PREFACE

In a bid to standardize higher education in the country, the University Grants Commission (UGC) has introduced Choice Based Credit System (CBCS) based on five types of courses viz. *core, generic, discipline specific general elective, ability and skill enhancement* for graduate students of all programmes at Honours level. This brings in the semester pattern, which finds efficacy in sync with credit system, credit transfer, comprehensive continuous assessments and a graded pattern of evaluation. The objective is to offer learners ample flexibility of choose from a wide gamut of courses, as also to provide them lateral mobility between various educational institutions in the country where they can carry their acquired credits. I am happy to note that the University has been recently accredited by National Assessment and Accreditation Council of India (NAAC) with grade "A".

UGC (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 have mandated compliance with CBCS for U. G. programmes for all the HEIs in this mode. Welcoming this paradigm shift in higher education, Netaji Subhas Open University (NSOU) has resolved to adopt CBCS from the academic session 2021-22 at the Under Graduate Degree Programme level. The present syllabus, framed in the spirit of syllabi recommended by UGC, lays due stress on all aspects envisaged in the curricular framework of the apex body on higher education. It will be imparted to learners over the six semesters of the Programme.

Self Learning Materials (SLMs) are the mainstay of Student Support Services (SSS) of an Open University. From a logistic point of view, NSOU has embarked upon CBCS presently with SLMs in English/Bengali. Eventually, the English version SLMs will be translated into Bengali too, for the benefit of learners. As always, all of our teaching faculties contributed in this process. In addition to this we have also requisitioned the services of best academics in each domain in preparation of the new SLMs. I am sure they will be of commendable academic support. We look forward to proactive feedback from all stakeholders who will participate in the teaching-learning based on these study materials. It has been a very challenging task well executed, and I congratulate all concerned in the preparation of these SLMs.

I wish the venture a grand success.

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Vice-Chancellor

Netaji Subhas Open University

Under Graduate Degree Programme

Choice Based Credit System (CBCS)

Subject : Honours in Geography (HGR)

Course : Climate Change, Vulnerability and Adaptations

Course Code : GE-GR-31

First Edition : May, 2022

Printed in accordance with the regulations of the Distance
Education Bureau of the University Grants Commission

Netaji Subhas Open University

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Notification

Kishore Sengupta
Registrar

Netaji Subhas Open University

UG : Geography (HGR)

Under Graduate Degree Programme

Choice Based Credit System (CBCS)

HONOURS IN GEOGRAPHY (HGR)

Course Code : GE-GR-31

Course : Climate Change, Vulnerability and Adaptations

MODULE - 1

MODULE - 2

Unit : 1 ❑ THE SCIENCE OF CLIMATE CHANGE: ORIGIN, SCOPE AND TRENDS

1.0 Introduction

Weather is the physical state of the atmosphere at a given place and time. It refers to the physical condition of the atmosphere for a short period like one to seventy-two

hours. Weather condition is therefore, regulated by-Amount of solar radiation received at a particular place, and Temperature, relative humidity, precipitation, evaporation, wind speed and wind direction.

Climate is the long term average of the atmospheric components. The state of atmosphere is never static but always it is changing to form an equilibrium. Therefore, the climate is always in a dynamic equilibrium. Now a days, a variability in climatic components particularly the temperature and rainfall is observed. The rising trend in the maximum and minimum temperature and the erratic behaviour of precipitation are termed as significant features of climate change. Therefore, the term climate change may be defined as the changing temperature, rainfall, humidity and wind flow pattern in a particular locality or in a zone of a country or continent. The ciimatologists differ in the use of this terminology of climate change, rather they prefer to use climate variability.

1.1 Objectives

i. To know the causes of climate change.

ii. To know the trend of climate change from the past to present,

iii. To know the factors, which are related to climate change,

iv. To know the change of global mean surface temperature from the year 1880-2018 and it's causes.

1.2 Science of Climate Change

The causes of climate change are as follows-

The extra terrestrial factors which are to be found outside the earth atmosphere system.

The terrestrial factors which are related primarily to man-made climatic changes.

1.3 Factors of Climate Change

A. Extra terrestrial factors

Astronomical or Orbital theories-

The sun is the primary source of energy in the earth.

The seasonal distribution of solar radiation varies due to sun-earth

geometry and it's apparent movement in between the Tropic of Cancer (23.5° N) and the Tropic of Capricon (23.5° S) through the equator.

During Perihelion, the sun is nearest to the sun, while during Aphelion it is farthest from the earth. A variation of ± 3.5% in the value of solar radiation I is observed because of the variation in the earth-sun distance in a year. It plays an important role in producing large scale climatic changes.

The earth's orbit undergoes a change of shape during a cycle of 90,000 and 1, 00,000 years. During the period of greater eccentricity of the earth's orbit, at the perihelion, the total solar radiation received at the earth surface may exceed 20-30% which is obtained at the aphelion. This may cause wide spread temperature increase and climate change.

At present the earth's axis is inclined by 23.5°. This angle may vary in between 22.1 -22.5 degree during a cycle of about 41,000 years. This may create temperature differences in winter and summer.

At present the axis of the earth points towards the Pole Star. This tilting may change which will produce warm summer and cold winter.

Theories involving Displacement of the Continents-

Some 300 million years ago all the continents were joined together to form the super continent **Pangaea.** There was a rift which caused disintegration to form the separate continents which are available at present. This hypothesis is known as Wesner's Continental Drift Theory. Thetlate Tectonic Theory explains that the outer portion of the earth is made up of several plates. This plates move in relation to one another upon a partially molten zone below. According to this theory, all the regions having glacial features were joined together to make one universal continent. The plates move at a very slow rate - a few centimeter **per year,** which may cause climate change.

Theories involving change in the composition of the atmosphere

1. Carbon-di-Oxide Theory-

According to this theory carbon-di-oxide concentration in the atmosphere plays a dominant role in climate change.

Carbon-di-Oxide is transparent to incoming solar radiation. It absorbs emitted long wave terrestrial radiation, which is radiated back to the earth surface as counter radiation.

Carbon-di-Oxide and water vapour of the atmosphere are two important gases which absorb long wave emitted radiation. This is known as Greenhouse effect. According to moderate estimate, the carbon-di-oxide concentration of air reached 450 ppm (Parts Per Million). This may lead to a rise of average temperature to the tune of 3.5° C by 2050 A.D.

2. Volcanic Dust Theory-

Light is reflected by the volcanic dust but long wave terrestrial radiation can easily pass through volcanic dust without any loss. Large scale volcanic dust may reduce the temperature of the earth to a certain extent. According to this theory the ice ages will be initialed because of frequent volcanic eruptions.

3. Geographical Theories-

The uplift of continents and mountain masses reduce temperature and initiates the condition for the formation of glaciers. This hypothesis is usually applied to changes in oceanic circulation.

4. Theories involving a change in Solar Radiation

Receipt of solar radiation on the earth surface varies according to latitude and sun-earth geometry. The variable sun theory of climate change says that the sun is a variable star and it's energy undergoes a change through time.

Increased solar radiation will warm the air whereas it's reduction will cool the air. The dark spots appear on the solar surface is called sunspots. These are huge magnetic storms that occur on the earth surface. The number of sunspots increases and decreases in a cyclic manner.

Any appreciable change in solar energy will cause climatic variations. Emission of solar energy depends on sunspot activity.

