1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 02 (Class XI, Semester - 2)
Module Name/Title	Monsoon Climate – India: Traditional Seasons, Climatic Regions, Vulnerability and Disasters – Part 4
Module Id	kegy_20404
Pre-requisites	Basic Concept about seasons, natural hazards like flood, drought and cyclone.
Objectives	After reading this lesson, learners will be able to: • Acquire knowledge and understanding about the traditional seasons of India. • Understand the distribution and variability of rainfall in India. • Know the different climatic regions of India as classified by Koeppen. • Learnhow Monsoon affects the economic life of the country. • Know about the areas prone to flood, drought and cyclone due to monsoon.
Keywords	Traditional seasons, variability of rainfall, Koeppen's scheme, Global warming, geological time scale, greenhouse effect, greenhouse gases.

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Introduction

In the previous modules of climate, you have read that there are different factors that make the climate of India unique, mechanism of monsoon and the characteristics of different seasons. Here, in this module we will discuss about the traditional Indian seasons, distribution of rainfall, climatic regions of India, effect of monsoon on the economic life of the people and the other environmental impacts due to change in climate. You must have noticed leaves falling from the trees or new leaves coming on the trees. You must have seen people celebrating some festivals in a particular season only. You must have observed there is a fixed season for sowing and harvesting of the crops. All these events are somewhere connected with the seasons. A year is divided into number of seasons. There is different basis to divide the year into seasons. So here we go with the traditional Indian seasons.

Traditional Indian Seasons

In the Indian tradition, a year is divided into six, two-monthly seasons. This cycle of seasons, which the common people in north and central India follow is based on their practical experience and age-old perception of weather phenomena. However, this system does not match with the seasons of south India where there is little variation in the seasons.

Ritu (Sanskrit: ऋतु) defines "season" in different ancient Indian calendars used in countries of India, Bangladesh, Nepal and Sri Lanka, and there are six **ritus** or **seasons**. The word is derived from the Vedic Sanskrit word Ṛtú, a fixed or appointed time, especially the proper time for sacrifice (yajna) or ritual in Vedic religion; this in turn comes from the word Ṛta (ऋत), as used in Vedic Sanskrit literally means the "order or course of things". This word is used in nearly all Indian languages.

Seasons	Months (According to the Indian Calendar)	Months (According to the Gregorian Calendar)
1. Vasanta	Chaitra-Vaisakha	March-April
2. Grishma	Jyaistha-Asadha	May-June

3. Varsha	Sravana-Bhadra	July-August
4. Sharada	Asvina-Kartika	September-October
5. Hemanta	Margashirsa-Pausa	November-December
6. Shishira	Magha-Phalguna	January-February

Features of the different seasons:

1. **Vasanta:** It is the spring season with temperature around 20°C to 30°C. It falls in Chaitra and Vaishakha of the Hindu lunar month and March and April of the Georgian month. Vernal equinox occurs in the middle of this season. Trees get new leaves during this season. Important festivals celebrated during this season are Vasant Panchami, Holi, Bihu, Baisakhi, Ram Navami etc.

Pic 1: Vasanta Ritu

Source:

https://ml.m.wikipedia.org/wiki/%E0%B4%AA%E0%B5%8D%E0%B4%B0%E0%B4%AE%E0%B4%BE%E0%B4%A3%E0%B4%82:Colorful_spring_garden.jpg

2. **Grishma**: It is the summer season with temperature around 40°C to 45°C. It falls in Jyeshtha and Ashadha of the Hindu lunar month and May and June of the Georgian month.This season ends with summer solstice. Important festivals celebrated during this season are Vat Purnima, Guru Purnima etc. This is the most typical Hindu marriage season.

Fig 2: Grishma Ritu

Source: https://commons.wikimedia.org/wiki/File:Good_Morning_-1_(20852280488).jpg

3. **Varsha:** It is the monsoon or rainy season with temperature around 30°C to 35°C. It falls in Shravana and Bhadrapada of the Hindu lunar month and July and August of the Georgian month. This season is very hot and humid with heavy downpour. This season starts with summer solstice. Important festivals celebrated during this season are Raksha Bandhan, Onam, Krishna Janmashtami etc.

Fig 3: Varsha Ritu

Source:https://www.needpix.com/photo/download/1642703/rain-male-umbrella-the-downpour-walk-in-the-rain-man-people-wet-street

4. **Sharad:** It is the autumn season with very pleasant temperature around 19°C to 25°C. It falls in Ashwina and Kartika of the Hindu lunar month and late September, October and mid-November of the Georgian month. Autumnal equinox occurs in the middle of this season. Important festivals celebrated during this season are Navaratri, Vijayadashami, Bihu, Deepawali etc.

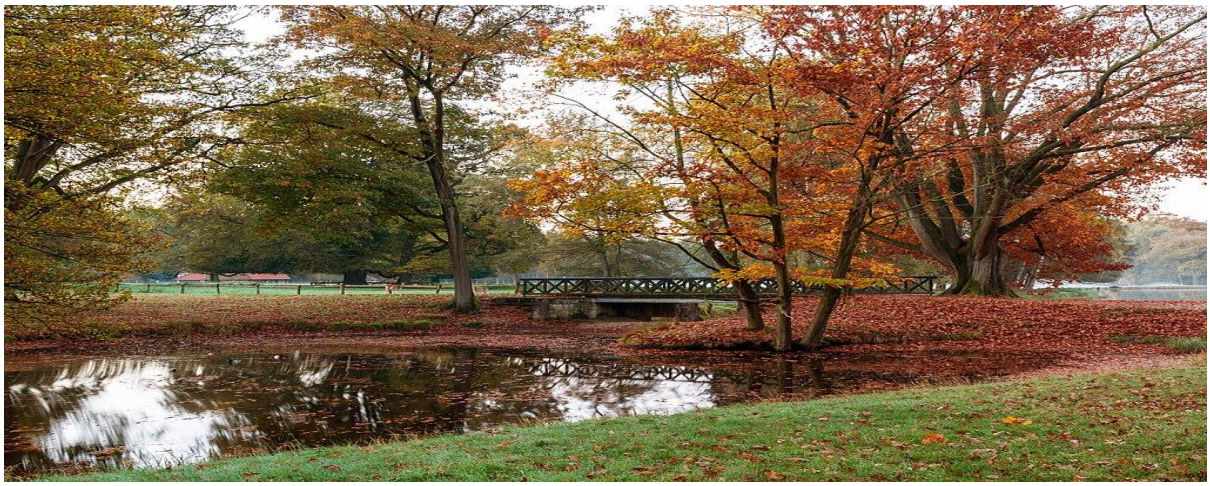


Fig 4: Sharad Ritu

Source: https://en.wikipedia.org/wiki/Autumn#/media/File:D%C3%BClmen,_Wildpark_--_2014_--_3808_color_balanced.jpg

