General Knowledge Today

Prelims Geography-7: India's Geology and Climatology

Target 2016: Integrated IAS General Studies
Last Updated: April 3, 2016
Published by: GKTODAY.IN

Contents

Model Questions

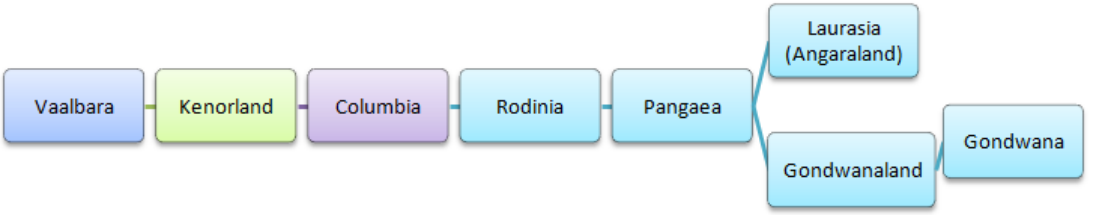
Please check Prelims Model Questions at the end of this Module.

Geology of India

Geological History of India

India is mostly located on the **Indian Plate**, which is generally called the northern portion of the Indo-Australian Plate. Indian subcontinent, Australia, New Guinea, and Tasmania, New Zealand etc. have a common geological history by virtue of being an integral part of the Mesozoic **Gondwana super-continent** until 160 million years ago.

The earth is 4700 million years old and the earliest supercontinent **Vaalbara** started forming around 3600 million years ago. It took nearly 400 million years to get completed and was ready by 3100 million years ago. Then, around 2500 years ago, Vaalbara started breaking. The result of this breaking was that another supercontinent **Kenorland** formed around 2700-2500 million years ago. The breaking kept on and then Supercontinent **Columbia** formed around 1800-1500 million years ago. Around 750 million years ago, a new supercontinent was formed that was called **Rodinia**. In the late Paleozoic period (542 – 250 million years ago) super continent **Pangaea** was formed that existed during the Paleozoic and Mesozoic eras. Pangaea started beginning to break up approximately 200 million years ago, before the component continents were separated into their current configuration. It first broke into Northern **Laurasia** (**Angaraland**) and Southern **Gondwanaland**.



Later, the Laurasia and Gondwana drifted apart. Gondwana included Antarctica, South America, Africa, Madagascar, Australia-New Guinea, and New Zealand, as well as Arabia and the Indian subcontinent, which have now moved entirely into the Northern Hemisphere.

Thus, from geological history two main structural divisions of India are:

- **Himalayan Mountain Chain**, **which is a part of Laurasia or Angaraland**
- southern pan called Gondwanaland of which Peninsular India formed one of the blocks.

The intervening space between the two giant continental blocks was filled with water. It was a

shallow sea called **Tethy's Sea**. During the subsequent geological periods, the Indian Peninsular block began drifting northward leaving a huge gap filled with water which truly came to be called the Indian Ocean. As the peninsular block continued its drift northward, the Indian Ocean continued to advance and filled up the depressions on either side of the landmass when it compressed the Tethy's Sea. Thus, the Arabian Sea and Bay of Bengal were formed. What was once the Tethy's Sea ***has become the Mediterranean Sea***. Other remnants are the Black, Caspian, and Aral Seas (via a former inland branch known as the Paratethys).

The similarity in the geological formation produced more or less similar type of mineral wealth in both India and Australia. Despite the variance in the biotic life between India and Australia, there are certain endemic plant and animal species, pointing to the super continent connection.

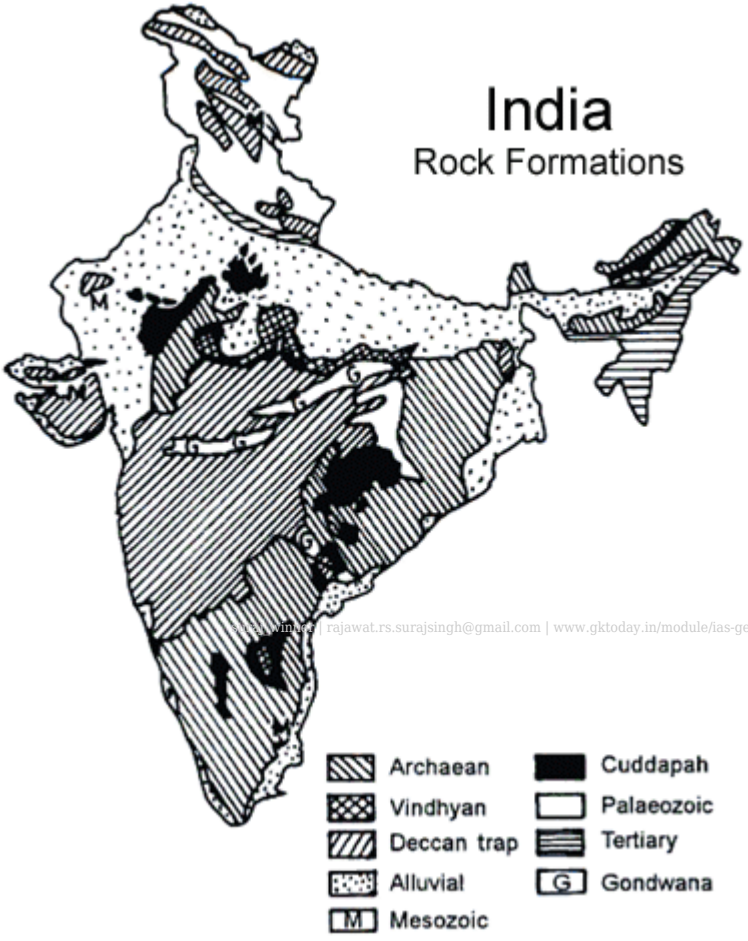
Please note that **Strait of Lombok** is part of the biogeographical boundary between the fauna of Indomalaya ecozone and the distinctly different fauna of Australasia. The boundary is known as the **Wallace Line**, for Alfred Russel Wallace, who first remarked upon the striking difference between animals of Indo-Malaysia from those of Australasia and how abrupt the boundary was between the two biomes.

India's Rock Formations (Stratigraphy)

India, being a large country, has diverse geology. Different regions in India contain rocks of all types belonging to different geologic periods. Some of the rocks are badly deformed and transmuted while others are recently deposited alluvium that has yet to undergo diagenesis. Mineral deposits of great variety are found in the subcontinent in huge quantity. Structurally the Indian landmass is divided into three main divisions consisting of

- The Himalayan Mountain Chain
- The North Indian Plain; and
- The Peninsular Plateau.

However, stratigraphically, India can be divided into several divisions such as Archean System, Dharwar System, Cudappah system, Vindhyan system, Paleozoic,Mesozoic, Gondwana, Deccan Trap, Tertiary and Alluvial.



Archean formations

Archean rocks, also known as **Pre-Cambrian rocks** are the oldest rocks of the earth's crust. The Archean period covers 86.7% of Total geological history time of earth and therefore is very significant. This period marks the development of first photosynthesis, the life support atmosphere. The major characteristic of the Archean rocks is that **they are azoid,** means that are *devoid of any form of remnants of life in them.* They serve as the basement complex or fundamental gneisses.

The Archean rocks in India are called **Purana Rocks** *means the oldest rocks*. The Archean or Purana rock system in India is found in Aravallis mountains, 2/3rd of the Deccan peninsula and some parts of north east. These rocks have abundant metallic and non-metallic minerals such as iron, copper, manganese, bauxite, lead, zinc, gold, silver, tin, tungsten, mica, asbestos, graphite, etc.

Dharwar system

Dharwar system is later than the Archean system but older than the other systems. The Dharwar period of rock formation has been largely fixed from 2500 million years ago to 1800 million years ago. Dharwar Rock System is special because it is the ***first metamorphic sedimentary rocks*** in India.

They are named Dharwar system because they were first studied in Dharwar region of Karnataka. But they are also found in Aravallis, Tamil Nadu, Chotanagpur plateau, Meghalaya, Delhi, and the Himalayas region.

The Dharwar rocks are rich in iron ore, manganese, lead, zinc, gold, silver etc.

The **Champions series** containing gold mines lie within this system. This Champion system is named after the Champion reef in the Kolar Gold Fields. The Kolar Gold Fields contain one of the deepest gold mines of world.

The other series of Dharwar system are as follows:

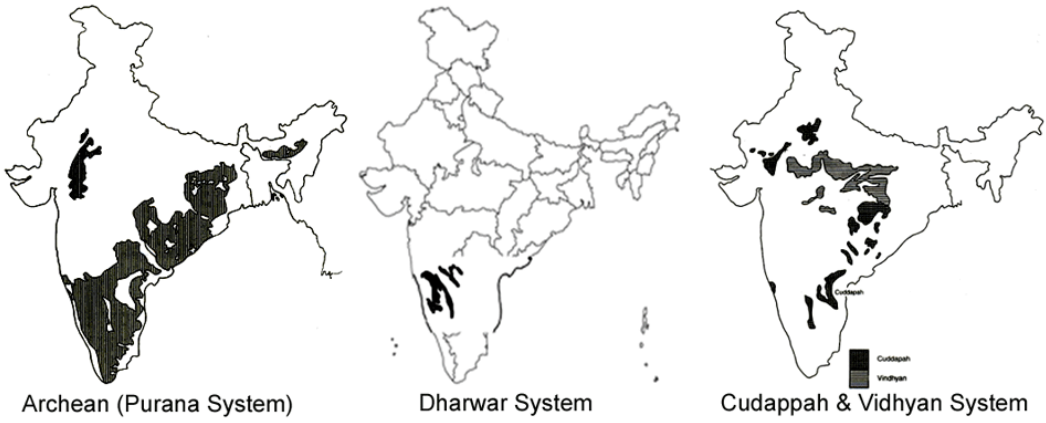
- Champaner series that is found near Baroda. This is source of a lush green variety of marble.
- Closepet series that is found in Balaghat and Chhindwara of Madhya Pradesh. It is rich in Copper ores.
- Chilpi Series that is found in and around the Closepet series in Balaghat and Chhindwara
- Iron-Ore series that is located in Singhbhum, Mayurbnhanj and Keonjhar rangaes.