B. Terrestrial factors :

Potential external causes of climate change include

- Tropospheric aerosol
- Clouds
- Stratospheric ozone
- Carbon-di-oxide
- Surface changes

1. Tropospheric aerosol: - The effect of troposheric aerosol on the radiative fluxes in the atmosphere is given in table 1. The particle effect is generally small and can be neglected. However some recent measurements show that the electrical conductivity of the northern hemisphere troposphere has been increasing steadily over the last 70 years. One reason proposed for this is an increase in the concentration of aerosol due to human activity.

Table 1 -

AGENT	EFFECT OF EFFECT	MAGNITUDE	
		SHORTWAVE	LONGWAVE
Gases CO_2	Absorption, Scattering	Moderate, small	Large, negligible
Aerosol (particles)	Absorption, Scattering	Moderate, small	Small (large for Man-made), small
clouds	Absorption, Scattering	Small, large	Large (varies with thickness), Large, but dominated by absorption

2. Clouds: - Variations in cloud type and amount can result for many processes. At heights of 10-18 kilometer aerosol particle may increase the formation of cirrus cloud. This cloud will increase the absorption of infrared radiation which leads to increase in temperature and warming of the atmosphere.

3. Stratospheric ozone: - A major detrimental effect on the earth's atmosphere is initiated due to emission of pollutant gases which affect ozone layer in the lower stratosphere. The prime concern is with chloro-fluro-methans known as 'freons', which are used in refrigeration. In the troposphere they are extremely stable and have the residence time of decades. When they reach above 25 kilometer they undergo photochemical dissociation, releasing free chlorine. This chlorine reacts with ozone breaks down it into oxygen.

4. Carbon-di-oxide: - The increase in the concentration of the atmospheric Carbon-dioxide raises the surface temperature by green house effect **(Fig-1).**

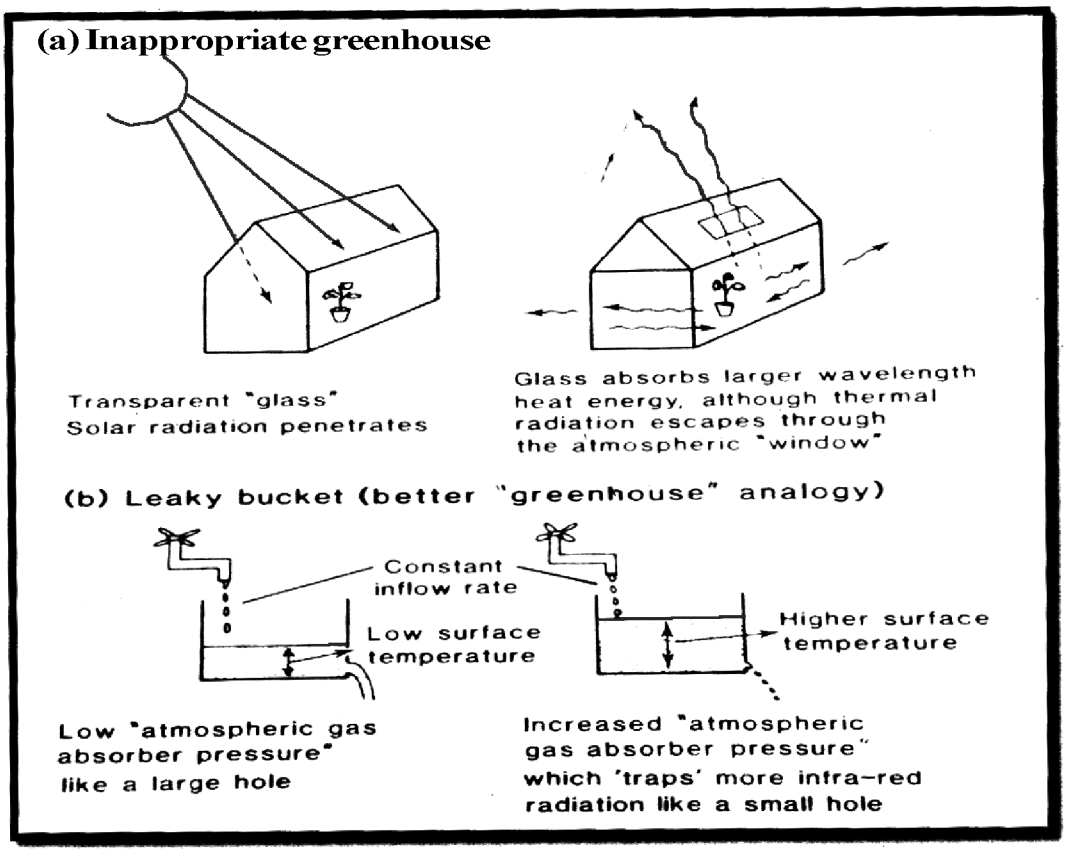

Fig. 1 Impact of carbon-di-oxide

5. Surface changes: - This occur through interactions between biological changes and atmospheric and/or hydrological changes. The changes in surface type may invite aridity and semi-aridity in some regions. When vegetation is removed and bare soil is exposed, there is a decrease in soil water storage because of increased runoff and an increase in albedo. When moisture content is low. surface temperature is increased.

1.4 Trends of Climate Change

Trends in temperature change shows that in the coming 50 years temperature may increase to the tune of 1.5-5° Celsius. In 2013 the IPCC Fifth Assessment Report concluded 'it is extremely likely that human influence has been the dominant cause of the observed warming since the mid 20[1] century'. Cl imate model projections summarized in the report indicated that during the 21st century, the global surface temperature is likely to increase further 0.3-1.7° Celsius in a moderate scenario, or

as much as 2.6-4.8° Celsius in an extreme scenario depending on the rate of future green house gas emissions and on climate feedback effects.

The global mean surface temperature change from 1880-2018, relative to the 1951 1980 mean is given in figure 2.