5. **Hemanta:** It is the pre winter season with very pleasant temperature around 19°C to 25°C. It falls in Agrahayana and Pausha of the Hindu lunar month and late November and

December of the Georgian month. This season ends with winter solstice. Important festivals celebrated during this season are Kartik Purnima, Bhai Dooj etc.

Fig 5: Mustard crop during Hemant Ritu

Source:https://upload.wikimedia.org/wikipedia/commons/4/46/Punjabi_Mustard_Flowers.JPG

6. **Shishira:** It is the winter season with temperature around 10°C. It falls in Magha and Phalguna of the Hindu lunar month and January and February of the Georgian month. This season starts with winter solstice. Trees usually shed their leaves during this season. Important festivals celebrated during this season are Makar Sankranti, Mahashivaratri etc.

Fig 7: Shishira Ritu

Source: https://commons.wikimedia.org/wiki/File:Morskie_Oko_Poland_Winter.jpg

Distribution of Rainfall

The average annual rainfall in India is about 125 cm, but it has great spatial variations. On the basis of the spatial distribution of the rainfall India is divided into the following four categories:

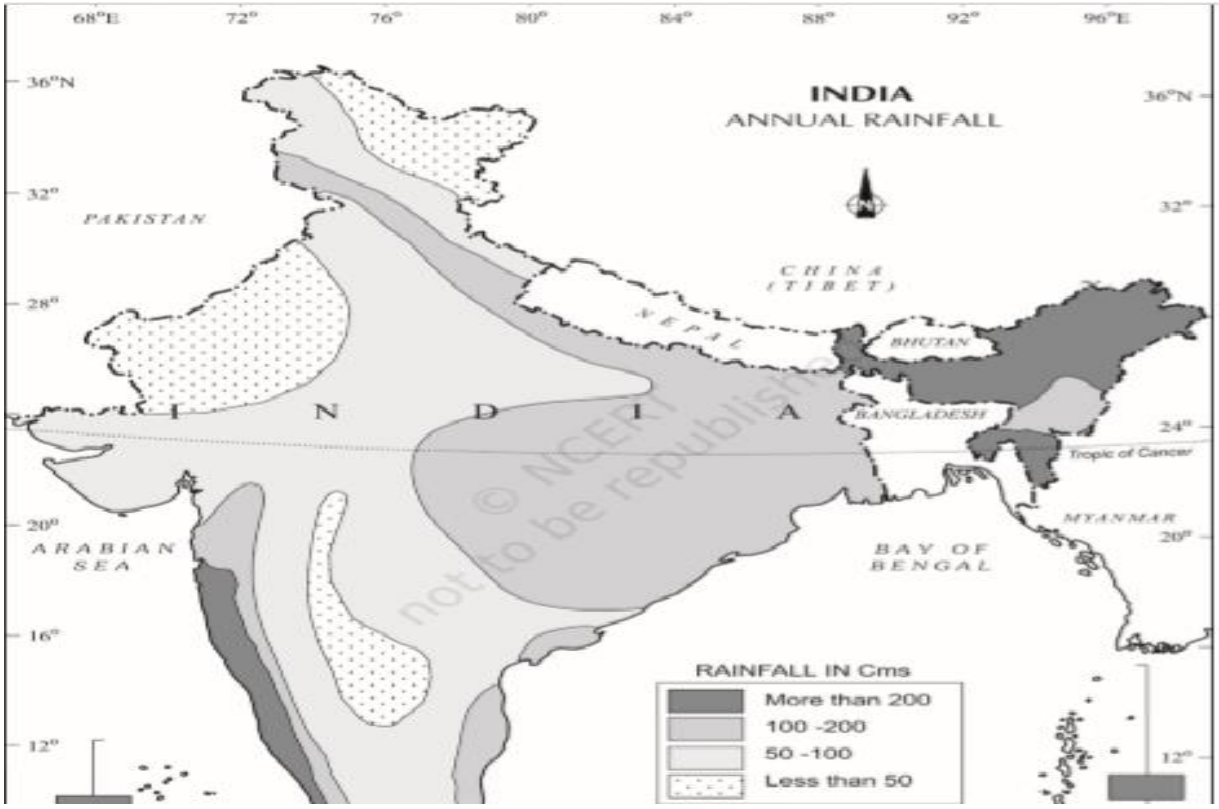
a) **Areas of High Rainfall:** The highest rainfall occurs along the west coast, on the Western Ghats, as well as in the sub-Himalayan areas is the northeast and the hills of Meghalaya. Here the rainfall exceeds 200 cm. In some parts of Khasi and Jaintia hills,

the rainfall exceeds 1,000 cm. In the Brahmaputra valley and the adjoining hills, the rainfall is less than 200 cm.

b) **Areas of Medium Rainfall:** Rainfall between 100-200 cm is received in the southern parts of Gujarat, east Tamil Nadu, northeastern Peninsula covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain along the sub-Himalayas and the Cachar Valley and Manipur.

c) **Areas of Low Rainfall:** Western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat and Deccan Plateau receive rainfall between 50-100 cm.

d) **Areas of Inadequate Rainfall:** Parts of the Peninsula, especially in Andhra Pradesh, Karnataka and Maharashtra, Ladakh and most of western Rajasthan receive rainfall below 50 cm. Snowfall is restricted to the Himalayan region.



