important** compared to commercial marine fishing.

- Most of China's marine fishing happens in the **Yellow Sea, the East China Sea and the South China Sea**.
- From the table, it is clear that **aquaculture in the dominant form of fisheries in the tropics and China** and **in the higher latitudes commercial marine fishing is dominant**.
- **By 2030, most of the fish production is going to come from aquaculture**.

India & South East Asia

- In India, the **west coast is more significant for fishing than the east coast as the west coast has a more extensive continental shelf**.
- However, just like in China**, aquaculture and inland fisheries produce far more fish (70-80%) than commercial marine fishing.**
- Technological lag and financial constraints have been the major bottlenecks in the take-off of the commercial marine (inshore and deep-sea) fishing industry in India.
- The case is the same in the South East Asian nations.
- In South-East Asia, the **South China Sea** and the **Sunda continental shelf** are major fishing grounds.

World fisheries harvest for 2018			
Country	**Capture**	**Aquaculture**	**Total**
Productio in 2018 in Million Tons (MT)	93.7 MT	101.1 MT	199.7 MT
China	17.8	63.7	81.5
Indonesia	6.6	16.6	23.2
India	5.1	5.7	10.8
United States	4.9	0.4	5.4
Russia	4.8	0.2	4.9
Peru	3.8	0.1	3.9
Japan	3.3	1.1	4.3
Vietnam	2.8	3.6	6.4
Norway	2.2	1.3	3.5

12.4.5 Southern Hemisphere (Peru and Chile Coast)

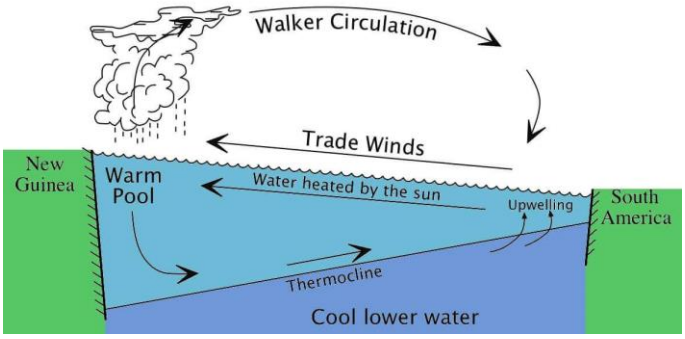
- The **continental shelf along the South American west coast is quite narrow**.
- However, the **Walker Circulation** causes upwelling off the coasts of **Peru, Chile and Ecuador**.
- This brings **nutrient-rich cold water to the surface**, increasing **fishing stocks.**
- The bulk of the fish caught is not eaten but is used in the manufacture of fertilizers.

Normal Conditions

- ***Coast of Peru and Ecuador == Cold Ocean Water == Good for Fishing.***

El Nino

- ***Coast of Peru and Ecuador == Warm Ocean Water == Fishing industry takes a hit.***



Falkland Islands (British overseas territory)

- Off the Argentine coast, the continental shelf is wide, and the **cold Falkland current** meets the **warm Brazilian current**, thus providing fertile grounds for fishing.

12.4.6 Commercial marine fishing is little developed in the southern hemisphere. Explain

- **Topography:** The continents in the southern hemisphere have very narrow continental shelves (**except for the region around the Falkland Islands**).
- **Market:** Cattle rearing in Pampas of South America and Eastern Australia, dairying in New Zealand and agriculture in South Africa means that the southern hemisphere has more affordable alternatives to fish.

12.4.7 Commercial marine fishing is little developed in the tropics. Explain

- **Climate:** Warm ocean waters are less favourable for plankton growth. Warm and humid climate increases the cost of refrigeration.
- **Economies of scale: Fish occur in smaller and scattered groups** which make fishing relatively expensive.
- **Market:** Fish are not the primary dietary choice as the tropics have abundant agricultural resources and cheaper proteinaceous foods like poultry.
- **Export potential:** Tropical fish have **higher oil content compared to the proteinaceous temperate fish**.
- **Capital:** The poor tropical countries do not stand a chance against their affluent temperate counterparts in the capital intensive commercial fishing industry.
- **Coastline:** Most of the **tropics have a straight coastline**, unlike the temperate region where most of the coast is **indented and deep**. Hence commercial fishing ports are hard to develop in the tropics.