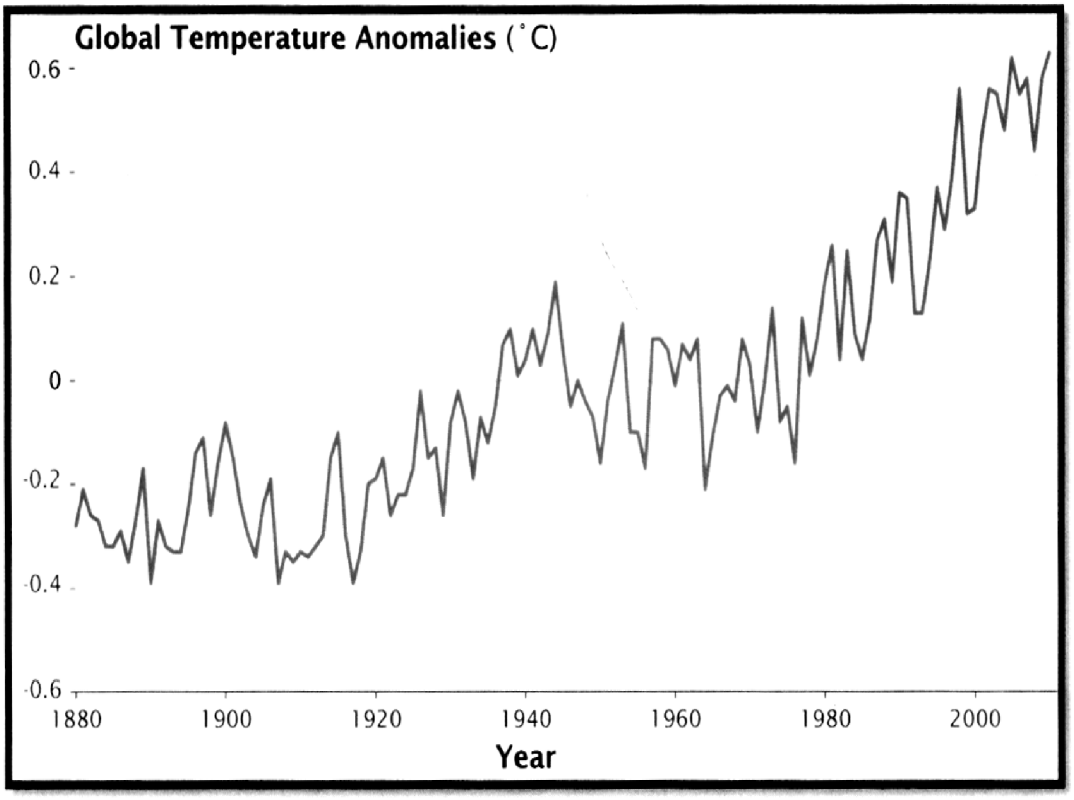

Fig- 2 global temperature anomaly from 1880 to 2000

1.5 Conclusion

From the above discussion it can be known that physical factors causes climate changes. It discusses the evidence that the concentration of the gases in the atmosphere have increased and still increasing rapidly. The most recent climate change is almost certainly due to emissions of green house gases caused by human activities.

The trend of temperature change shows that in the coming 50 years temperature may increases to 1.5-5.0° Celsius. It can be estimated, from 1880-2018 the global mean surface temperature also changes and rises.

1.6 Summary

Scientific knowledge about climate change is being improved all the time through research into the climate system, climate forcing, climate variations and changes, and climate effects.

This knowledge base is well established when it comes to the fundamental physics behind the greenhouse effect and the fact that the average surface temperature has increased over the past 50 years. It is also highly likely that most of the observed warming is due to human impact on the climate.

This discussion shows that-

- Weather condition is therefore, regulated by the amount of solar radiation received at a particular place and temperature, relative humidity, precipitation, evaporation, wind speed and wind direction.
- The rising trend in the maximum and minimum temperature and the erratic behaviour of precipitation are termed as significant features of climate change.
- In the coming 50 years temperature may increase to the tune of 1.5-5° Celsius.
- Human influence has been the dominant cause of the observed warming since the mid 20th century.
- During the 21st century, the global surface temperature is likely to increase further 0.3-1.7° Celsius.

1.7 Glossary

Appreciable- intelligible, apprehensible

Detrimental- harmful

Differ- disagree

Dissociation- separation, differentiation

Disintegration- difference, separation

Dominant- principal, prime

Erratic-uncertain, problematic

Emitted- throw out, eject

Exceed- surpass, go beyond

Extent- range, limit Feedback- recompose

Frequent- numerous
Initiated- introduced
Manner- method, system
Potential- effective
Rather- certainly
Receipt- getting
Scenario- Phase, Period.
Significant- important
Term- word, nomenclature
Tune- accordance, balance
Undergoes- suffer

1.8 Model Questions

A. Very short answer type question **Marks:- I**

1. Define Weather.
2. Why climate is called as 'Dynamic Equilibrium'?
3. Define Pangaea.
4. What is the primary source of energy in the earth?
5. In which degree earth axis is inclined?
6. Who is the propounder of 'Continental Drift theory'?
7. What is greenhouse gas?
8. How much concentration of Co? are there in air?
9. Which are 'Freons"?
10. In which year IPCC Fifth Assessment Report was published?

B. Short answer type question **Marks:- 3**

1. Write about the extra-terrestrial factors of climate change.
2. Write about the terrestrial factors of climate change.
3. Discuss the trends of climate change.
4. Write the science of climate change in brief
5. Write the Astronomical theories of climate change.

6. What is Continental drift theory said about climate change?
7. Discuss the carbon-di-oxide theory of climate change.
8. Discuss the solar radiation theory of climate change.

C. Answer the following question **Marks:- 5**

1. Which factors are responsible for the climate change?
2. State the trends of climate change with suitable diagram.
3. Discuss the theories involving change in the composition of the atmosphere.
4. Discuss the terrestrial factors that are responsible for the climate change.

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Unit : 2 ◻ UNDERSTANDING CLIMATE CHANGE WITH REFERENCE TO GEOLOGICAL TIME SCALE

2.0 Introduction

Atmospheric conditions vary on all time scale. Day to day weather fluctuations are observed. Changes in climate condition occur in a span of millions of year. To understand the past climate, a highly inter-disciplinary approach is essential. Geologists, Oceanographers, Glaciologists, Botanists, Archaeologists, Historians and Climatologists should come together to construct the past climate. Conditions

during the last 100000 years or so are becoming increasingly clear from studies of glacial, and other landscape forming activities, pollen analysis and the analysis of lake sediments.

These various approaches and the differing amounts of sophisticated information make it convenient to divide the past climate into three major divisions:

A. Geological- covering the entire history of the earth

B. Intermediate- dealing primarily with the latest great Ice Ages and

C. Historical- where more or less direct evidence of climatic condition is available.

2.1 Objectives

i. To observe the weather fluctuation.

ii. To observe the changes in climatic conditions that occur in a span of million of years.

iii. To understand the past climate,

iv. To know temperature trend.

v. To know different notable events during evolution of different organisms in relation to geological time scale.

2.2 Geological Record of Climate

Over the longest possible time scale, the ambient surface temperature remained remarkably stable. Geological data suggest that temperatures have varied only between 275 K and 305 K (K= Kelvin) during the last 3.8*10 years before Precambrian conditions. During the last $2.3*10^9$ years BP there have been a series of alternations

between glacial and inter-glacial periods suggesting relatively small temperature excursion (Fig- 3).