Map: India: Annual Rainfall

Source: NCERT

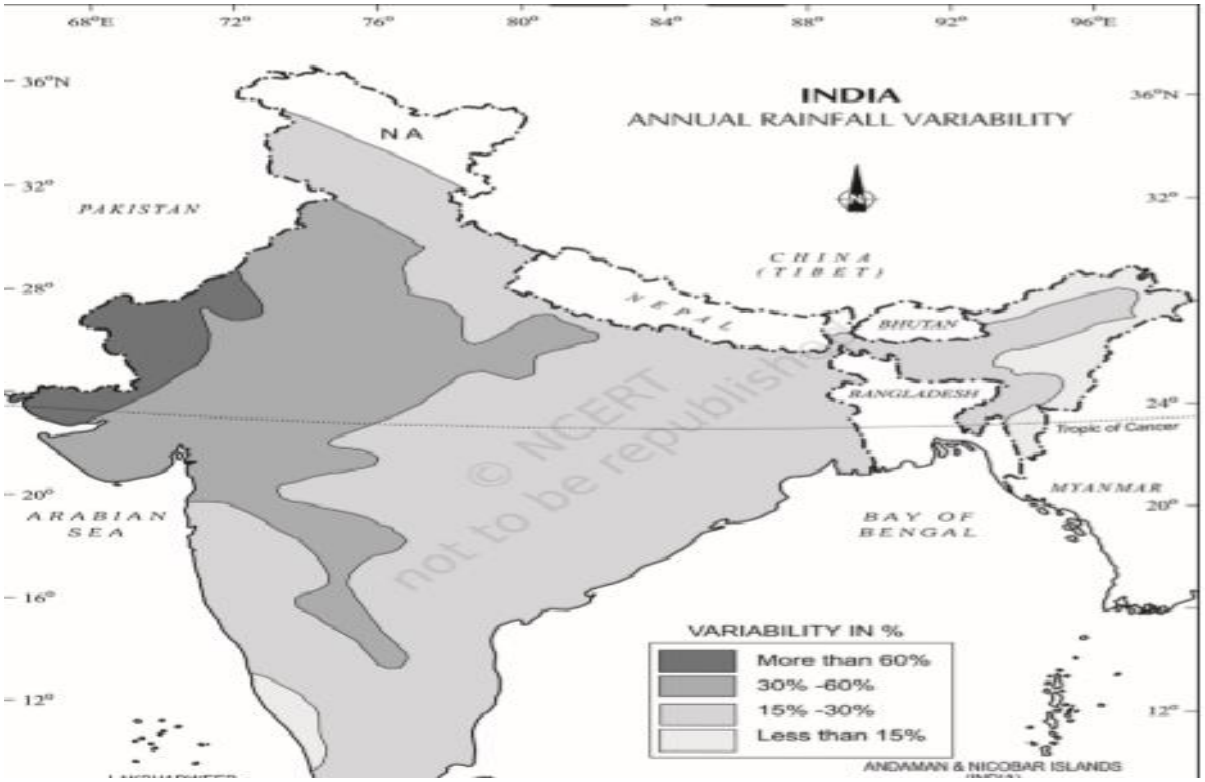
Variability of Rainfall

A characteristic feature of rainfall in India is its variability. The variability of rainfall is computed with the help of the following formula:

C.V. =Standard Deviation/ Mean × 100

Where, C.V. is the coefficient of variation.

The values of coefficient of variation show the change from the mean values of rainfall. The actual rainfall in some places deviates from 20-50 per cent. The values of coefficient of variation show variability of rainfall in India. A variability of less than 25 per cent exists on the western coasts, Western Ghats, northeastern Peninsula, eastern plains of the Ganga, northeastern India, Uttarakhand and Himachal Pradesh and south-western part of Jammu and Kashmir. These areas have an annual rainfall of over 100 cm. A variability of over 50 per cent exists in the western part of Rajasthan, northern part of Jammu and Kashmir and interior parts of the Deccan plateau. These areas have an annual rainfall of less than 50 cm. Rest of India have a variability of 25-50 per cent and these areas receive an annual rainfall between 50 -100 cm.



Map: Annual rainfall variability in India

Source: NCERT

Climatic Regions of India

The whole of India has a monsoon type of climate. But the combination of elements of the weather, however, reveal many regional variations. These variations represent the subtypes of the monsoon climate. It is on this basis that the climatic regions can be identified. A climatic region has a homogeneous climatic condition which is the result of a combination of factors. Temperature and rainfall are two important elements which are considered to be decisive in all the schemes of climatic classification. The classification of climate, however, is a complex

exercise. There are different schemes of classification of climate. Major climatic types of India based on Koeppen's scheme have been described below:

Koeppen based his scheme of Climatic classification on monthly values of temperature and precipitation. He identified five major climatic types, namely:

(i) Tropical climates, where mean monthly temperature throughout the year is over 18°C.

(ii) Dry climates, where precipitation is very low in comparison to temperature, and hence, dry. If dryness is less, it is semi-arid (S); if it is more, the climate is arid(W).

(iii) Warm temperate climates, where mean temperature of the coldest month is between 18°C and minus 3°C.