Cudappah System

Cudappah System rocks are rich in metamorphic rocks such as sandstone, shale, limestone, quartzite, and slate. They contain iron and other inferior quality of ores and minerals. They are mainly found in Cudappah district of Andhra Pradesh along with other places such as Chhattisgarh, Rajasthan, Delhi, and the lesser Himalayas. One of the important series of Cudappah System is Papaghani series, named after the river of same name in Andhra Pradesh.

Vindhyan System

The Vindhyan Mountains form a dividing line between the Ganges plain and Deccan Plateau. The Vindyan system is named after Vidhyan Mountains. This system rocks are extensively distributed in India from Chittorgarh (Rajasthan) to Sasaram (Bihar). The Vindhyan System is separated from Aravallis by the Great Boundary Fault. They are famous sources of Red Sandstone and other building material. The well known Panna and Golconda diamonds are found in this formation. The important series of this system are Bhander series, Bijwar series and Kaimur series. All are rich sources of Building material.



Gondwana System or Carboniferous period System or Dravidian System

As the name suggests, these are the **major coal deposits of India.** This system contains famous **Damuda and Panchet series** which are *famous for coal deposits (discussed below).* The important coal bearing areas of this series are Raniganj, Jharia, Karanpur, and Bokaro of the Damodar basin in Odisha, and the Pench valley in Chhattisgarh and Madhya Pradesh, the jhingurda coal seam (Chhattisgarh). The Gondwana Supergroup forms a unique sequence of fluviatile rocks deposited in Permo-Carboniferous time. Damodar and Sone river valley and Rajmahal hills in the eastern India is depository of the Gondwana rocks.

The Cretaceous system or the Deccan Trap

Some people broadly divide the geographical land area of India into three parts viz. Deccan trap, Gondwana and Vindhyan. The Deccan Trap covers almost all of Maharashtra, some parts of Gujarat, Karnataka, Madhya Pradesh and marginally Andhra Pradesh. Deccan Trap is thought to have formed as result of sub-aerial volcanic activity associated with the continental deviation in this part of the Earth during the Mesozoic era. This implies that generally, the **rocks of Deccan Trap are igneous**. The Deccan system is marked by a transgression of the sea at Coromandal coast and Narmada valley and the upwelling of huge quantity of Lava/ basalt , so the Cretaceous system or Deccan Trap is made up of Basalt rocks. This system is also called lava trap and is 3000 meters deep. The rocks of this system are found in Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, Jharkhand, Orissa, and Karnataka.

Deccan Trap and Paleontological Murder Mystery

Some scientists believe that a series of monumental volcanic eruptions in India may have killed the dinosaurs 65 million years ago, not a meteor impact in the Gulf of Mexico. The eruptions, which created the gigantic Deccan Traps lava beds of India, are now the prime suspect in the most famous and persistent paleontological murder

mystery, say scientists who have conducted a slew of new investigations honing down eruption timing. The main phase of the Deccan eruptions spewed 80 percent of the lava which spread out for hundreds of miles. It is calculated to have released ten times more climate altering gases into the atmosphere than the nearly concurrent Chicxulub meteor impact, according to volcanologist Vincent Courtillot.

How it was formed?

When the Indian Plate mobbed northward after breaking off from the rest of Gondwana, it passed over a geologic hotspot, the Réunion hotspot, which caused extensive melting underneath the Indian craton. The melting broke through the surface of the craton in a massive flood basalt event, creating what is known as the Deccan Traps. It is also thought that the Reunion hotspot caused the separation of Madagascar and India.

The Tertiary System

The Tertiary rock system belongs to Cenozoic era. The Cenozoic era has two periods' viz. tertiary and quaternary. The beginning of the tertiary period is about 66 million years back. The final break-up of the Gondwana land occurred in this era and the Tethys sea got lifted in the Himalayas. The most important rocks of this system are in northern plains of India, karewas of Kashmir and bhadarwah, **Bhangar,** and **Khadar** of the Great Plains. The terraces of Jeelum Narmada, Taptii, Godavari, Krishna, Kaveri, etc. are of this period. The rocks of this system are also found in coast of Kachchh, Katiawar, Konkan, Malabar, Nilgiri, and the Eastern Ghats.

Gondwana and Tertiary Coal Deposits of India

Most of the coal mined in India comes from the rock formations of two geological ages viz. Lower Gondwana and Tertiary. About 80 per cent of the coal deposits in India is of bituminous type and is of non-coking grade. This is one of the reasons that India has to rely upon imports of coking coal.

Gondwana Coal

Gondwana coal has overwhelmingly higher share (99%) in India's coal resources and the entire coal mined in the peninsular plateau part belongs to this category. This coal was formed in carboniferous period between 600 to 300 million years ago. The coal obtained from the Gondwana formations is mainly bituminous and needs to be converted into Coke before it can be used in the iron and steel industry.

Distribution of Gondwana Coal

The Gondwana coal mines are located in river valleys of Damodar, Mahanadi, Godavari, Son and Narmada. Damodar valley is home to largest coal mines in Jharkhand-West Bengal coal belt located in Jharia (largest coal field of India), Raniganhj (second largest coal field of India), Bokaro, Giridih, Karanpura , Chandrapur, Tatapani, Talcher, Himgiri, Korba, Singrauli etc.

On the basis of geological units, there are three different Gondwana formations viz. Raniganj

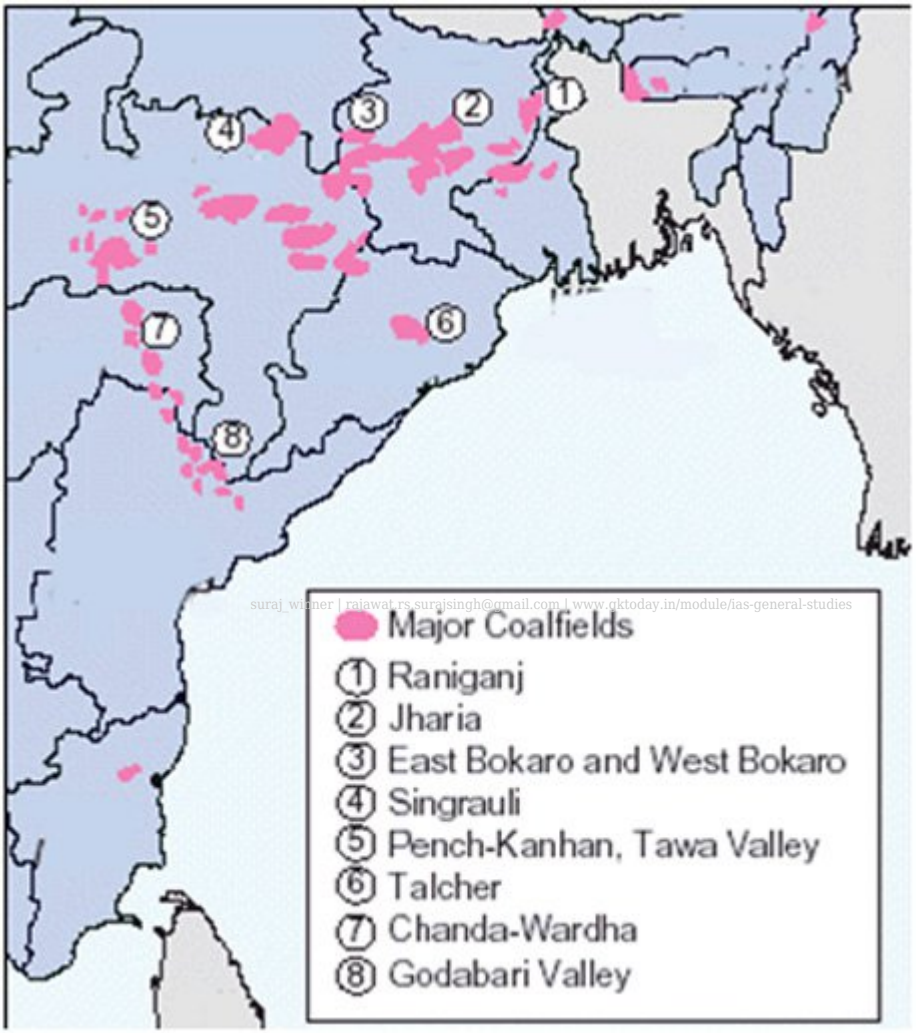
Formation, Barkar Formation and Karharbari Formation. **Karharbari Formation** is the oldest coal formation in India.

The states in which Gondwana coal fields are found include Jharkhand, Orissa, Chhattisgarh, West Bengal, Madhya Pradesh, Andhra Pradesh, Maharashtra, Uttar Pradesh, Bihar, Sikkim, Assam, with the quantity of reserves in the same order.

Tertiary coals

Tertiary coal fields share only 1% of coal production of India. Such fields occur in Assam, Arunachal Pradesh, Meghalaya and Nagaland and also in small quantities in Jammu & Kashmir. It is extracted from Darangiri, Cherrapunji, Mewlong and Langrin (Meghalaya); Makum, Jaipur and Nazira in

upper Assam, Namchik – Namphuk (Arunachal Pradesh) and Kalakot (Jammu and Kashmir).



Tertiary coal is the lignite coal . Lignite also occurs in the coastal areas of Tamil Nadu, Pondicherry, Gujarat and Jammu and Kashmir. The coal is of inferior quality with around 30 to 50% carbon. India's largest ignite deposits are at Neyveli in Tamil Nadu.

Coal Mines

81% of the coal production in India comes from open pit mines while underground mining currently accounts for around 19% of national output.

List of Gondwana Coalfields

West Bengal

- Damodar Valley: Raniganj (Trans Barakar),Bankura

- Darjeeling District: Bagrakote, Tindharia

Bihar

- Damodar Valley: Ranigunj (Cis Barakar), Jharia, Bokaro, Chandrapura, South Karampura, North Karampura, Ramgarh
- Rajmahal Area: Hura, Gilhuria and Jilbari, Chuparbhita, Pachwara, Brahmini
- Deogarh Area: Kundit Kuria, Sahajuri, Jainti
- Hazaribagh District: Giridhi, Chope, Itkhori.
- Palamu Region: Anuranga, Daltongunj, Hutar

Madhya Pradesh

- South Rawa Region: Singrauli, Korar, Johilla river, Umaria, Sohagpur
- North Chattishgarh Region: Jhilmili, Tatapani-Ramkola, Sanhat, Jharkhand, Chirimiri-Kurasia, Koreagarh, Bassar, Bisrampur, Lakhanpur, Panchbhaini, Dambhamunda, Sendargarh
- South Chattishgarh Region: Hasdo -Rampur, Korba, Raigarh, Mand River, Kankani.
- Satpura Region: Mohpani, Sonada, Sahpur (Tawa), Dulhara (Tawa), Pathakera, Bamhanwara, Upper Tawa Valley, Kanhan Valley, Pench Valley.