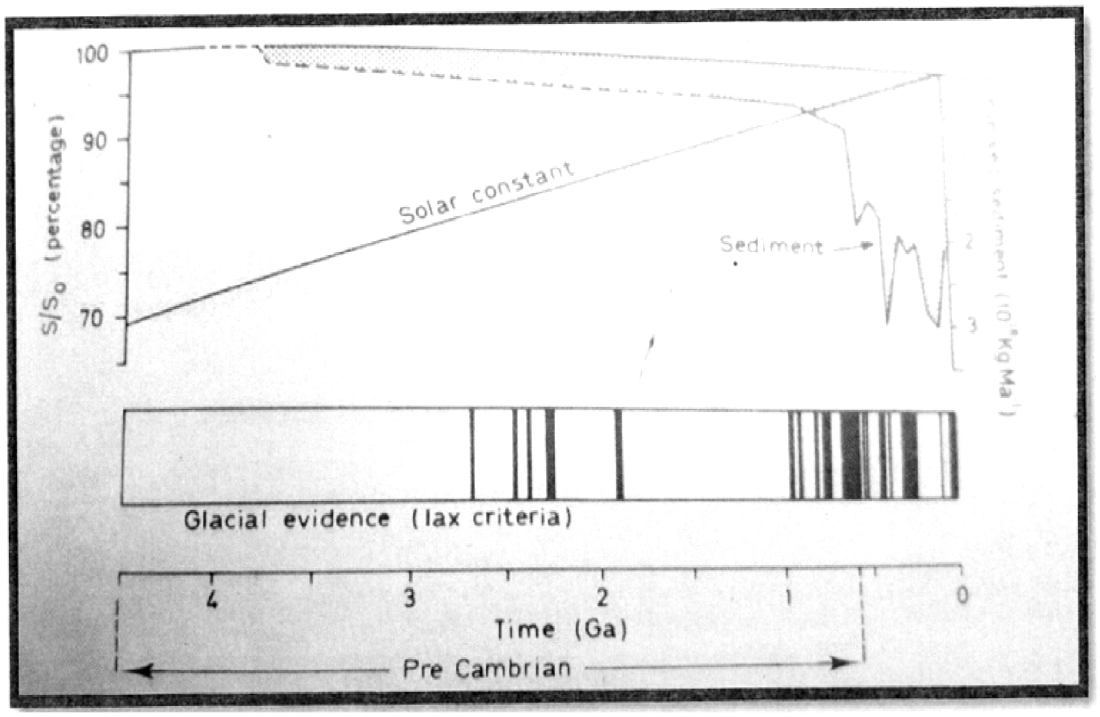

Fig. 3 Evidence of glacier

The first glaciations appears about 2.3*10' years BP. During this time oxygen appeared in the atmosphere. A new cool phase was initiated during $2.3*10^9$ years BP. There is a very long term fluctuation in climate observed. The magnitude of the fluctuation is small. Long term stability observed in temperature was due to interaction between the climate and biosphere. This is known as **Gaia hypothesis.** This hypothesis suggests that biologically induced surface and atmospheric changes generate negative feedback for stabilizing the whole system.

2.3 Table of geological time scale

Over the geological time significant changes were observed in the types of rocks and in the biospheric composition. This is given in Table 2

Table 2-

Subdivisions of geologic time		Apparent ages (years before present)	Notable events in evolution of organisms
Eras (Periods)	Epochs		
Cenozoic Quartenary	Holocene (Recent) Pleistocene	$2*10^6$	Man appears
Tertiary	Pliocene	$10*10^6$	Elephants, horses, large carnivores become dominant
	Miocene	$25*10^6$	Mammals diversity
	Oligocene	$36*10^6$	Grasses become abundant, grazing animals spread
	Eocene	$58*10^6$	Primitive horses appear
	Palaeocene	$63* 10^6$	Mammals develop rapidly, Dinosaurs become extinct, flowering plants appear
Mesozoic Creataceous		$135* 10^6$	
Jurassic		$180* 10^6$	Dinosaurs reach climax. Birds appear
Triassic		$230* 10^6$	Primitive mammals appear; conifers and cycads become abundant. Dinosaurs appear
Palaeozoic Permian		$280* 10^6$	Reptiles spread, conifers develop

Subdivisions of geologic time		Apparent ages (years before present)	Notable events in evolution of organisms
Carboniferous		340* 10^6	Primitive reptiles appear, insects become abundant. Coal forming forests widespread. Fishes diversity
Devonian		400* 10^6	Amphibians, first known land vertebrates, appear. Forests appear
Silurian		440* 10^6	Land plants and animals first recorded
Ordovician		500* 10^6	Primitive fishes, first known vertebrates appear
Cambrian		570* 10^6	Marine invertebrate faunas become abundant
Precambrian Proterozoic		2.5* 10^9	Life forms abundant
Archaean			Primitive life forms (e.g. blue-green algae

2.4 Shorter Time Scale Climate Changes

During the last 700000 years the earth was warmer than today only for 8% of the time. The last Pleistocene Ice Age reached 22000-14000 years age. During thisperiod, two large ice sheets have been identified in the northern hemisphere- the Laurentide ice sheet and the Scandinavian ice sheet. During this period maximum sea level dropped by 85 meter and sea surface temperature was reduced to an extent of 10° Celsius in the mid latitudes of north Atlantic and 3° Celsius in the Caribbean sea.

About 14000 years ago de-g!aciation started abruptly.

By about 8500 years ago the conditions in Europe was more or less similar to the present state. Within this overall warming period, wide spread cooling and glacial advance occurred every 2500 years.

Approximately 7000-5000 years ago post glacial climatic optimum was observed. Summer temperature in both Antarctica and Europe were 2-3° Celsius higher than the present day. This resulted to a reduction of ice. Sea level rose rapidly, 3 meter above the present level,

2.5 Historical Climate Change

Iron age (900-300 BC) - The climate was generally wet. The secondary optimum in climate reached at AD 1000-1200. Slight warming was observed. Summer temperature was 1° Celsius higher than the present day temperature in western and central Europe. In China cool climate was observed.

The Little Ice Age (1430-1850 AD)- It was most harsh in Britain during the second half of the 17^{th} century. Glaciers advance in Europe, Asia and North America, although there was also times when summer temperatures were higher than the present level. During this whole time the Arctic pack ice expanded with detrimental effects on Greenland and Iceland.

The temperature across the North Atlantic zone (north of 50°N) was 1-3 K less

than the present day temperature. The southern hemisphere partly escaped the cold period until 1830-1900.

The warming trend of 1880-1940 was specially observed in the Atlantic sector of the Arctic and in northern Siberia. In the southern hemisphere cooling was observed towards the south of 30° S. A cooling trend was observed in the northern hemisphere following high temperature of 1940s. Cooling at high latitudes ceased in the mid 1960s.

Overall sea surface temperature in the northern hemisphere was reduced by 0.75 K but in the southern hemisphere 1 K rise was observed during the period of 1935-1970. The glacial and inler-glaciai temperature variation was in the order of 6-7 K.

The temperature range over the last century is about 0.5 K (Fig-4)

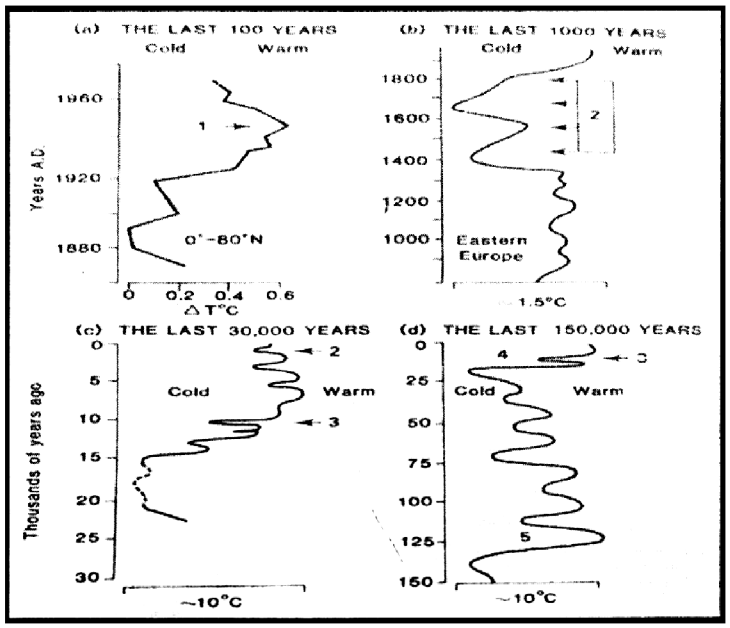

Fig 4 Temperature range in different ages

2.6 Conclusion

In conclusion it may be said that from above discussion one can know about the past climate. The warming and cooling trend were also understood briefly from the discussion.

2.7 Summary

Changes in climatic condition occur in a span of millions of years. Conditions during the last 100000 years or so are becoming increasingly clear from studies of glacial, and other landscape forming activities, pollen analysis and the analysis of lake sediments.