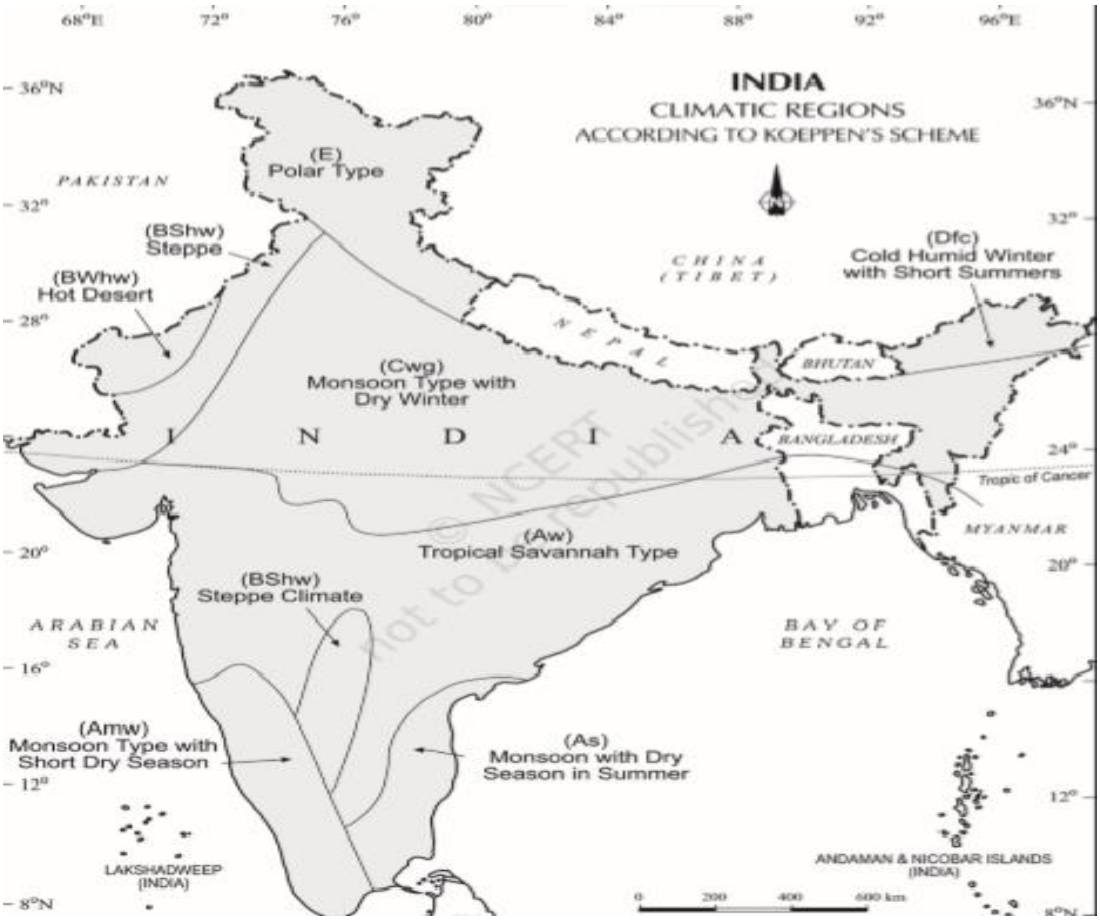
(iv) Cool temperate climates, where mean temperature of the warmest month is over 10°C, and mean temperature of the coldest month is under minus 3°C.

(v) Ice climates, where mean temperature of the warmest month is under 10°C.

Koeppen used letter symbols to denote climatic types as given above. Each type is further sub-divided into sub-types on the basis of seasonal variations in the distributional pattern of rainfall and temperature. He used S for semi-arid and W for arid and the following small letters to define sub-types: f (sufficient precipitation), m (rain forest despite a dry monsoon season), w (dry season in winter), h (dry and hot), c (less than four months with mean temperature over 10°C), and g (Gangetic plain). Accordingly, India can be divided into eight climatic regions.

Table 4.1: Climatic Regions of India According to Koeppen's Scheme

Type of Climate	Areas
Amw Monsoon with short dry season	West coast of India south of Goa
As – Monsoon with dry summer	Coromandel coast of Tamil Nadu
Aw – Tripical savannah	Most of the Peninsular plateaus, south of the Tropic of Cancer
Bwhw – Semi-arid steppe climate	North-western Gujarat, some parts of western Rajasthan and Punjab
Bwhw – Hot desert	Extreme western Rajasthan
Cwg – Monsoon with dry winter	Ganga plain, eastern Rajasthan, northern Madhya Pradesh, most of North-east India
Dfc – Cold humid winter with short summer	Arunachal Pradesh
E – Polar type	Jammu and Kashmir, Himachal Pradesh and Uttarakhand



Map: climatic regions of India by Koeppen,

Source: NCERT

Monsoon and the Economic Life in India

(i) Monsoon is that axis around which revolves the entire agricultural cycle of India. It is because about 64 per cent people of India depend on agriculture for their livelihood and agriculture itself is based on southwest monsoon.

(ii) Except Himalayas all the parts of the country have temperature above the threshold level to grow the crops or plants throughout the year.

(iii) Regional variations in monsoon climate help in growing various types of crops.

(iv) Variability of rainfall brings droughts or floods every year in some parts of the country.

(v) Agricultural prosperity of India depends very much on timely and adequately distributed rainfall. If it fails, agriculture is adversely affected particularly in those regions where means of irrigation are not developed.

(vi) Sudden monsoon burst creates problem of soil erosion over large areas in India.

(vii) Winter rainfall by temperate cyclones in north India is highly beneficial for Rabi crops.

(viii) Regional climatic variation in India is reflected in the vast variety of food, clothes and house types.

Global Warming

You know that change is the law of nature. Climate has also witnessed change in the past at the global as well as at local levels. It is changing even now but the change is imperceptible. A number of geological evidences suggest that once upon a time, (see geological time scale) large part of the earth was under ice cover.

Geological Time Scale

Eons	*Era*	*Period*	*Epoch*	*Age/ Years Before Present*	*Life/ Major Events*
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene	0 - 10,000	Modern Man
			Pleistocene	10,000 - 2 million	Homo Sapiens
		Tertiary	Pliocene	2 - 5 million	Early Human Ancestor
			Miocene	5 - 24 million	Ape: Flowering Plants and Trees
			Oligocene	24 - 37 million	Anthropoid Ape
			Eocene	37 - 58 Million	Rabbits and Hare
			Palaeocene	57 - 65 Million	Small Mammals : Rats – Mice
	Mesozoic 65 - 245 Million Mammals	Cretaceous		65 - 144 Million	Extinction of Dinosaurs
		Jurassic		144 - 208 Million	Age of Dinosaurs
		Triassic		208 - 245 Million	Frogs and turtles
	Palaeozoic 245 - 570 Million	Permian		245 - 286 Million	Reptile dominate-replace amphibians
		Carboniferous		286 - 360 Million	First Reptiles: Vertebrates: Coal beds
		Devonian		360 - 408 Million	Amphibians
		Silurian		408 - 438 Million	First trace of life on land: Plants
		Ordovician		438 - 505 Million	First Fish
		Cambrian		505 - 570 Million	No terrestrial Life : Marine Invertebrate
Proterozoic	Pre-Cambrian 570 Million - 4,800 Million			570 - 2,500 Million	Soft-bodied arthropods
Archean				2,500 - 3,800 Million	Blue green Algae: Unicellular bacteria
Hadean				3,800 - 4,800 Million	Oceans and Continents form – Ocean and Atmosphere are rich in Carbon dioxide
Origin of Stars	5,000 - 13,700 Million			5,000 Million	Origin of the sun
Supernova				12,000 Million	Origin of the universe
Big Bang				13,700 Million	