Maharashtra

- Wardha Valley: Kamptee, Bandar, Warora, Rajur (Wun), Ghugus – Telwasa, Chanda, Ballarpur, Wamanapalli, Antargaon – Aksapur, Sasti – Rajpura.

Odisha

- Mahanadi Valley: Talcher, Ib river (Rampur – Hingir).

Andhra Pradesh / Telangana

- Pranhita – Godavari Valley
- Tandur Kanala, North Godavari, South Godavari, Jangam, Chinur-Sendrapalli, Kamavaram, Bandala – Alapalli, Singareni (yellendu), Lingala, Kothagudium, Damar-cherla, Kannergiri, Beddadanuru.

Uttar Pradesh

- Kota (in Mirzapur District)

Assam

- Abor, Aka and Daphla Hills

Sikkim

- Ranjit Valley

List of Tertiary Coal Fields

- **Assam:** Makum coalfield in Dibrugarh district is the main coalfield. Other include Nahorkatiya, Doigrung, Nambor and Longoi.
- **Meghalaya:** Khasi Jaintia and Mikir hills, Balyong, Doigring and Waimong coal-fields

- **Arunachal Pradesh:** Namchick- Namphuk (Tirap) Abor hills, Miri, Daphla, Aka hills and Miao Bum
- **Nagaland:** Nazira, Janji, Disai and Barjan are important coalfields of Nagaland.
- **Jammu and Kashmir:** Kalakot, Mohogala, Metka, Ladda and Saugar Marg

India's Climatology

Climate of India and Factors Affecting it

India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. India's climate is strongly influenced by the Oceans, Himalayas and the Thar Desert. The Himalayas act as a barrier to the frigid katabatic winds flowing down from Central Asia keeping the bulk of the Indian subcontinent warmer than most locations at similar latitudes.

The climate of India may be broadly described as **tropical monsoon type**. India's climate is affected by **two seasonal winds** viz. the north-east monsoon and the south-west monsoon.

- The north-east monsoon commonly known as winter monsoon **blows from land to sea** whereas south-west monsoon known as summer monsoon **blows from sea to land** after crossing the Indian Ocean, the Arabian Sea and the Bay of Bengal.
- The south-west monsoon brings most of the rainfall during the year in the country.

As such, land areas in the north of the country have a continental climate with severe summer conditions that alternates with cold winters when temperatures plunge to freezing point. In contrast are the coastal regions of the country, where the warmth is unvarying and the rains are frequent. India, not only its physiographic divisions are diverse but also far more contrasting in nature. Each one of these factors (Size, Shape, location extent etc.,) has an impact on climatic conditions of India, be it temperatures, atmospheric pressure, wind system or precipitation.

Factors influencing the Indian climate

Location and Latitudinal Extent

- The Tropic of Cancer passes through the middle of the country. The southern parts being closer to the Equator, experience high temperatures throughout the The northern parts on the other hand lie in the warm temperate zone. Hence they experience low temperatures particularly, in winter.
- For example, Bangalore would be hotter than Faridabad. Broadly speaking parts lying south of the Tropic of Cancer receive more solar heat than those lying north of it.

Distance from the Sea

- Southern or peninsular India is surrounded by the Arabian Sea, the Indian Ocean and the Bay of Bengal, hence the climate of coastal regions of India is equable or maritime.

- Contrary to this, the climates of the regions located in the interior of the country are cut off from the oceanic influence. As a result, they have an extreme or continental type of climate.

Altitude

- The atmosphere becomes less dense and temperature also decreases with the height. For example, the cities located on the hills are cooler like Shimla whereas the cities lying in the plains will have hot climate like Ludhiana.

Mountain Ranges

- These ranges protect India from the bitterly cold and dry winds of Central Asia during winter. Further more, they act as an effective physical barrier for the rain bearing southwest monsoons winds to cross the northern frontiers of India.
- On the other hand, they check rain bearing South-West Monsoon winds and compel them to shed their moisture in India.
- Similarly, Western Ghats force rain bearing winds to cause heavy rain fall on the Western slopes of the Western Ghats.

Direction of Surface Winds

- The wind system also affects the Indian climate. This system consists of monsoon winds, land and sea breeze, and local winds. In winter the winds blow from land to sea so they are cold and dry.
- On the other hand, in summer wind blow from sea to land bringing the moisture along with them from the sea and they cause wide spread rain in most part of the country.

Upper air Currents

Besides surface winds, there are strong air currents called Jet streams which also influence the climate of India. These jet streams are a narrow belt of fast blowing winds located generally at 12,000 metre height above the sea level. They bring western cyclonic disturbances along with them. These cyclonic winds originate near the Mediterranean Sea and move eastwards. On their way, they collect moisture from Persian Gulf and shed it in the North western part of India during winter seasons. These Jet streams shift northwards during summer season and blow in Central Asia. Thus helps in the onset of monsoons.

Physiography

The physical features influence the air temperature, atmospheric pressure, direction of winds and the amount of rainfall in different parts of the country.

El-Nino & La Nina

- Weather conditions in India are also influenced by El-Nino which causes wide spread floods and droughts in tropical regions of the world. This warming of tropical Pacific waters affects the global pattern of pressure and wind systems including the monsoon winds in the Indian Ocean. It is believed that the severest droughts in India have been caused by El-Nino.

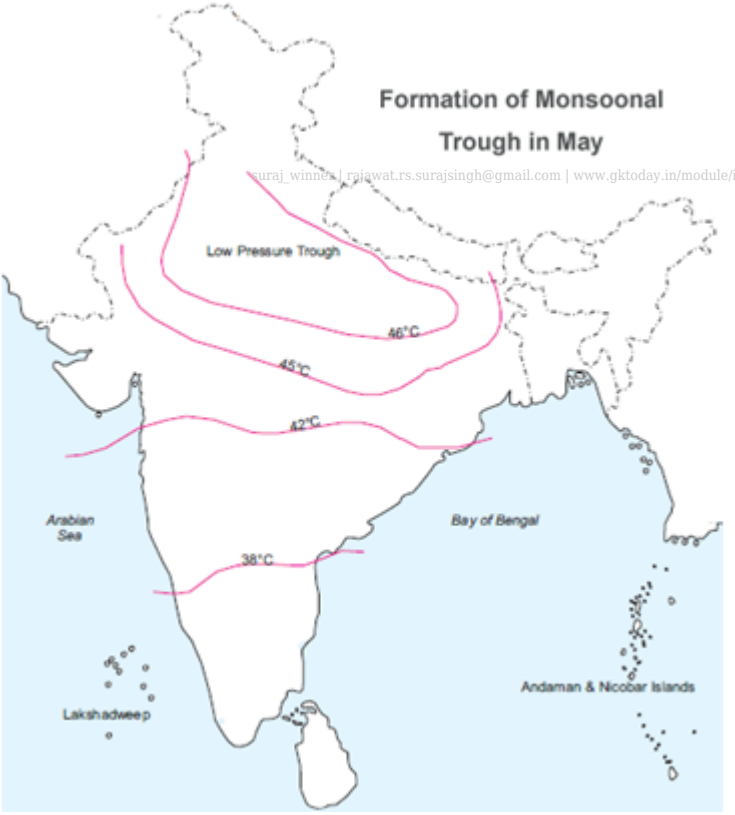
- La Nina is thought to be favourable to India as it brings rains.

Monsoon and Seasons in India

The word monsoon is derived from the Arabic word 'Mausim' which means season. Monsoon refers to the ***seasonal reversal in the wind direction*** during a year. During summer, the interior parts of North Indian Plains covering Rajasthan, Punjab, Haryana, and Western Uttar Pradesh are intensely hot. The daily maximum temperature in some of these parts is as high as 45° to 47° C.

Summer Monsoon

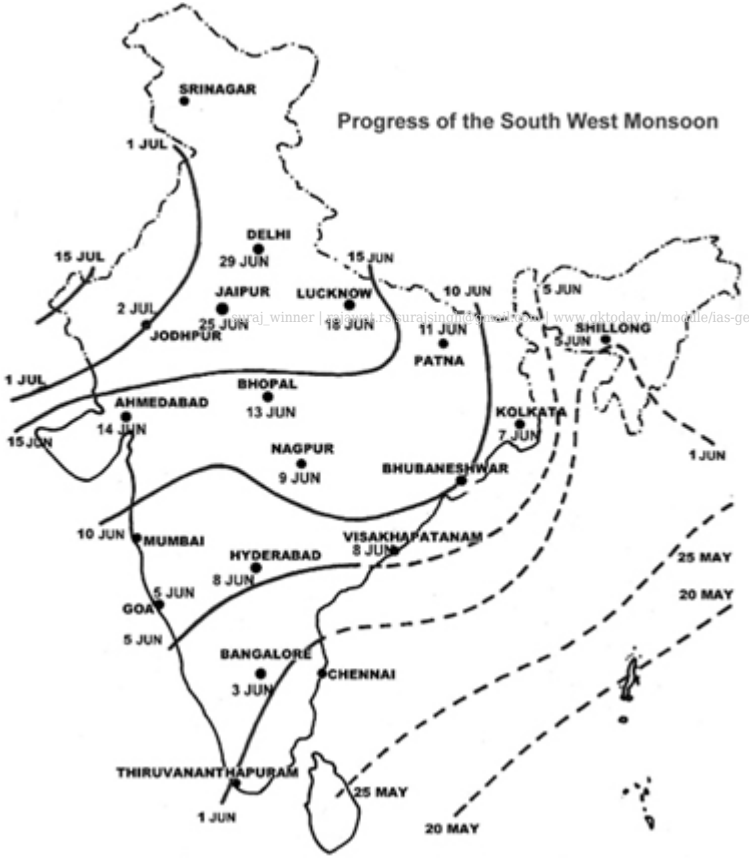
The average maximum temperature is above 33°C in the month of May at Delhi, Jodhpur and Jaisalmer. Such high temperature heats up the air of that region. Hot air rises and due to this a low pressure area is created under it. This low pressure is also known as **monsoonal trough**. It lies between western Rajasthan to Odisha.



On the other hand temperature over Indian Ocean is relatively low. So a relatively high pressure region is created over the sea.