The past climate is divided into three major divisions:

A. Geological- covering the entire history of the earth

B. Intermediate- dealing primarily with the **latest** great Ice Ages and

C. Historical- where more or less direct evidence of climatic condition is available.

- Geological data suggest that temperatures have varied only between 275 K and 305 K (K= Kelvin) during the last 3.8*10 years before Precambrian conditions.

- The first glaciations appears about 2.3*10 years BP.
- Long term stability observed in temperature was due to interaction between the climate and biosphere. This is known as **Gaia hypothesis.**
- Table 2 illustrates about the geological time scale and different organisms in different time scale.
- During the last 700000 years the earth was warmer than today only for 8% of the time.
- overall warming period wide spread cooling and glacial advance occurred every 2500 years.
- Approximately 7000-5000 years ago, summer temperature in both Antarctica and Europe were 2-3° Celsius higher than the present day. This resulted to a reduction of ice. Sea level rose rapidly, 3 meter above the present level.
- In AD 1000-1200 slight warming was observed. Summer temperature was 1° Celsius higher than the present day.
- The warming trend of 1880-1940 was specially observed in the Atlantic sector of the Arctic and in northern Siberia.
- Cooling at high latitudes ceased in the mid 1960s.
- Overall sea surface temperature in the northern hemisphere was reduced by 0.75 K but in the southern hemisphere 1 K rise was observed during the period of 1935-1970.

2.8 Glossary

Analysis- examination, experiment
Approach- access
Construct- set up
Convenient- advantageous
Detrimental- harmful
Excursion- emergence
Hypothesis- presumption, guess
Induced- introduced
Initiate- introduced
Magnitude- hugeness, extent
Span- a unit of time

2.9 Model Questions

A. Very short answer type question **Marks:- 1**

1. When the first glaciation was appeared?
2. When the new cool phase was appeared?
3. Define 'Gaia hypothesis'?
4. State the time period of iron age.
5. State the time period of the little ice age.
6. From which year cooling in high altitude was ceased?
7. How many meter the present sea level has rised?

B. Short answer type question **Marks:- 3**

1. Write about the historical climate changes."
2. Geological records of climate change- explain in brief.
3. Discuss trend of climate change.

C. Answer the following question **Marks:- 5**

1. Explain climate change with reference to geological time scale.

2.10 References

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Unit : 3 ❑ EVIDENCES AND FACTORS OF CLIMATE CHANGE: THE NATURE-MAN DICHOTOMY

3.0 Introduction

Climate change refers to the rise in average surface temperatures on Earth. An overwhelming scientific consensus maintains that climate change is due primarily to the use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air. The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires.

3.1 Objectives

i. To understand the causes of climate change.

ii. To know the major scientific evidences of climate change,

iii. To understand the different factors of climate change.

iv. To understand the role of human beings in nature.

3.2 Causes of climate change

The primary cause of climate change is the burning of fossil fuels, such as oil and coal, which emits greenhouse gases into the atmosphere— primarily carbon dioxide. Other human activities, such as agriculture and deforestation, also contribute to the proliferation of greenhouse gases that cause climate change.

Some quantities of these gases are naturally occurring. Which control the earth's temperature. The atmospheric concentration of CO_2 did not rise above 300 parts per million between the advent of human civilization roughly 10,000 years ago and 1900. Today it is at about 450 ppm, a level not reached in more than 400,000 years.

3.3 Evidences of climate change

Scientific evidence is clear that our climate is changing. These are realized through-

- direct surface temperature measurements
- changes in rainfall and weather patterns
- an increase in the frequency of extreme weather events
- loss of Arctic sea ice

- sea level rise
- melting of the Antarctic and Greenland ice sheets, shifts in the geographic ranges, distribution of some plant and animal species
- earlier unfolding of new leaves in spring
- changes in bird migration patterns.

3.4 Factors of Climate change

Humans are increasingly influencing the climate and the earth's temperature by burning fossil fuels, cutting down rainforests and farming livestock.

Greenhouse Gases

Some gases in the earth's atmosphere act a bit like the glass in a greenhouse, trapping the sun's heat and stopping it from leaking back into space. Many of these gases occur naturally, but human activity is increasing the concentrations of some of them in the atmosphere, in particular:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Fluorinated gases (RF)
- Water vapour (H_2O)
- Carbon monoxide (CO)

CO_2 is the greenhouse gas most commonly produced by human activities and it is responsible for 64% of man-made global warming. Its concentration in the atmosphere is currently 40% higher than it was when industrialization began.

Other greenhouse gases are emitted in smaller quantities, but they trap heat far more effectively than CO_2, and in some cases are thousands of times stronger. Methane is responsible for 17% of man-made global warming, nitrous oxide for 6%.

Causes for rising emission

- Burning of coal, oil and natural gas produces carbon-di-oxide, carbon monoxide and nitrous oxide.
- Trees help to regulate the climate by absorbing CO_2 from the atmosphere and releasing oxygen through the process of photosynthesis. So when they are cut

down, that beneficial effect is lost and the carbon stored in the trees is released into the atmosphere adding to the greenhouse effect.

- Cattle farming produces large amount ofmethane.
- Fertilizers containing nitrogen produce nitrous oxide.
- Submerged rice cultivation produces methane as well as nitrous oxide because of bacterial activities under anaerobic condition.
- Large dams store huge amount of water which produces large quantities of water vapour in the surrounding area. This water vapour traps long wave radiation increasing the atmospheric temperature.
- Use of choloro fluoro carbon in refrigeration, aviation fuel depletes the stratospheric and upper troposheric ozone level. This helps to penetrate the ultra violet radiation into the atmosphere.

Global Warming-

The current global average temperature is 0.85°C higher than that observed in the late 19th century. Each of the past thre decade since records began in 1850. 19th century. Each of the past three decades has been warmer than any preceding

An increase of 2°C compared to the temperature observed in pre-industrial times is seen by scientists as the threshold beyond which there is a much higher risk. There is a probability of rising minimum temperature in winter season. A number of reports indicated that a rise of 2-3°C in minimum temperature will be observed in the Indian subcontinent. Various global simulation model (GCM) indicated a rise of minimum temperature to the tune of 4°C which will be observed within 2050.

3.5 Role of human beings in Environment

Human activities influence the natural environment. Some human activities have devastating consequences on the environment. These are enlisted below:

1. Over population

Population has grown into an epidemic since mortality rates have decreased, keeping humans alive for much longer period and increasing the total population which degrades the environment. At present population above the age limit 60 years is about 25%.

Man requires space. He also requires farmland, water bodies and industries for

their livelihood. This has created a lot of pressure on different component of the ecosystem. Because of growth of population, forest land is encroached, wet lands are filled up for human habitation. Humanity continuously requires more space, which devastates ecosystems and increases CO_2 levels, further devastating the delicate environment. Although processed materials are necessary to power the cities, the previous assessment tells us that the planet can only sustain so much damage until it will begin to damage us.

2. Pollution

Pollution is everywhere. From the trash thrown out on the freeway, to the millions of metric tons of pollution pumped into the atmosphere every year- it's obvious, pollution and waste are inescapable.

Pollution is so bad thai lo date, 2.4 billion people do not have access to water sources. Humanity is continuously polluting indispensable resources like air. water. and soil which requires millions of years to replenish.

3. Climate Change

Climate change is closely connected to historical development of industry and technology. As global temperatures increase, earth's weather patterns will drastically change. While some areas will experience longer growing seasons, others will become barren wastelands as water will deplete in vast areas, turning once floral regions into deserts.

The increase will impact weather patterns, promising more intense hurricanes in both size and frequency, as well as intensifying and prolonging droughts and heat waves. But air pollution does not just affect the environment.