Fig 8: Geological Time Scale

Source: NCERT

Now you might have read or heard the debate on global warming. Besides the natural causes, human activities such as large scale industrialisation and presence of polluting gas in the atmosphere are also important factors responsible for global warming. You might have heard about the “greenhouse effect” while discussing global warming.

The temperature of the world is significantly increasing. Carbon dioxide produced by human activities is a major source of concern. This gas, released to the atmosphere in large quantities by burning of fossil fuel, is increasing gradually. Other gases like methane, chlorofluorocarbons, and nitrous oxide which are present in much smaller concentrations in the atmosphere, together with carbon dioxide are known as greenhouse gases.

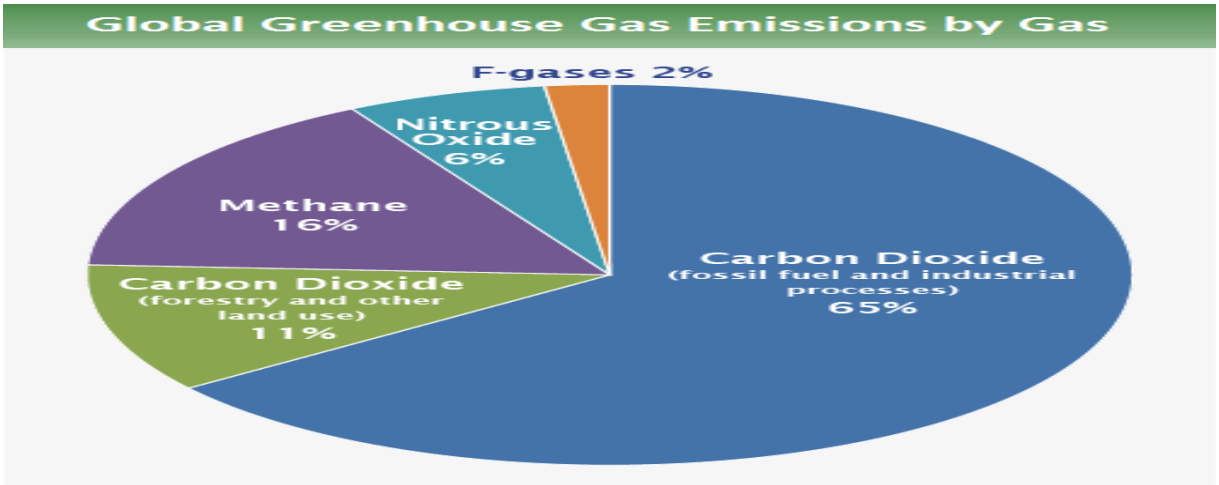


Fig: Major Gases Contributing to Global Warming

Source: https://commons.wikimedia.org/wiki/File:Global_emissions_gas_2015.png

These gases are better absorbers of long wave radiations than carbon dioxide, and so, are more effective at enhancing the greenhouse effect. These gases have been contributing to global warming. It is said that due to global warming the polar ice caps and mountain glaciers would melt and the amount of water in the oceans would increase.

Fig 9: Melting of Glaciers in the Polar Regions

Source: https://www.pxfuel.com/en/free-photo-jeprr

The mean annual surface temperature of the earth in the past 150 years has increased. It is projected that by the year 2,100, global temperature will increase by about 2°C. This rise in temperature will cause many other changes: one of these is a rise in sea level, as a result of

melting of glaciers and sea-ice due to warming. According to the current prediction, on an average, the sea level will rise 48 cm by the end of twenty first century.

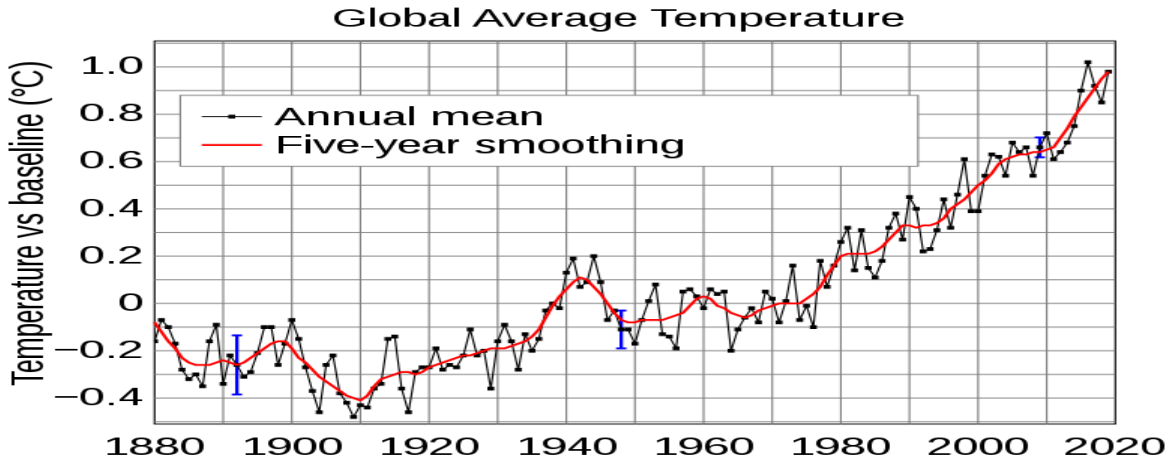


Fig 10: Rise in global average temperature

Source:https://en.wikipedia.org/wiki/Instrumental_temperature_record#/media/File:Global_Temperature_Anomaly.svg

This would increase the incidence of annual flooding. Climatic change would promote insect borne diseases like malaria, and lead to shift in climatic boundaries, making some regions wetter and others drier. Agricultural pattern would shift and human population as well as the ecosystem would experience change. What would happen to the Indian sea coasts if the sea level rises 50 cm above the present one?