The pressure difference between Indian Ocean and North Central Indian Plains causes the air from

high pressure region of the sea move towards the low pressure region of North India. This implies that the general movement of air is in June is from equatorial region of Indian Ocean to the Indian subcontinent in the South-West to North-East direction. This direction is exactly opposite to that of the trade winds (North – East to South-West) prevailing during winter in India. This complete reversal of wind direction from North-East to South West and vice-versa is known as monsoons. The winds contain a lot of moisture. When these moisture laden winds move over the Indian sub-continent they cause wide spread rain throughout India and from June to September. Thus, most of the total rainfall in India is confined to these four months only.



Winter Monsoon

During the winter season, **North-East trade winds** prevail over India. They blow from land to sea and that is why that for most part of the country, it is a dry season. A part of North-East trade winds blow over Bay of Bengal. They gather moisture which causes rainfall in the Coromandal coast while the rest of the country remains dry. Strictly speaking these winds are planetary winds known as

Northeast Trades. In India they are essentially land bearing winds.

Irregularity of Monsoon

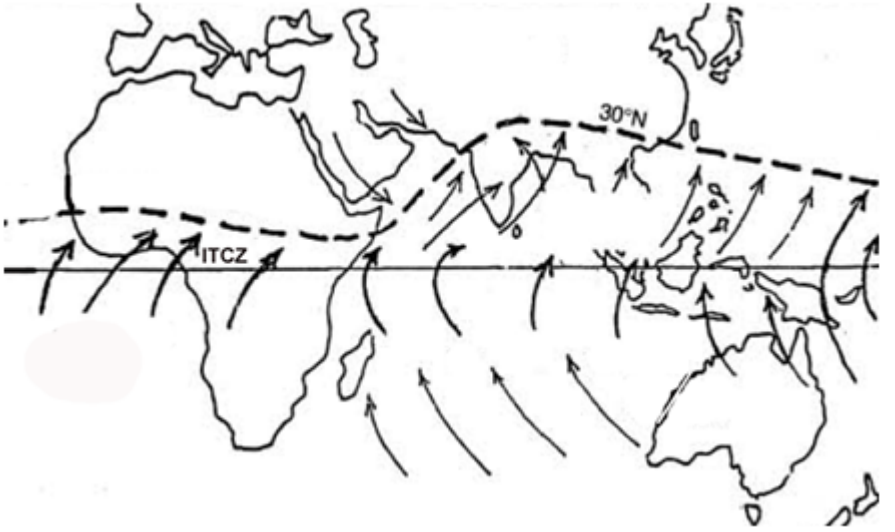
Monsoons winds are irregular in nature affected by different atmospheric conditions. They are also not equally distributed. Coastal areas like Kerala West Bengal and Odisha receive heavy rain fall, whereas interior regions like Haryana, Madhya Pradesh, receive less rainfall. When monsoon arrives, it gives heavy rainfall which continues for several days. This is known as 'burst of monsoon', which generally occurs at the Kerala coast. The monsoon tends to have 'breaks' in its rainfall which causes wet and dry spells. This means that monsoon rains occur only a few days at a time. Rainless dry spells occur in between.

The above simple story is based upon a mechanism proposed by **Halley and is also known as Thermal Concept**. However, it fails to answer the following questions:

- Why the low pressure areas on land are not stationary and why they suddenly change their location?
- Why there is no antimonsoon circulation in the upper troposphere, which must be there if the monsoon winds are thermally induced?
- Low Pressure are in northern India is in April and May, but rains start in the end of June or beginning of July.
- Monsoon rains are an amalgamation of convectional, orographic and cyclonic rainfall, the thermal concept is unsatisfactory to explain in details.

Another gentleman **Fohn** tried to link the Monsoon with the ITCZ or Intertropical Convergence Zone, which is called **Dynamic Concept**.

This concept says that monsoon is the result of seasonal migration of planetary winds and pressure belts around Equator. The Inter-Tropical Convergence Zone (ITCZ) is formed due to the convergence of north-east and south-east trade winds near the equator. In summer when the rays of Sun are directly above the Tropic of Cancer, the Northern Intertropical Zone gets extended up to 30° N latitude, thus covers the South Asia as well as South East Asia, where a low pressure area develops.



When this happens, the trade winds of the Southern Hemisphere need to cross the equator in order to reach the ITCZ. Thus, the trade winds of the Southern Hemisphere cross the equator but are deflected towards right under the Coriolis Effect. In this manner a new belt of "*equatorial westerlies*" is developed and Indian landmass receives the south west monsoon due to these winds.

This theory further explains that in winter, the ITCZ shifts towards south of Equator and the North East Trade winds have to cross the equator to reach the ITCZ. These winds blowing from the northern hemisphere to southern hemisphere deflected left due to Coriolis Effect and blow as North westerly Monsoon there. Since the winds blowing over the Indian subcontinent at this time are usual trade winds of these latitudes, they blow from North East to South West and so become the North East Monsoon.

Seasons in India

There are four seasons in India viz. Winter (December-February), Hot weather summer (March-May), Rainy south-western monsoon (June-September) and Post-monsoon, also known as north-east monsoon in the southern Peninsula (October-November).

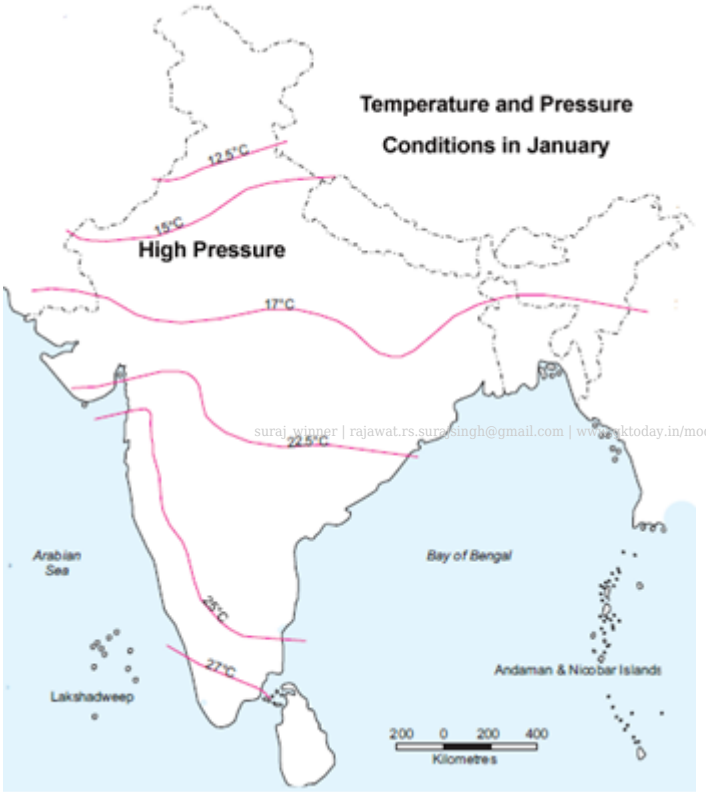
Winter Season

During the winter season, the temperature decreases with increasing latitude in India from 25°C in South to near zero temperature on north. This season is characterised by Fog and Frost in North and North-West India. There is light rainfall in this region due to Western disturbances. There is a sustained snowfall on the higher slopes of the Himalayas.

North East Monsoon

In India, rains occur in winter due to the North East Monsoon. During the winter season, **North-**

East trade winds prevail over India. They blow from land to sea and that is why that for most part of the country, it is a dry season. A part of North-East trade winds blow over Bay of Bengal. They gather moisture which causes rainfall in the Coromandal coast while the rest of the country remains dry. In the northern part of the country the weather is marked by clear sky, low temperatures and low humidity. The winter rainfall is very important for the cultivation of 'Rabi' crops.



Impact of Jet streams in Winter

Jet streams are **fast flowing**, **narrow** air currents located ***near the Tropopause***, the transition between the troposphere and the stratosphere. The **major jet streams on Earth are westerly winds** (flowing west to east). Their paths typically have a **meandering shape**; jet streams may start, stop, split into two or more parts, combine into one stream, or flow in various directions including the opposite direction of most of the jet.

The **strongest jet streams are the polar jets**, at around 7–12 km above sea level, and the higher and somewhat weaker subtropical jets at around 10–16 km. The Northern Hemisphere and the Southern Hemisphere each have both a polar jet and a subtropical jet. The northern hemisphere polar jet flows over the middle to northern latitudes of North America, Europe, and Asia and their

intervening oceans, while the southern hemisphere polar jet mostly circles Antarctica all year round. The Jet streams are upper level, irregular, concentrated, meandering bands of westerly winds that travel at speeds of 300 to 400 kmph and come to India from the Mediterranean side in winter. This jet stream is bifurcated due to the physical obstruction of the Himalayas and Tibetan Plateau. One branch is located to the south of the Himalayas, while the second branch is positioned to the north of the Tibetan Plateau. The southern branch blows eastwards south of the Himalayan ranges along 25° N latitude (Rajasthan., MP, Chhattisgarh etc.) . These winds tend to descend over the north-western parts of India, resulting into the development of atmospheric stability and **dry conditions**. It is believed that this branch of jet stream exercises a significant influence on the winter weather conditions in India. *This jet stream is responsible for bringing western disturbances from the Mediterranean region into Indian sub-continent.* Winter rain and hail storms in north western plains and occasional heavy snowfall in hilly regions are caused by these disturbances. These are generally followed by cold waves in whole of northern plains.

Western Disturbances

Western Disturbances are basically the **temperate cyclones** that originate in the Mediterranean Sea and west Asia and happen to reach Afghanistan and Pakistan. In winters, they cross the North West borders of India and reach up to Central India. These disturbances bring small winter rains in India which are locally called *Mahavat* (Rajasthan, Haryana, Punjab) and are beneficial for the Rabi Crops. They also bring cold waves and snowfall in the higher altitudes of the Jammu and Kashmir and Himachal Pradesh.

Summer Season

By the end of February the temperature starts rising and there is a hot weather season in India from March to May. During these months the central part of peninsular India expiries extreme hot weather and an elongated low pressure belt which is called monsoonal trough created, which extends from Jaisalmer in western Rajasthan to Jharkhand and parts of Odisha to the East.

However, over Indian Ocean south of the equator high pressure belt begins to develop in this season. In North-West India, afternoon dust storms are common. During summer, very hot and dry winds blow over North Indian plains. They are locally called 'Loo'. At the same time, localized thunderstorms, associated with violent winds, torrential downpours, often accompanied by hail occur in many parts of India.