4. Genetic Modification

Genetically modified organisms (GMOs) have been a major contributor to the survival and prosperity of human being. GMO's are selected bred crops or crops that have had DNA directly implanted into it in order to give an advantage to the crop, whether that be to sustain colder temperatures, require less water, or yield more product.

But GMO's are not always intentional. For years humans have used glyphosate, a herbicide designed to eliminate weeds - the biggest threat to any plant. However, just as humans have a learning immune system, certain weeds have developed a

resistance to 22 of 25 known herbicides, with 249 species of weeds completely immune according to the latest scientific report.

"Super weeds" threaten farming lands by chocking out crops. One of the only solutions is to till the land, turning over the soil to kill the weeds and give an early advantage to the planted crops. The disadvantage of tilling, however, is that it causes the soil to dry faster and kills off beneficial bacteria, making its fertile lifespan significantly shorter. To replenish the depleted soil, fertilizer is used, which introduces a whole new set of problems to the environment and can be disastrous for local agriculture in the long run.

5. Ocean Acidification

Ocean acidification is caused when CO_2 dissolves into the ocean bonding with sea water creating carbonic acid. The acid reduces the pH levels in the water, essentially changing the Ocean acidity by 30% in the last 200 years according to analysis - a level that the ocean has not been at in over 20 million years.

The acidity depletes the calcium concentrations, making it difficult for crustaceans to build their shell, leaving them vulnerable without their armor. Between the global temperature rise of one degree and the ocean acidification, scientists say a quarter of al! coral reefs are considered damaged beyond repair, with two-thirds under serious threat.

6. Water Pollution

Every year, over 8 million tons of garbage dumped into the water bodies. Not only garbage, but also the excessive amounts of fertilizer that finds its way into the water bodies through rains, floods, winds, or dumped in excess right into the largest producer of oxygen we have.

Phytoplankton and algae thrive off of nitrogen, causing excessive growth in what is known as "red tides" or "brown tides" in areas with high concentrations of nitrogen. The brown tide is caused by the rapid growth of billions of algae, which deplete water bodies of oxygen and cause poison to accumulate in all life that consumes it, including fish and birds. But water pollution does not end there.

Pollution is the number one threat to all aquatic life and it causes the reduction in biodiversity.

7. Deforestation

With an exponential expansion in human population, forests are cleared to make way for new habitations. According to international data, an estimated 18 million acres of trees are clear-cut each year to make way for new development and wood products-that is just under half of all the trees on the planet since the industrial revolution began. `With trees being one of the largest producers of oxygen, clearly that is not a good thing for humans- and especially not for the animals that call the forest home.

With millions of different species that live in forests, deforestation is a major threat to their survival and a big conservation issue. It also increases the greenhouse gases within the atmosphere which leads to further global warming. Such human activities need to stop if we wish to survive.

8. Acid Rain

When humans burn coal, sulphur dioxide and nitrogen oxides are released into the atmosphere where they rise up and accumulate in the clouds until the clouds become saturated and rain acid, causing havoc on the ground beneath.

When the rain falls, it accumulates in water bodies which are especially harmful to lakes and small bodies of water. The ground surrounding the water soaks up the acid, depleting the soil of essential nutrients. Trees that absorb the acid accumulate toxins that damage leaves and slowly kills large areas of forest.

Acid rain has also been known to completely eliminate entire species of fish, causing a snowball effect of damage to the ecosystem that relies on diverse organisms to sustain the environment.

3.6 Conclusion

The human society did not do much harm to the environment till pre industrial period. Development of technology increased the production level to meet the desire of the modern society to a great extent. This greedy desire of the modern society are causing immense harm to the environment in such a way that it invites it's own extinction according to Guy R. McPherson.

3.7 Summary

Climate change refers to the rise in average surface temperatures on Earth. The primary cause of climate change is the burning of fossil fuels, such as oil and coal, which emits greenhouse gases into the atmosphere— primarily carbon dioxide. Other human activities, such as agriculture and deforestation, also contribute to the proliferation of greenhouse gases that cause climate change.

Causes :

- CC_2 is the greenhouse gas most commonly produced by human activities and it is responsible for 64% of man-made global warming. Its concentration in the atmosphere is currently 40% higher than it was when industrialization began.
- Burning coal, oil and gas produces carbon-di-oxide and nitrous oxide.
- Cutting down forests (deforestation).
- Fertilizers containing nitrogen produce nitrous oxide emissions.
- Submerged rice cultivation produces methane as well as nitrous oxide because of bacterial activities under anaerobic condition.

Impact of human in nature:-

Human activities impact the natural environment. Some human activities have devastating consequences on the environment.

1. Because of growth of population, forest land is encroached, wet lands are filled up for human habitation. Humanity continuously requires more space, \\hich devastates ecosystems and increases CC_2 levels, further devastating the delicate environment.
2. Humanity is continuously polluting indispensable resources like air, water, and soil which requires millions of years to replenish.
3. As global temperatures increase, Earth's weather patterns will drasticalh change. While some areas will experience longer growing seasons, others will become barren wastelands

4. humans have used glyphosate, a herbicide designed to eliminate weeds - the biggest threat to any plant. "Super weeds" threaten farming lands by chocking outcrops
5. Ocean acidification is caused when CO_2 dissolves into the ocean bonding with sea water creating carbonic acid. The acid reduces the pH levels in the water, essentially changing the Ocean acidity by 30% in the last 200 years
6. Every year over 8 million tons of garbage and fertilizers dumped into the water bodies and polluted the water bodies and killed the aquatic life as well as destroys the biodiversity.
7. With an exponential expansion in human population, forests are cleared to make way for new habitations. According to international data, an estimated 18 million acres of trees are clear-cut each year to make way for new development and wood products
8. Due to human activities such as emission, burn coal etc caused acid rain. Acid rain has also been known to completely eliminate entire species of fish, causing a snowball effect of damage to the ecosystem that relies on diverse organisms to sustain the environment.

3.8 Glossary

Advent- arrival

Alive- live, living

Consensus- agreement

Critical- troublesome

Delicate- pleasant

Deplete- decrease

Encroach- enter

Epidemic- murrain

Regulate- govern

Relies- rely, rely on Render- offer

Replenish- restock

Severe- intense

Susceptible- liable to be influenced or harmed by a particular thing

Sustain- maintain

Threshold- maximum limit

Trap- net

3.9 Model questions

A. Very short answer type question **Marks:- 1**

1. What do you mean by climate change?
2. State the standard atmospheric Co_2 concentration.
3. State the present concentration of atmospheric CO_2.
4. Name some major atmospheric gases.
5. Name the gas which is mainly responsible for global warming.
6. What is the full form of GMOs?
7. Which mineral depletes by ocean acidification?
8. Which gas is responsible for ocean acidification?
9. How many tones of garbage are dumped into water bodies in every year?
10. What is 'red tides' or 'brown tides'?

B. Short answer type question **Marks:- 3**

1. What are the causes of climate change?
2. Slate some evidences which show that our climate has changed.
3. What are the major causes for rising emission?
4. State about the factors that affecting the climate change.
5. What are the impacts of GMOs in nature?