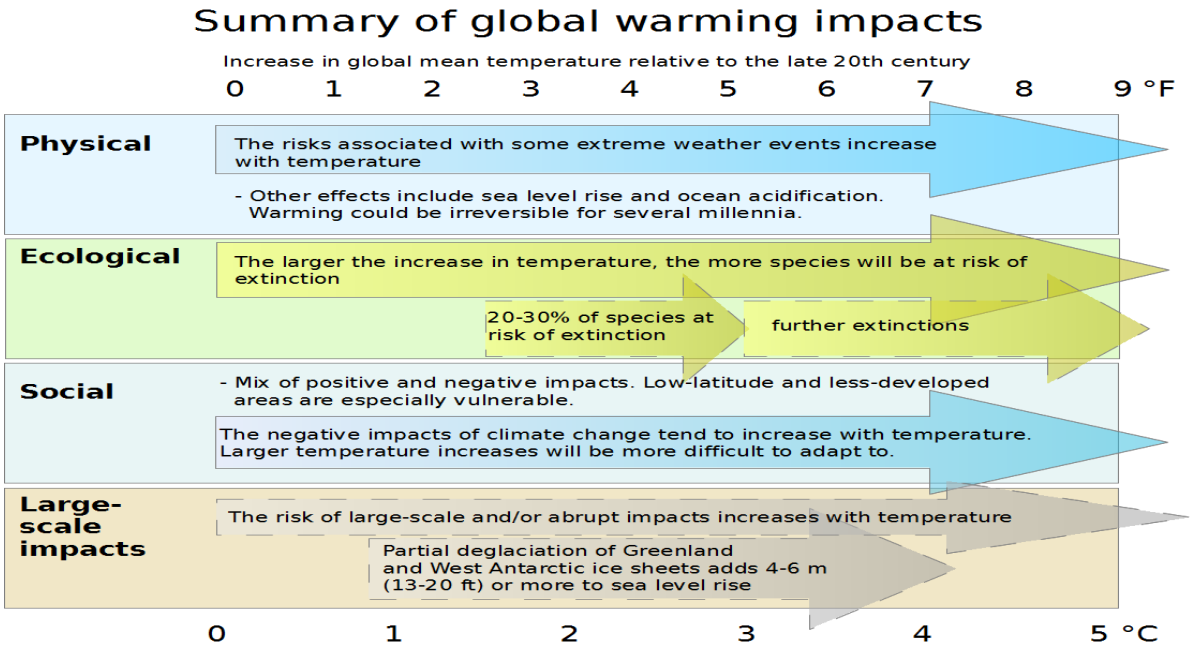


Fig 11: Global Warming Impacts

Source:

https://upload.wikimedia.org/wikipedia/commons/a/a2/Effects_of_global_warming%2C_plotted_against_changes_in_global_mean_temperature.png

Vulnerability and Disaster Due the Monsoon – Flood, Drought And Cyclone

Flood

A **flood** is an overflow of water that submerges land. Flooding may occur as an overflow of water from water bodies, such as a river, lake, or ocean, in which the water overtops or breaks levees, resulting in some of that water escaping its usual boundaries, or it may occur due to an accumulation of rainwater on saturated ground in an areal flood. Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends or meanders in the waterway.

The primary effects of flooding include loss of life and damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals. Floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins.

Floods also frequently damage power transmission and sometimes power generation, which then has knock-on effects caused by the loss of power. This includes loss of drinking water treatment and water supply, which may result in loss of drinking water or severe water contamination. It may also cause the loss of sewage disposal facilities. Lack of clean water combined with human sewage in the flood waters raises the risk of waterborne diseases, which can include typhoid, giardia, cryptosporidium, cholera and many other diseases depending upon the location of the flood.

The Indian monsoon (either the advancing monsoon or the retreating monsoon) is the main source of rainwater in India. The advancing monsoon is causing almost 80 to 90% of the rainfall in India. By early June, the low-pressure condition over the northern plains intensifies. It attracts, the trade winds of the southern hemisphere. These south-east trade winds originate over the warm subtropical areas of the southern oceans. They cross the equator and blow in a south westerly direction entering the Indian peninsula as the south-west monsoon. As these winds blow over warm oceans, they bring abundant moisture to the subcontinent.

The southwest monsoon after gathering enough moisture from the Arabian Sea causes heavy rainfall on to the windward side of the western Ghats which cause a situation of flood in the that region. The windward side of the Western Ghats receives very heavy rainfall, more than 250 cm. When the advancing monsoon (Bay of Bengal branch) crosses over the Bay of Bengal again it gets a large source of water and gather enough moisture from there. These moisture laden wind gets trapped in the Garo, Khasi and Jaintia hills of Meghalaya and cause a heavy downpour there. Mawsynram in the southern ranges of the Khasi Hills (Meghalaya) receives the highest average rainfall in the world.

After that the advancing monsoon turns towards the Ganga plain. Now the winds are moving from land to land. We know that when the winds move from land to land it does not cause enough rainfall as they do not have enough moisture with them. Rainfall in the Ganga valley decreases from the east to the west. For various reasons, the trough and its axis keep on moving northward or southward, which determines the spatial distribution of rainfall.

When the axis of the monsoon trough lies over the plains, rainfall is good in these parts. On the other hand, whenever the axis shifts closer to the Himalayas, there are longer dry spells in the plains, and widespread rain occur in the mountainous catchment areas of the Himalayan Rivers. These heavy rains bring in their wake, devastating floods causing damage to life and property in the plains.