- In West Bengal, these storms are known as the '**Kaal Baisakhi**' (calamity for the month of Baisakh).
- Towards the close of the summer season, pre-monsoon showers are common, especially in Kerala and Karnataka, which help in the early ripening of mangoes, and are often referred to

as '**mango showers**'.

- The thunderstorms which occur during summer to bring some rainfall in Karnataka are also known as **Cherry Blossom Showers**.

Rainy south-western monsoon (June-September)

June to September are the months of advancing South-West monsoon season. By the end of May, the monsoon trough further intensifies over north India due to high temperature. The General direction of the wind during this season is from South-West to north-east. These winds are strong and blow at an average velocity of 30 km per hour. These moisture laden winds first hit at Andaman and Nicobar Islands in the last week of May and Kerala coast in the first week of June with violent thunder and lightning. This South-West monsoon that flows in to India brings about a major change in its weather. Two branches of south-west monsoon originate from:

- Arabian Sea
- Bay of Bengal.

The Arabian Sea Branch obstructed by Western Ghats gives heavy rainfall on the Western side of Western Ghats. It reaches Mumbai by 10th June. When this branch crosses the Western Ghats and reaches the Deccan Plateau and parts of Madhya Pradesh, it gives less rainfall as it is a rain shadow region. Further, this branch reaches in Northern Plain by 20th June.

Rains in Bangalore versus Mangalore

Bangalore receives less rainfall in comparison to Mangalore because Bangalore is located in the rain shadow (Leeward Side) of Western Ghats and when the wind blows from the west, it gets obstructed by the hills. Thus the moisture laden wind blows to the windward side of the ghats, causing heavy rainfall in the coastal region and ghat areas and the rainfall in Bangalore is limited. However, you must note here that during weak monsoon condition when there is ample sunshine, the lower levels of the atmosphere are warm which gives rise to convection current. The air goes up leading to the formation of clouds, resulting in rainfall in the city.

Similarly, Pune receives less rainfall because it is also located on lewardside of western Ghats. Other examples are Shillong and Hyderabad. Shillong lies on the northern leeward slopes of the Khasi Hills and therefore receives less rain.

The monsoon winds that move from Bay of Bengal strike Andaman and Nicobar Islands North-Eastern states and coastal areas of West Bengal and cover the whole of India by the 15th of July. They cause heavy rainfall in the region. However, quantity of rainfall decreases as they move towards West over the Northern plains. For examples rainfall at Kolkata is 120 cm, Allahabad 91 cm and Delhi 56cm.

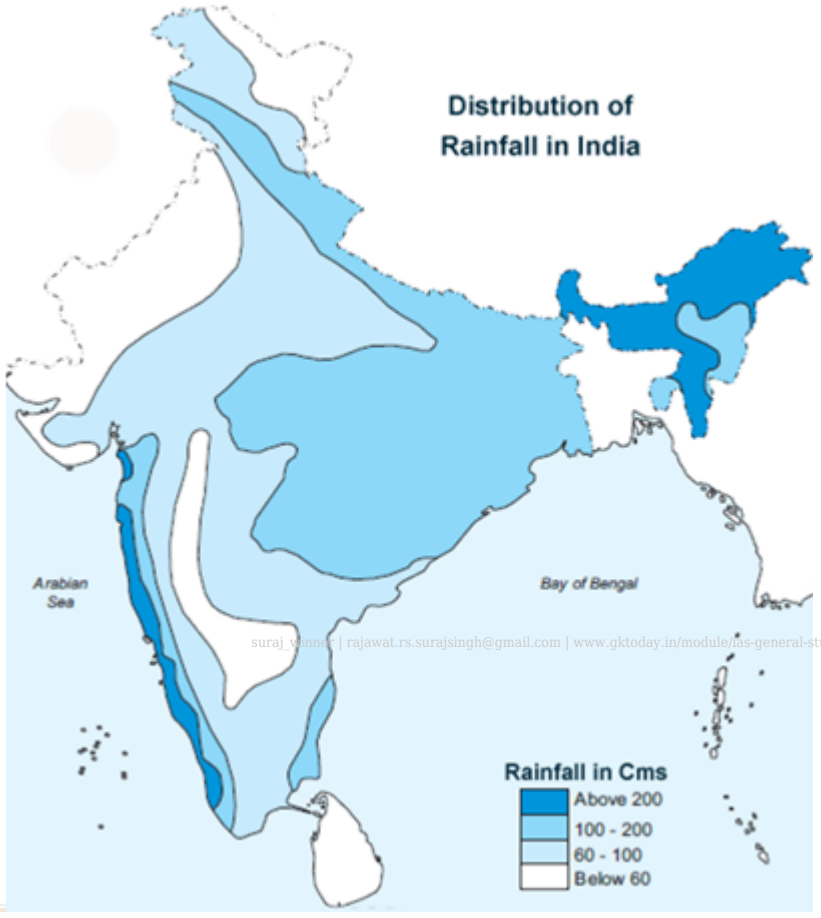
Post Monsoon Season

October and November are the months of post (or retreating) monsoon season. The temperatures during September-October start decreasing in north India. Monsoonal trough also becomes weak over North-West India. This is ***gradually replaced by a high pressure system***. The South-West monsoon winds weaken and start withdrawing gradually from North Indian Plains by November. In October the weather remains humid and warm due to continuing high temperature and moist land in month of October. *In Northern plains hot and humid weather becomes oppressive at this time. It is commonly called 'October Heat'. However, towards the end of October, temperature starts decreasing, making nights pleasant.*

By the month of November, the low pressure of North India shifts to Bay of Bengal and this is the time of cyclonic storms which develop in the Bay of Bengal. These storms create havoc in coastal areas of Odisha, Andhra Pradesh and Tamil Nadu, especially in the deltas of Mahanadi, Godavari and Krishna rivers.

Distribution of Rainfall in India

Rainfall in India is highly uneven over a period of time in a year. The western coasts and North East India receive rainfall of over 400 cm. It is less than 60 cms in western Rajasthan and adjoining parts of Gujarat, Haryana and Punjab. Similarly, rainfall is *low in the interiors of the Deccan Plateau and east of Western Ghats*. Then, Leh in Jammu and Kashmir is also an area of low precipitation.



Here are some more observations about distribution of rainfall in India

- As we move from Meghalaya to Haryana or Punjab in Northern plains, we observe that the rainfall decreases.
- In peninsular India, rainfall decreases from coast to interior parts.
- In North-East India, the *rainfall increases with altitude.*
- Maximum rainfall (above 200 cms) in India occurs in the western coast, sub Himalayan regions of north-east and Garo, Khasi and Jaintia hills of Meghalaya.
- Moderate rainfall (100-200cm) occurs in some parts of the Western Ghats, West Bengal, Odisha and Bihar and many states.
- Low rainfall (60 to 100cm) occurs in parts of Uttar Pradesh, Rajasthan, and interior Deccan plateau.
- Inadequate rainfall (Less than 60cm) occurs in western part of Rajasthan and Gujarat, Ladakh

and south central part receives a rainfall of less than 20cm.

Impact of El Niño/La Niña–Southern Oscillation

A recurring characteristic of the climate is called Climatic Pattern. The gap between two recurrences may be from one year to as long as tens of thousands of years. Some of the events are in regular cycle, while some are not. When they recur in the form of regular cycles of fluctuations in climate parameters, they are called **climate oscillations**. The term **oscillation** is used because such fluctuations are *not perfectly periodic.* For example, we say that El Nino returns every four and half years. But actually it may or may not return. Or it may return too early or too late. So, El Nino is quasi periodic.

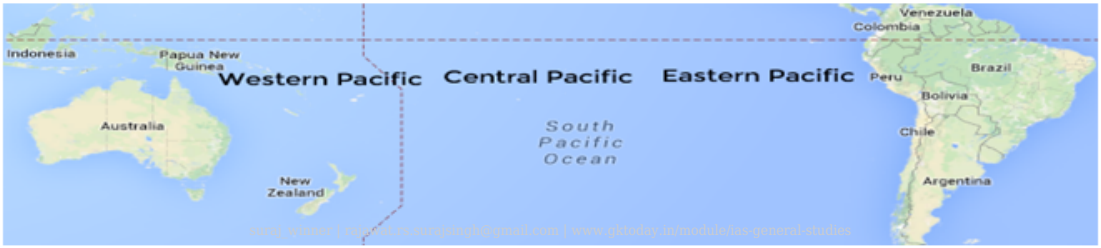
El Niño

El Niño was originally recognized by fisherman off the coast of **Peru** in South America. The ocean off the coast of Peru is one of the world's richest fisheries regions. In most years trade winds flow from the southeast push warm surface water **away** from the coast. In its place, the cold water comes up on the surface *due to upwelling*. This cold water is full of nutrients and provides nourishments to planktons. These planktons serve as food for fishes. Fishes in turn provide food to the sea birds. Due to all this, not only there is a good catch of fishes but also good collection of the **Guano**, the bird excreta, used as a valuable fertilizer. This is what that made Peru number one fishing nation in the world by the early 1970s.

Pattern of flow of warm winds off the coast of Peru

However, every few years, there is a change in the pattern of air circulation. It changes in such a way that the trade winds reverse direction, blowing from west to east. Due to this reversal, the upwelling of the cold water gets weakened. The surface water is warm. This lowers the nutrients available to

fish and thus poses problems to the economics of fisheries. The problems don't end here. The accumulation of large mass of warm water allows formation of more and more clouds and this would bring destructive rains that occur in normally dry areas of Peru and Chile. The same is also responsible for bring outbreaks of Malaria and Cholera in some parts of South America. Peru , as you may know is a **Hispanophone** country as many people speak Spanish out there. The above mentioned reversal of the winds occurred during Christmas times (Please note that we have Christmas in winter, but Peruvians have in summer, because they are in southern hemisphere), so they named it El Niño or "Christ Child" or "The Little Boy" in their own language. Before, you read further, please understand the location of Eastern, Central and Western Pacific on the map, otherwise it would be too confusing (earth is round…after all)



Now, here is how it affects the entire tropical region.