C. Answer the following question **Marks:- 5**

1. Write the factors of climate change.
2. State the role of human being in changing the nature.

3.10 References

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Unit : 4 ◻ GREEN HOUSE GASES AND GLOBAL WARMING

4.0 Introduction

The atmosphere contains several gases some of whose concentration do not change, the concentration of the remaining gases are changed according to situation. Oxygen and nitrogen fall in the first category whereas carbon-di-oxide, water vapour, methane, oxides of nitrogen falls in the second category. The nitrogen and oxygen together make 99% of the total gaseous constituents; other gases form only 1%. The nitrogen and oxygen are di-atomic linear molecule which absorbs the iight in the ultra-violet range. The carbon-di-oxide, methane, water vapour are polyatomic non-linear molecule. They absorb light in the infrared wave band. A beam of solar radiation (short wave) passes through the glass house, easily however the long wave radiation cannot pass through the glass and warms the glass house. The solar radiation when falls on the ground and any object, the surface is heated. The long wave radiations emitted by the surfaces are captured by carbon-di-oxide. water vapour, methane and oxides of nitrogen.

This process warms atmospheric air thus increased the air temperature. The atmospheric gases which cause the temperature rise are known as Greenhouse gases. Global warming is a long term rise in the average temperature of the earth's climatic system. The global warming commonly refers to the observed and continually increased in average air and ocean temperatures since 1900 caused mainly by emissions of greenhouse gases in the modern industrial economy. The effects of global warming include sea level rise, regional changes in precipitation, more frequent extreme weather events such as- heat waves and expansion of deserts. Surface temperature increases are greatest in the Arctic, with the continuing retreat of glaciers, permafrost and sea ice. Overall higher temperatures bring more rain and snowfall in some areas but droughts and wild fire in some other areas.

A majority of people consider global warming a serious threat to the existence of this planet. Every country in the world is a party to the United Nations Framework Convention on Climate Change (UNFCCC). The ultimate objective of this organization is to prevent anthropogenic climate change.

4.1 Objectives

i. To know the gaseous component of the atmosphere.

ii. To know the effect of greenhouse gases.

iii. To know the causes of global warming due to greenhouse gases.

iv. To know the effect of global warming.

v. To know the objective of UNFCCC to prevent anthropogenic climate change.

4.2 Greenhouse Gases

Water vapour is one of the major greenhouse gas which causes 36-70% of the greenhouse effect.

Carbon-di-oxide comes in the second and it causes 9-26% green house effect.

Methane causes 4-9%.

Ozone causes 3-7%.

Carbon-di-oxide:- Since the industrial revolution the atmospheric concentration of

Carbon-di-oxide has been increasing as a direct consequence of fossil fuel combustion. Pre-industrial level carbon-di-oxide concentration remained in between 288 ppmv and 295 ppmv ± 10 ppmv. The **figure** 5 shows an exponential rise in carbon-di-oxide.

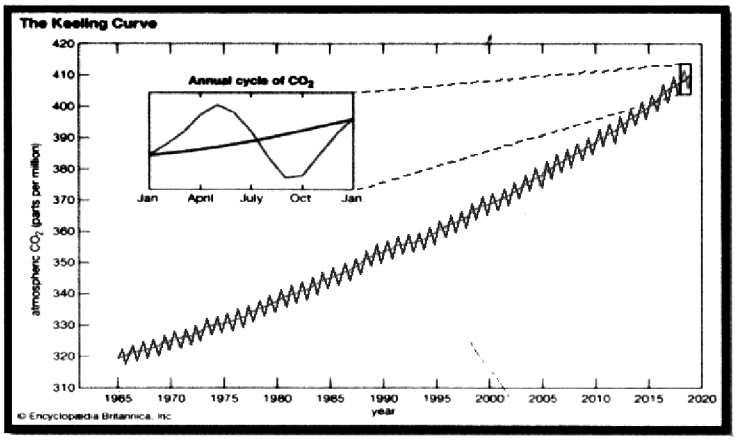

Fig. 5 Keeling curve

The mean yearly level increased from 315 ppmv to 335 ppmv between 1958 and 1978. At present the carbon-di-oxide concentration reached 420 ppmv (Fig-6)

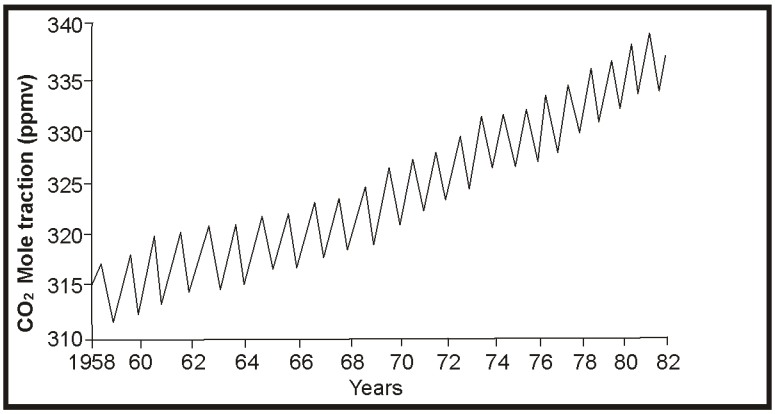

Fig. 6 Concentration of carbon-di-oxide A

Charles Keeling records carbon-di-oxide level which is known as Keeling curve. Different climate models showed that if the carbon-di-oxide concentration is doubled, the global surface temperature will rise to an extent of 1.5-4 K with an expected average value of 2.5 K in high latitude region the surface temperature rise will be closer to 3-4 K near the south pole and 7-8 K near the north pole.

4.3 Conclusion

From the above discussion it can be concluded that global warming is caused by greenhouse gases. The major greenhouse gases are water vapour, CO_2, methane and ozone. Nowadays, the CO_2 level increased from 315 ppmv to 335 ppmv between 1958 and 1978. At present the CO_2 concentration reached 450 ppmv due to global warming mainly for greenhouse gases.

4.4 Summary

The atmosphere contains several gases the nitrogen, oxygen, carbon-di-oxide, water vapour, methane etc. This atmospheric gases which cause the temperature rise are known as Greenhouse gases. This caused global warming.

- The effects of global warming include sea level rise, regional changes in precipitation, more frequent extreme weather events such as- heat waves and expansion of deserts. Surface temperature increases are greatest in the Arctic, with the continuing retreat of glaciers, permafrost and sea ice.
- Percentage of major greenhouse gases in the atmosphere-

Greenhouse gases	Percentage
Water vapour	36-70
Carbon-di-oxide	9-26
Methane	4-9
Ozone	3-7

- Due to global warming, the mean yearly Co2 level increased from 315 ppmv to 335 ppmv between 1958 and 1978. At present the carbon-di-oxide concentration reached 450 ppmv.
- Charles Keeling records carbon-di-oxide level which is known as Keeling curve. Here it can be seen that, the global surface temperature wili rise to an extent of 1.5-4 K with an expected average value of 2.5 K in high latitude region the surface temperature rise will be closer to 3-4 K near the south pole and 7-8 K near the north pole.

4.5 Glossary

Category- class, group
Consequence- result, outcome
Constituent- component

Extent- range, limit
Frequent- very often
Threat- fear

4.6 Model questions

A. Very short answer type question **Marks:- 1**

1. Name the major greenhouse gases.
2. Write down the concentration of nitrogen and oxygen in the atmosphere.
3. Define greenhouse gases.
4. What do you mean by global wanning?
5. Write the full form of UNFCCC.
6. What is the main objective of UNFCCC?
7. Write the percentage of different greenhouse gases.
8. Who is the propounder of Keeling Curve?
9. Define Keeling Curve.