Map: India: Flood Zone Map

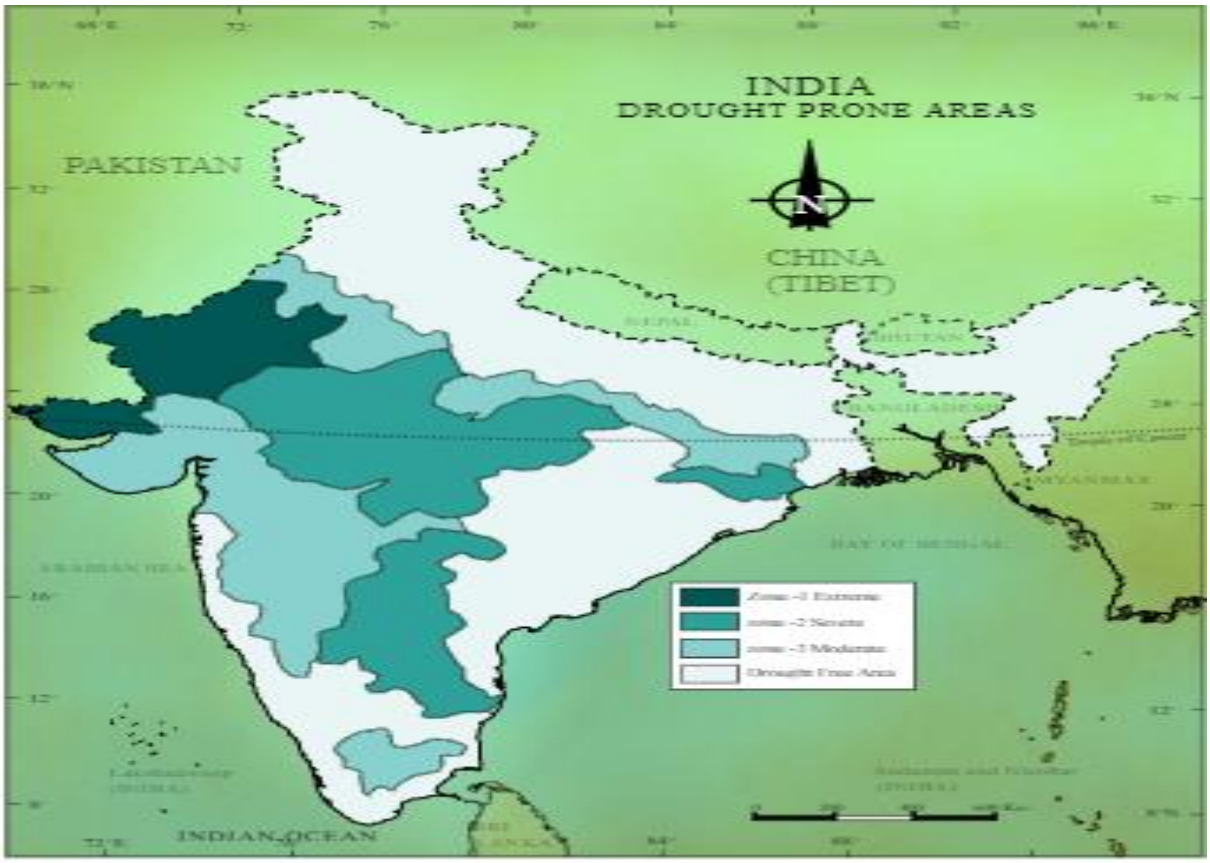
Source: https://commons.wikimedia.org/wiki/File:India_flood_zone_map.svg

Drought

A **drought** is an event of prolonged shortages in the water supply, whether atmospheric (below-average precipitation), surface water or ground water. A drought can last for months or years, or may be declared after as few as 15 days. It can have a substantial impact on the ecosystem and agriculture of the affected region and harm to the local economy. Annual dry seasons in the tropics significantly increase the chances of a drought developing and subsequent bush fires. Periods of heat can significantly worsen drought conditions by hastening evaporation of water vapour.

Drought in India has resulted in tens of millions of deaths over the 18th, 19th, and 20th centuries. Indian agriculture is heavily dependent on the country's climate: a favorable southwest summer monsoon is critical to securing water for irrigating India's crops. In parts of India, failure of the monsoons causes water shortages, resulting in below-average crop yields. This is particularly true of major drought-prone regions such as southern and eastern Maharashtra, northern Karnataka, Andhra Pradesh, Odisha, Gujarat, Telangana, and Rajasthan.

In the past, droughts have periodically led to major Indian famines, including the Bengal famine of 1770, in which up to one third of the population in affected areas died; the 1876–1877 famine, in which over five million people died; and the 1899 famine, in which over 4.5 million died.1972 Maharashtra drought affected 2.5 crore people. In simple words, drought has destroyed India on a large scale.



Map: India: Drought Prone Zones

Source:https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/57cff60e16b51c038dedcbad

The Deccan Plateau and parts of Madhya Pradesh also receive some amount of rain by the south west monsoon in spite of lying in the rain shadow area. Rajasthan and parts of Gujarat get scanty rainfall during this season.

The frequency and intensity of tropical depressions too, determine the amount and duration of monsoon rains. The depressions follow the axis of the “monsoon trough of low pressure”. The monsoon is known for its uncertainties. The alternation of dry and wet spells vary in intensity, frequency and duration. While it causes heavy floods in one part, it may be responsible for droughts in the other. It is often irregular in its arrival and its retreat. Hence, it sometimes disturbs the farming schedule of millions of farmers all over the country.

Cyclone

A **tropical cyclone** is a rapidly rotating storm system characterized by a low-pressure center, a closed low-level atmospheric circulation, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain or squalls. Depending on its location and strength, a tropical cyclone is referred to by different names, including hurricane, typhoon, tropical storm, cyclonic storm, tropical depression, and simply cyclone.