- Off the coast of Peru (read in Eastern Pacific and Central Pacific), there is normally cool surface water. But El Niño makes it go warm. When the water becomes warm, the tread winds, which otherwise flow from East to west, either reverse their direction or get lost. The warm water causes lots of clouds getting formed in that area, causing heavy rains in Peruvian desert during El Niño years.
- Due to this warm water, the air gets up and surface air pressure above Eastern Pacific gets down. On the other hand, the waters cool off in western pacific and off Asia. This leads to rise in surface pressure over the Indian Ocean, Indonesia, and Australia
- So, while there is raining (read flooding) in Eastern Pacific; the drought sets in over Asia as high pressure builds over the cooler ocean waters.
- The net result is:
- Normal or high rainfall in eastern / central pacific.
- Drought or scant rainfall in western pacific / Asia.

Although El Niño originally referred to local conditions off the coast of Peru and Ecuador, the use of the term has been broadened by many scientists to represent all surface temperature warming in the eastern and central Pacific. The impacts of El Niño , which have been well documented include the following:

- Heavy rains in Ecuador and Peru.
- Heavy rains in southern Brazil but drought in north East Brazil
- Drought in Zimbabwe, Mozambique, South Africa, Ethiopia
- Warm winter in the northern half of the United States and southern Canada
- Drought, Scant rains off Asia including India, Indonesia, and Philippines etc.
- Coral bleaching worldwide
- Drought in eastern Australia

La Niña

La Niña, which means "The Little Girl" or "El Viejo" or "anti-El Niño" or simply "a cold event" or "a cold episode is the cooling of water in the Eastern Pacific Ocean. Here is what happens in La Niña.

- The water in Eastern Pacific, which is otherwise cool; gets colder than normal. There is no reversal of the trade winds but it causes strong high pressure over the eastern equatorial Pacific.
- On the other hand, low pressure is caused over Western Pacific and Off Asia.
- This has so far caused the following major effects:
    - Drought in Ecuador and Peru. Low temperature, High Pressure in Eastern Pacific
    - Heavy floods in Australia; High Temperature in Western Pacific, Indian Ocean, Off coast Somalia and good rains in India.
    - Drought in East Africa (Somalia Drought of 2011 was linked to it)

ENSO

Both **El Nino** and **La Nina** are part of a larger cycle called ENSO, or **El Niño–Southern Oscillation**. The El Niño (warm event) and La Nina (Cold event) both have now established themselves as the integral part of the global climate system. It is a recurrent phenomenon with an average return period of $4^{1/2}$ years, but can recur as little as 2 or as much as 10 years apart. Such events have occurred for millennia, and can be expected to continue to occur in the future.

Impact of El Niño and La Nina on Indian Weather

- El Nino and La Nina are among the most powerful phenomenon on the Earth. These are known to alter climate across more than half the planet and dramatically impact weather patterns.
- Over Indian subcontinent, El Nino during winter results in development of warm conditions. During summer, it leads to dry conditions and deficient monsoon. It also leads to drought in Australia. On the other hand, La Nina results in better than normal monsoon in India. At the same time, in Australia it has caused floods.
- In the recent past, India experienced deficient rainfall during El Nino years 2002 and 2009

whereas monsoon was normal during El Nino years 1994 and 1997. *This so far implies that in about 50 per cent of the years with El Nino during summer, India experienced droughts during monsoon.*

- This implies that *El Nino is not the only factor that affects monsoon in India*. There are other factors that affect India's rainfall pattern. These include North Atlantic SST, Equatorial SE Indian Ocean SST, East Asia Mean Sea Level Pressure, North Atlantic Mean Sea Level Pressure and North Central Pacific wind at 1.5 km above sea level.

Difference between El Nino and La Nina

Feature	El-Nino	La-Nina
Meaning	El Nino is a Spanish term which represents "little boy"	La Nina is a Spanish term which represents 'little girl'.
Temperature at Sea Surface	Temperature at sea surface is warmer than normal sea-surface temperatures. El Nino is a warming of the Pacific Ocean between South America and the Date Line, centred directly on the Equator, and typically extending several degrees of latitude to either side of the equator.	Temperature at sea surface is cooler than normal sea-surface temperatures. La Nina exists when cooler than usual ocean temperatures occur on the equator between South America and the Date Line.
Pressure	It accompanies high air surface pressure in the western Pacific	accompanies low air surface pressure in the eastern Pacific
Trade winds	El Niño occurs when tropical Pacific Ocean trade winds die out and ocean temperatures become unusually warm	La Nina, which occurs when the trade winds blow unusually hard and the sea temperature become colder than normal
Seasons	Winters are warmer and drier than average in the Northwest of pacific, and wetter in Southwest of pacific and experience reduced snowfalls.	Winters are wetter and cause above-average precipitation across the Northwest of pacific and drier and below average precipitation in South west of pacific.
Coriolis force	El Nino results in a decrease in the earth's rotation rate (very minimal) , an increase in the length of day, and therefore a decrease in the strength of the Coriolis force	La Nino results in increase in the earth's rotation rate, decrease in the length of day, and therefore a increase in the strength of the Coriolis force.
Ocean waters in Pacific	Warm water approaches the coasts of South America which results in reduced upwelling of nutrient-rich deep water impacting impacts on the fish populations.	Cold water causes increased upwelling of deep cold ocean waters numbers of drought occurrence, with more nutrient-filled eastern Pacific waters.

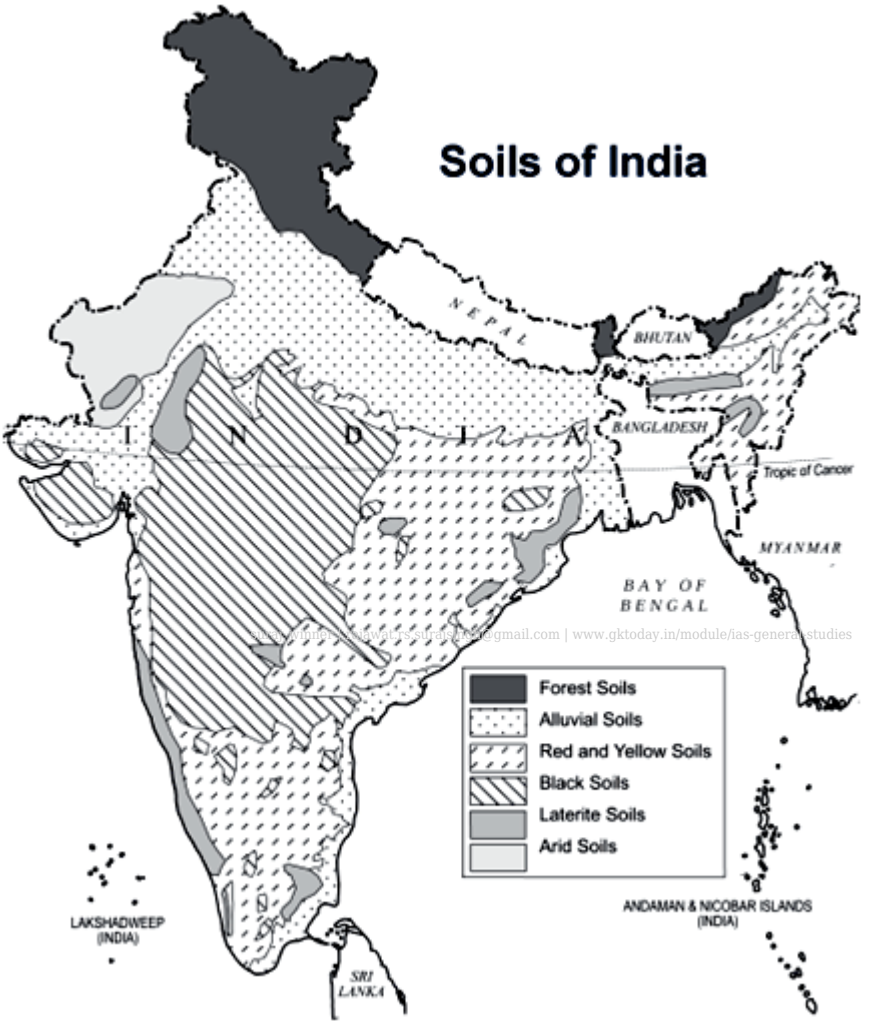
Feature	El-Nino	La-Nina
Cyclones	Comparatively less compared to La Niña as wind speed is low	La Nina had a greater tendency to trigger intense tropical cyclones as wind direction changes pilling up water between Indonesia and nearby areas as winds from Africa onwards gets blocked.

Do El Nino and La Nina explain most of the unusual climatic happenings?

It is undeniable that the El Nino has been used to explain unusual climatic changes across the globe. But, modern climatology taken into account various other phenomena also. However, El-Nino has far-reaching and varied effect on climate across the world. The major reason for these unusual climatic happenings is the shifting in tropical rainfall, which in turn affect the wind patterns across the world. When the El-Nino effect causes the rainy areas centered around Indonesia and the Pacific region to move eastward, the subsequent changes result in unseasonable weather in many regions of the world. The El Nino is typically characterized by warm ocean currents and heavy rains, however, it also plays havoc with the normal weather conditions in different areas of the world. Also, the increase in temperatures affects fishing adversely, disrupts local weather and indigenous marine life in the areas concerned, other than having an effect on climatic conditions worldwide. When the linkage between El Nino and climate effects were initially suggested by the British scientist, Gilbert Walker, it was deemed ridiculous that one phenomenon could have an effect on regions as far off as Australia, India etc and Canada. However, the occurrence of El Nino in the past few decades has proved without a doubt, their far-reaching consequences. Some of the effects of El Nino in the past have been causing of droughts and forest fires in South Asia (Indonesia and Philippines) and Australia, floods in the South American countries in the eastern Pacific region, increased rain in certain other areas of the world etc.

Soils of India

Soil is the mixture of rock debris and organic materials which develop on the earth's surface. The major *factors affecting the* ***formation of soil are relief, parent material, climate, time, and biodiversity*** including the human activities. India is a diverse country with variety of relief features, landforms, climatic realms and vegetation types. These have contributed in the development of various types of soils in India.



In ancient times, soils used to be classified into two main groups – **Urvara and Usara**, which were fertile and sterile, respectively. In medieval times, the soils were classified on the basis of the external features such as texture, colour, slope of land and moisture content in the soil. So, the soils were identified as sandy, clayey, silty and loamy, etc. Then, they were also classified on the basis of colour such as red soil, yellow soil, black soil, etc.

The Indian soils have been classified by ICAR on the basis of characters as per the United States Department of Agriculture (USDA) Soil Taxonomy. These types are as follows:

Types of Soils in India			
Soil Type	General Characters / Position in entire world soil classification	Area	% of Total area of India
Inceptisols	These are usually the weakly developed young soil though they are more developed than entisols.	130372.9	39.74
Entisols	Usually young or underdeveloped. Lack vertical development of horizons. These are less fertile soils.	92131.71	28.08
Alfisols	Pale, grayish brown to reddish in colour with moderate-to-high reserves of basic cations and are fertile. However, their productivity depends on moisture and temperature. They are supplemented by the moderate application of lime and other chemical fertilizers.	44448.68	13.55
Vertisols	These are expandable clay soils , composed of more than 30 per cent clays. Vertisol clays are black when wet and become iron hard when dry. When drying, Vertisols crack and the cracks widen and deepen as the soil dries ; this produces cracks 2-3 cm wide. These are productive soils. The regur soils of India are an example of vertisols.	27960	8.52
Aridisols	Ardisoil is the largest single soil order occurs in dry regions of the world. These soils occupy nearly 19 per cent of the earth's land surface. These are pale and light near the surface, deficit in moisture. Lack in organic matter. Salinisation is the main problem of these soils. Salinisation complicates farming in Aridisols.	14069	4.28
Ultisols	Highly weathered forest soil, which tend to be reddish in colour because of residual iron and aluminum oxides in the a horizon. The increased precipitation in ultisol regions means greater mineral alteration, more leaching, and therefore,a lower level of fertility. Fertility is further reduced by certain agricultural practices and the effect of soil damaging crops such as cotton and tobacco. These soils need substantial management.	8250	2.51
Mollisols	Most productive soils of the earth. They are rich in humus content. They have dark –colored surface. Mollisols are soft, even when dry, with granular pads, loosely arranged when dry. These humus rich organic soils are high in basic cations and have high fertility. Soils of the steppes and prairies of the world belong to this group	1320	0.4
Others		9503.1	2.92

The Indian Classification of Soils

On the basis of genesis, colour, composition and location, the soils of India have been classified into various soils such as Alluvial soils, Black soils, Red and Yellow soils, Laterite soils, Arid soils, Saline soils, Peaty soils, Forest soils etc.

Important Observations have been written down in the below descriptions:

Alluvial Soils

Alluvial soils, the depositional soils transported by rivers, are the predominant type of soil in the northern plains of the country, widespread in the **Ganga plains and the river valleys**. These soils cover about **40 per cent** of the total area of the country.

Apart from the northern Gangetic plains, via a narrow corridor in Rajasthan, they extend into the plains of Gujarat.

In the Peninsular region, they are found in deltas of the east coast such as Mahanadi , Godavari and Krishna.

The alluvial soils are generally **rich in potash** but **poor in phosphorous**.

In the Upper and Middle Ganga plain, two different types of alluvial soils have developed, viz. Khadar and Bhangar.

- Khadar is the new alluvium and is deposited by floods annually, which enriches the soil by depositing fine silts.
    - Bhangar represents a system of older alluvium, deposited away from the flood plains.
        - Both the Khadar and Bhangar soils contain calcareous concretions (Kankars). These soils are more loamy and clayey in the lower and middle Ganga plain and the Brahamaputra valley. The sand content decreases from the west to east.

The colour of the alluvial soils varies from the light grey to ash grey. Its shades depend on the depth of the deposition, the texture of the materials, and the time taken for attaining maturity. Alluvial soils are intensively cultivated.

Coastal Alluvium: Please note that the alluviums of the peninsular coastal strip are darker in colour than the alluvium of the northern plains because the rivers of the peninsula flow over the Deccan Plateau composed of basalt, and over black soil are only to deposit It in coastal areas . Maharastra has no alluvial soils but coastal alluvium is found in that state.

Black Soil

Most of the Deccan plateau, including Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and some parts of Tamil Nadu has black soils .

In the upper reaches of the Godavari and the Krishna, and the north western part of the Deccan Plateau, such as parts of Gujarat, the black soil is very deep. These soils are also known as the 'Regur

Soil' or the 'Black Cotton Soil'. This soil is of volcanic origin.

The black soils are generally clayey, deep and impermeable. They swell and become sticky when wet and shrink when dried. So, during the dry season, these soil develop wide cracks. Thus, there occurs a kind of '**self ploughing**'. Because of this character of slow absorption and loss of moisture, the black soil retains the moisture for a very long time, which helps the crops**, especially, the rain fed crops**, to sustain even during the dry season.

Chemically, the **black soils are rich in lime, iron, magnesia and alumina.** They also contain potash. But they lack in phosphorous, nitrogen and organic matter. The colour of the soil ranges from deep black to grey.

Red and Yellow Soil

On the eastern and southern parts of the Deccan Plateau, the Red soil develops on crystalline igneous rocks.

These soils are abundant along the eastern slopes of Western Ghats, Odisha and Chhattisgarh and in the southern parts of the middle Ganga plain.

The soil develops a reddish colour due to a **wide diffusion of iron in crystalline and metamorphic rocks**. It looks yellow when it occurs in a hydrated form (Iron Hydroxides).

The fine-grained red and yellow soils are normally fertile, whereas coarse-grained soils found in dry upland areas are **poor in fertility due to leaching of the nutrients.** They are generally poor in nitrogen, phosphorous and humus but respond well to fertilizers.

Laterite Soil

The Laterite soils develop in areas with high temperature and high rainfall and are common in the high altitude areas of Peninsular plateau.

Laterite soil and is mainly found on the summits of the Western Ghats, Eastern Ghats, Rajmahal Hills, Vindhyas, Satpuras and Malwa plateau, thus abundant in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Odisha and Assam.

Laterite soil represents intense leaching due to heavy rains, due to which the lime and silica are leached away, and soils rich in iron oxide and aluminium compound are left behind. Then, the Humus content of the soil is removed fast by bacteria that thrives well in high temperature.

This implies that the Laterite soil is poor in organic matter, nitrogen, phosphate and calcium, while **iron oxide and potash are in excess.** **Due to excess of Iron**, laterites are not suitable for cultivation*; however, application of manures and fertilisers are required for making the soils fertile for cultivation.*

Red Laterite soils in Tamil Nadu, Andhra Pradesh and Kerala are more suitable for tree crops like cashewnut.

Laterite soils are widely cut as bricks for use in house construction.

Arid Soils

Arid soils, which is sandy and saline soil is abundant in arid regions of western Rajasthan. These soils are poor and contain little humus and organic matter. The color appears from red to brown.

In some areas, the salt content is so high that common salt is obtained by evaporating the saline water. Due to the dry climate, high temperature and accelerated evaporation, they lack moisture and humus. Nitrogen is insufficient and the phosphate content is normal.

Lower horizons of the soil are occupied by 'kankar' layers because of the increasing calcium content downwards. The 'Kankar' layer formation in the bottom horizons restricts the infiltration of water, and as such when irrigation is made available, the soil moisture is readily available for a sustainable plant growth.

Saline Soils

Saline soils or **Usara soils** contain a larger proportion of sodium, potassium and magnesium, and thus, they are infertile, and do not support any vegetative growth.

They have more salts, largely because of dry climate and poor drainage. They occur in arid and semi-arid regions, and in waterlogged and swampy areas.

Their structure ranges from sandy to loamy. They lack in nitrogen and calcium.

- Saline soils are more widespread in western Gujarat, deltas of the eastern coast and in Sunderban areas of West Bengal.
- In the Rann of Kuchchh, the Southwest Monsoon brings salt particles and deposits there as a crust. Seawater intrusions in the deltas promote the occurrence of saline soils. In the areas of intensive cultivation with excessive use of irrigation, especially in areas of green revolution, the fertile alluvial soils are becoming saline.
- Excessive irrigation with dry climatic conditions promotes capillary action, which results in the deposition of salt on the top layer of the soil. In such areas, especially in Punjab and Haryana, farmers are advised to add gypsum to solve the problem of salinity in the soil.

Peaty Soils

- Peaty soils arte found in the areas of heavy rainfall and high humidity, where there is a good growth of vegetation. Thus, large quantity of dead organic matter accumulates in these areas, and this gives a rich humus and organic content to the soil.
- Organic matter in these soils may go even up to 40-50 per cent.
- These soils are normally heavy and black in colour. At many places, they are alkaline also.
- These soils occur widely in the northern part of Bihar, southern part of Uttaranchal and the coastal areas of West Bengal, Orissa and Tamil Nadu.

Forest Soils

Forest soils are formed in the forest areas where sufficient rainfall is available. The soils vary in structure and texture depending on the mountain environment where they are formed.

They are loamy and silty on valley sides and coarse-grained in the upper slopes.

In the snow-bound areas of the Himalayas, they experience denudation, and are acidic with low humus content. The soils found in the lower valleys are fertile.

Major Soils abd Crops Grown in them

Alluvial Soils

Rice, wheat, sugarcane, cotton and jute all grow well in these soils.

Black Soils

Rice, wheat, sugarcane and cotton apart from groundnut, millet and oilseeds.

Arid Soils

Only drought-resistant crops such as barley and millet can grow in this type of soil.

Laterite Soils

It is an acidic soil and is rich in iron, which gives the soil a somewhat red appearance. Cash crops such as cashew, rubber, coconut, tea and coffee.

Red and Yellow Soils

Derive names from the very large amounts of iron oxide & Hydroxides present in them. They are sandy and somewhat acidic, and are also low in nitrogen and phosphorous. Despite this, red and yellow soils are used to grow rice, wheat, sugarcane, millet, groundnut, ragi and potato.

Soil Degradation & Soil Erosion

The decline in soil fertility, when the nutritional status declines and depth of the soil goes down due to erosion and misuse is called Soil degradation. Soil degradation is the main factor leading to the depleting soil resource base in India. The degree of soil degradation varies from place to place according to the topography, wind velocity and amount of the rainfall.

Soil Erosion

The soil forming processes and the erosion processes of running water and wind go on simultaneously. However, generally, there is a balance between these two processes. Sometimes, such a balance is disturbed by natural or man made factors, leading to a greater rate of removal of soil.

- With increasing population, the pressure on the land increases and forests are removed for human settlement, for cultivation, for grazing animals and for various other needs.

The two most important agents of soil erosion are wind and water. Wind erosion is significant in arid and semi-arid regions. Water erosion is significant in regions with heavy rainfall and steep slopes. Water erosion which is more serious and occurs extensively in different parts of India, takes place mainly in the form of sheet and gully erosion.

There are four kinds of soil erosion which can be arranged in an order of Splash erosion, Sheet

erosion, Rill erosion, Gully erosion.