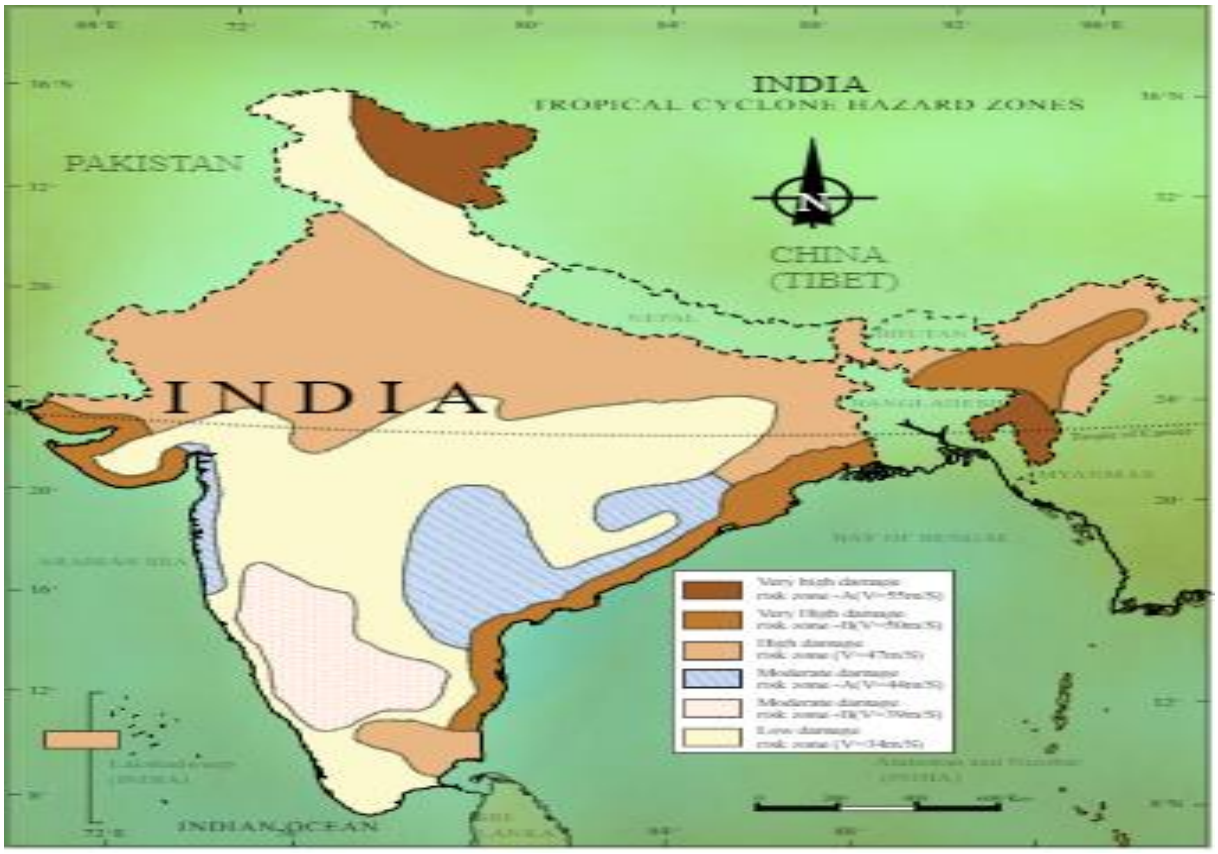
“Tropical" refers to the geographical origin of these systems, which form almost exclusively over tropical seas. "Cyclone" refers to their winds moving in a circle, whirling round their central clear eye, with their winds blowing counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. The opposite direction of circulation is due to the Coriolis Effect. Tropical cyclones typically form over large bodies of relatively warm water. They derive their energy through the evaporation of water from the ocean surface, which ultimately re-condenses into clouds and rain when moist air rises and cools to saturation.

Coastal regions are particularly vulnerable to the impact of a tropical cyclone, compared to inland regions. The primary energy source for these storms is warm ocean waters. These forms are therefore typically strongest when over or near water, and weaken quite rapidly over land. Coastal damage may be caused by strong winds and rain, high waves (due to winds), storm surges (due to wind and severe pressure changes), and the potential of spawning tornadoes. Tropical cyclones also draw in air from a large area—which can be a vast area for the most severe cyclones—and concentrate the precipitation of the water content in that air (made up from atmospheric moisture and moisture evaporated from water) into a much smaller area.

The retreating monsoon causes almost 10% of the total rainfall in India. During October-November, with the apparent movement of the sun towards the south, the monsoon trough or the low-pressure trough over the northern plains becomes weaker. This is gradually replaced by a high-pressure system. The south-west monsoon winds weaken and start withdrawing gradually. By the beginning of October, the monsoon withdraws from the Northern Plains. The

low-pressure conditions, over northwestern India, get transferred to the Bay of Bengal by early November.

This shift is associated with the occurrence of cyclonic depressions, which originate over the Andaman Sea. These cyclones generally cross the eastern coasts of India cause heavy and widespread rain. These tropical cyclones are often very destructive. The thickly populated deltas of the Godavari, the Krishna and the Kaveri are frequently struck by cyclones, which cause great damage to life and property. Sometimes, these cyclones arrive at the coasts of Odisha, West Bengal and Bangladesh. The bulk of the rainfall of the Coromandel Coast is derived from depressions and cyclones.



Map: India: Tropical Cyclone Hazard Zones

Source: https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/57cff60716b51c038dedcb67

Conclusion

In the end of this module it can be concluded that the monsoon type of climate is characterised by a distinct seasonal pattern. The weather conditions greatly change from one season to the other. These changes are particularly noticeable in the interior parts of the country. The coastal areas do not experience much variation in temperature though there is variation in rainfall pattern.

India experiences six traditional seasons namely Vasanta, Grishma, Varsha, Sharada, Hemanta and Shishira. There is variability in the amount of rainfall. On the basis of temperature and rainfall Koeppen has classified the country in five different zones. Monsoon in India is responsible for affecting the economic life of the people. Monsoon in India causes flood in some parts and droughts and cyclones in other parts of the country.

The unifying influence of the monsoon on the Indian subcontinent is quite perceptible. The seasonal alteration of the wind systems and the associated weather conditions provide a rhythmic cycle of seasons. Even the uncertainties of rain and uneven distribution are very much typical of the monsoons. The Indian landscape, its animal and plant life, its entire agricultural calendar and the life of the people, including their festivities, revolve around this phenomenon. Year after year, people of India from north to south and from east to west, eagerly await the arrival of the monsoon. These monsoon winds bind the whole country by providing water to set the agricultural activities in motion. The river valleys which carry this water also unite as a single river valley unit.