Splash Erosion

Raindrop splash erosion is a result of the energy of falling raindrops causing detachment of soil particles and and down-slope movement of sediment. Maintenance of ground cover, such as in reduced- or no-till operations, use of cover crops, and enhancement of the stability of soil aggregates can be important in reducing detachment of soil particles. The effect of manure application in enhancing soil aggregation also leads to reducing soil erodibility due to the raindrop splash effect.

Sheet Erosion

Sheet erosion, although less noticeable than other types of erosion, typically is the main erosive force. Sheet erosion is less noticeable, as it does not leave obvious cuts in the soil surface as with gully erosion. Sheet erosion is the removal of a relatively uniform, although thin, layer of soil from the land surface by unchanneled runoff, or sheet flow.

Sheet erosion takes place on level lands after a heavy shower and the soil removal is not easily noticeable. But it is harmful since it removes the finer and more fertile top soil.

Rill Erosion

Rill erosion is the process by which numerous small channels–less than three inches in depth–are formed. This type of erosion results from concentration of overland water flow associated with sheet erosion. Rill erosion can be especially serious on recently cultivated land. Rill erosion is best minimized by minimizing sheet flow, such as by maintaining crop residues and utilizing cover crops. Physical barriers, such as terraces, and vegetative barriers can be effective in stopping or reducing rill erosion.

Gully Erosion

Gully erosion refers to the cutting of narrow channels called gullies. The gullies can be caused by small channels of approximately 3 to 12 inches deep. Gullies may be one to several feet deep. Gully erosion cuts deep and removes the **surface soil as well as deeper soil** that may still have substantial amounts of total nutrients but less compared to the surface soil.

Gully erosion needs to be prevented, as it is difficult to check once started. Gully erosion is common on steep slopes. Gullies deepen with rainfall, cut the agricultural lands into small fragments and make them unfit for cultivation.

- A region with a large number of deep gullies or **ravines** is called **badland topography**. Ravines are widespread, in the Chambal basin, which have been caused due to gully erosion. Apart from Chambal valley, the ravines are also found in Tamil Nadu and West Bengal.

Some more observations

- The Indian soils have been formed under varied geographical conditions and differ widely in their physical properties, chemical composition and fertility level. *Most soils are old and mature*.

- Soils of the peninsular plateau are much older then the soils of the great northern plain.
- Indian soils are largely deficient in nitrogen, minerals salts, humus and other organic materials.
- Plains and valleys have thick layers of soils while hilly and plateau areas depict thin soil cover.
- Some soils like alluvial and black soils are fertile while some other soils such as Laterite, desert and alkaline soils lack in fertility and do not yield good harvest.
- Indian soils have been used for cultivation for hundreds of years and have lost much of their fertility. As such there is urgent need of giving scientific treatment to our soils.
- Indian climate is characterized by seasonal rainfall and our soils need irrigation during the dry period.
- Indian soils suffer from soil erosion and other allied problems.

Prelims Model Questions

India Geology and Climate Model Questions

1. Consider the following statements:

1.The distribution of coal in India is more abundant on the eastern side of the country

2.Most coal produced in India is from Gondwana Coal Fields

Which among the above statements is / are correct?

[A] Only 1 is correct

[B] Only 2 is correct

[C] Both 1 & 2 are correct

[D] Neither 1 nor 2 is correct

Answer: [C] Both 1 & 2 are correct

The India coal fields have been classified in two parts viz. Gondwana coal fields and Tertiary coal fields. The Gondwana Fields account for 98% of the total reserve and 99% of the total coal production in India. Rest 2% is the tertiary coal. Please note that distribution of coal in India is more abundant on the eastern side of the country. While Gondwana coal is about 200 million years old, tertiary deposits are approximately 55 million years old.

Gondwana Coal

The Gondwana coal fields occur mostly in the river valleys such as Damodar, Mahanadi, Godavari, and Narmada. The Gondwana coal is a laminated bituminous coal within which dull and bright layers alternate. This coal is almost free from moisture but it contains variable quantities of sulphur and phosphorous. In general, Gondwana coal is good steam or gas coal. This is also known as metallurgical coal. The largest resources of Gondwana coal are located in the Damodar valley (West Bengal, Jharkhand), Jharia, Raniganj and Bokaro. The Godavari, Mahanadi, Son and

Wardha valleys also contain coal deposits.

2. With reference to the rock formation in India, the Deccan Trap is exposed in__:

1. Maharashtra
2. Gujarat
3. Uttar Pradesh
4. Tamil Nadu

Choose the correct option from the codes given below:

[A] Only 1 & 2

[B] Only 1

[C] Only 1, 2 & 3

[D] 1, 2, 3 & 4

Answer: [C] Only 1, 2 & 3

In Western and Central India, DVP is exposed mainly in the states of Maharashtra, Madhya Pradesh, Karnataka, Gujarat, and Andhra Pradesh and also has its nominal presence in southern parts of Uttar Pradesh and eastern parts of Rajasthan.

Based on the area of occurrence, the Deccan Lavas have been further classified into four classes viz. Malwa Trap: occurring in Malwa region of Madhya Pradesh, Mandla Traps: occurring in Mandla region of Madhya Pradesh, Saurashtra Trap: occurring in Saurashtra region of Gujarat and Main Deccan plateau: occurring in States of Maharashtra, Karnataka and Andhra Pradesh.

3. Consider the following caves of historical importance in India?

1. Ajanta Caves
2. Elephanta Caves
3. Barabar Caves

Which among the above is / are Deccan Trap caves?

[A] Only 1

[B] Only 1 & 2

[C] Only 2 & 3

[D] 1, 2 & 3

Answer: [B] Only 1 & 2

Some of the best known Deccan Trap caves are close to Mumbai (Bombay), including Ajanta (perhaps the oldest one dating back to 200 B.C.), Mandapesvara Caves, Kanheri Caves, Jogeshwari Caves, Mahakali Caves, and Elephanta Caves.

4. Consider the following:

1. Kashmir Valley
2. Tamil Nadu
3. Arunachal Pradesh
4. Rajasthan

One can fine tertiary coal in which among the above regions / states?

[A] Only 1 & 2

[B] Only 2 & 3

[C] Only 2 & 4

[D] 1, 2, 3 & 4

Answer: [D] 1, 2, 3 & 4

Kashmir Valley-Nichahom lignite, Former South Arcot (Now Cuddalore and surrounding area) of Tamilnadu and of Kerala, Jaipur, Nazira and Makum coalfields of Assam ; Namchick and Namphuk coalfields of Arunachal Pradesh. Palana of Rajasthan; Katch of Gujarat, Darranggiri, Rongrenggiri in the Garo Hills; Cherapunji, Mawlong and Shilong in Meghalaya, Mikir Hills in Upper Assam, and Coals of Jammu coalfields– Kalkot, Metka, Mahogala, Chakar Dhanwal Sawalkot-Lodhra, Kura and Chinkah. All of them are sources of tertiary coal.

5. With reference to the Jet streams, which among the following statements is / are correct?

1. Most Jet streams on earth flow westwards
2. They help in bringing western disturbances from the Mediterranean region into Indian sub-continent
3. Withdrawal of subtropical jet stream from India is critical for the onset of the southwest monsoon over India

Choose the correct option from the codes given below:

[A] Only 1 & 2

[B] Only 2 & 3

[C] Only 1 & 3

[D] Only 2

Answer: [B] Only 2 & 3

First statement is incorrect because jet streams blow from west to east.

6. Which among the following affect the behaviour of the monsoon over India?

1. Subtropical westerly jetstream
2. Tropical easterly jet stream

3. El Nino and La Nina
4. Indian Ocean Dipole
5. Anthropogenic aerosols

Choose the correct option from the codes given below:

[A] 1, 3, 4 & 5

[B] 1, 2, 3, 4, 5

[C] 1, 3, 4

[D] 1 & 3

Answer: [B] 1, 2, 3, 4, 5

7. Consider the following statements in context with the Jet streams:

1.Jet stream are fast moving moisture laden winds blowing only in the stratosphere

2.They help to bring the Western Disturbances Into India In winter

3.They generally blow from West to East

4.They generally blow in a wavy pattern

Which among the above statements is / are correct?

[A] Only 1 & 2

[B] Only 2 & 3

[C] Only 2, 3 & 4

[D] 1, 2, 3 & 4

Answer: [C] Only 2, 3 & 4

First statement is incorrect because Jet Streams are fast moving winds which blow over an altitude of 8-15 km, which includes both troposphere as well as stratosphere.

8. The Deccan Trap:

1. is spread in all states of Peninsular India
2. is made of predominantly Igneous Rocks
3. formed as result of sub-aerial volcanic activity

Which among the above statements is / are correct?

[A] Only 1 & 2

[B] Only 2 & 3

[C] Only 1 & 3

[D] 1, 2 & 3

Answer: [B] Only 2 & 3

Some people broadly divide the geographical land area of India into three parts viz. Deccan trap, Gondwana and Vindhyan. The Deccan Trap covers almost all of Maharashtra, some parts of Gujarat, Karnataka, Madhya Pradesh and marginally Andhra Pradesh. Deccan Trap is thought to have formed as result of sub-aerial volcanic activity associated with the continental deviation in this part of the Earth during the Mesozoic era. This implies that generally, the rocks of Deccan Trap are igneous.

9. The Indian monsoon is characterised by great variability. Consider the following statements with this reference:

1. The single most important characteristic of monsoon is seasonal reversal of winds.
2. A delay in onset of monsoon usually results in an early retreat

Which among the above is / are correct statements?

[A] Only 1

[B] Only 2

[C] Both 1 & 2

[D] Neither 1 nor 2

Answer: [C] Both 1 & 2

10. The north-east monsoon:

1. Blows from land to sea
2. Comes between October to December
3. Brings 60% of the annual rainfall in coastal Tamil Nadu

Which of the above is / are correct statements?

[A] Only 1 & 2

[B] Only 2 & 3

[C] Only 1 & 3

[D] 1, 2 & 3

Answer: [D] 1, 2 & 3

India's climate is affected by two seasonal winds—the north-east monsoon and the south-west monsoon. The north-east monsoon commonly known as winter monsoon blows from land to sea whereas south-west monsoon known as summer monsoon blows from sea to land after crossing the Indian ocean, the Arabian sea and the Bay of Bengal. The south-west monsoon brings most of the rainfall during the year in the country.

http://www.imdchennai.gov.in/northeast_monsoon.htm