B. Answer the following question **Marks:-** 3/5

1. What is greenhouse gases?
2. How does the greenhouse gas affect global warming?
3. What is Keeling Curve? Explain it.

4.7 References

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Unit : 5 ❑ UNITS: 5 GLOBAL CLIMATIC ASSESMENT: IPCC REPORTS

5.0 Introduction

The intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations dedicated to providing the world with an objective, scientific view of climate change, its natural, political and economic impacts and risks, and possible response options.

The IPCC prepares comprehensive Assessment Reports about knowledge on climate change, its causes, potential impacts and response options. The IPCC also produces Special Reports, which are an assessment on a specific issue and Methodology Reports, which provide practical guidelines for the preparation of greenhouse gas inventories.

The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and later endorsed by the United Nations General Assembly. Membership is open to all members of the WMO and UN.

The IPCC produces reports that contribute to the work of the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty on climate change. The objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system".

5.1 Objectives

IPCC reports cover the-

i. Scientific, technical and socio-economic information
ii. It is relevant to understand the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigations.

5.2 Assessment Reports

First assessment report

The IPCC First Assessment Report (FAR) was completed in 1990, and served as the basis of the UNFCCC.

This report says that emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases, resulting on an average in an additional wanning of the Earth's surface. They calculate with confidence that CO_2 has been responsible for over half the enhanced greenhouse effect. They predict that global mean temperature will increase by about 0.3 °C per decade during

the 21st century. They judge that global mean surface air temperature has increased by 0.3 to 0.6 °C over the last 100 years. The unequivocal detection of the enhanced greenhouse effect is not likely for a decade or more.

Second assessment report

Climate Change 1995, the 1PCC Second Assessment Report (SAR). was finished in 1996. This report staled the following-

- Greenhouse gas concentrations have continued to increase
- Anthropogenic aerosols tend to produce negative radiative forcing.
- Climate has changed over the past century (air temperature has increased by between 0.3 and 0.6 °C since the late 19th century: this estimate has not significantly changed since the 1990 report).
- The balance of evidence suggests a discernible human influence on global climate (considerable progress since the 1990 report in distinguishing between natural and anthropogenic influences on climate, because of including aerosols; coupled models; pattern-based studies)
- Climate is expected to continue to change in the future (increasing realism of simulations increases confidence; important uncertainties remain but are taken into account in the range of model projections)
- There are still many uncertainties (estimates of future emissions and biogeochemical cycling; models; instrument data for model testing, assessment of variability, and detection studies).

Third assessment report

The Third Assessment Report (TAR) was completed in 2001. Robust finding of the TAR Synthesis Report include:

- Observations show Earth's surface is warming. Globally, 1990s very likely warmest decade in record. Atmospheric concentrations of anthropogenic (i.e., human-emitted) greenhouse gases have increased substantially.
- Since the mid- 20th century, most of the observed warming is likely (greater than 66% probability, based on expert judgment) due to human activities.
- Projections based on the Special Report on Emissions Scenarios suggest warming over the 21st century at a more rapid rate than that experienced for at least the last 10,000 years.

- Projected climate change will have beneficial and adverse effects on both environmental and socio-economic systems, but the larger the changes and the rate of change in climate, the more the adverse effects predominate.
- Ecosystems and species are vulnerable to climate change and other stresses (as illustrated by observed impacts of recent regional temperature changes) and some will be irreversibly damaged or lost.
- Greenhouse gas emission reduction (mitigation) actions would lessen the pressures on natural and human systems from climate change.
- Adaptation (to the effects of climate change) has the potential to reduce adverse effects of climate change and can often produce immediate ancillary benefits, but will not prevent all damages. An example of adaptation to climate change is building levees in response to sea level rise.

Fourth assessment report

The Fourth Assessment Report (AR4) was published in 2007. Robust findings of the Synthesis report include:

- Wanning of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Most of the global average warming over the past 50 years is very likely (greater than 90% probability, based on expert judgment) due to human activities.
- Impacts of climate change will very likely increase due to increased frequencies and intensities of some extreme weather events.
- Anthropogenic warming and sea level rise would continue for centuries even if GHG emissions were to be reduced sufficiently for GHG concentrations to stabilize, due to the time scales associated with climate processes and feedbacks. Stabilization of atmospheric greenhouse gas concentrations is discussed in climate change mitigation.
- Some planned adaptation (of human activities) is occurring now; more extensive adaptation is required to reduce vulnerability to climate change.
- Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt.

- Many impacts (of climate change) can be reduced, delayed or avoided by mitigation.

Fifth assessment report

The IPCC's Fifth Assessment Report (AR5) was completed in 2014. It consists three working groups. Conclusions of AR5 are summarized below:

- **Working Group I**
- Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.
- Atmospheric concentrations of carbon-di-oxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years.
- Human influence on the climate system is clear. It is extremely likely (95-100% probability) that human influence was the dominant cause of global warming between 1951-2010.
- **Working Group II**
- "Increasing magnitudes of global warming increase the likelihood of severe, pervasive, and irreversible impacts".
- A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability.
- The overall risks of climate change impacts can be reduced by limiting the rate and magnitude of climate change.
- **Working Group III**
- Without new policies to mitigate climate change, projections suggest an increase in global mean temperature in 2100 of 3.7 to 4.8 °C, relative to pre-industrial levels (median values; the range is 2.5 to 7,8 °C including climate uncertainty).
- The current trajectory of global greenhouse gas emissions is not consistent with limiting global warming to below 1.5 or 2 °C, relative to pre-industrial levels. Pledges made as part of the Cancun Agreements are broadly consistent with cost-effective scenarios that give a "likely" chance (66-100% probability) of limiting global warming (in 2100) to below 3 °C, relative to pre-industrial levels.

5.3 Reports of IPCC

IPCC report of 2018

This report understands the impacts of 1.5°C global warming above pre-industrial levels and related to global green house gas emission pathways, building on the IPCC Fifth Assessment Report (AR5), in the context of climate change.

Human-induced warming reached approximately 1°C (likely between 0.8°C and 1.2°C) above pre-industrial levels in 2017, increasing at 0.2°C (likely between 0.1°C and 0.3°C) per decade. Global warming in this report is an increase in combined surface air and sea surface temperatures over a 30-year period. Warming is expressed relative to the period 1850-1900, used as an approximation of pre-industrial temperatures in AR5. Accordingly, warming from pre-industrial levels to decade 2006-2015 is assessed to be 0.87°C (likely between 0.75°C and 0.99°C). By the decade 2006-2015, earth had already experienced wanning of more than I.5°C above pre-industrial in at least one season.

This 2018 report of IPCC assess

- Projected impacts at a global average warming of 1.5°C and higher levels of warming. Global warming of 1.5°C is associated with global average surface temperature.
- Climate adaptation refers to the actions taken to manage impacts of climate change by reducing vulnerability and exposure to it's harmful effects and exploiting any potential benefits.
- Ambitious mitigation actions are indispensable to limit wanning to 1.5°C while achieving sustainable development and poverty eradication.
- Multiple forms of knowledge, including scientific evidence, narrative scenarios and prospective pathways, inform the understanding of 1.5°C.
- It also emphasizes the global inter-connectivity of past present and future human-environment relations.

IPCC report of 2019

The report's full name is Climate change and land, an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security and green house fluxes in terrestrial ecosystem.

It is one of the special report that the IPCC is preparing during the current Sixth

Assessment Report Cycle. This report shows that better land management can contribute to tackle climate change, but is not the only solution. Reducing green house gas emissions from all sectors is essential if global warming is to be kept to well below 2°C, if not 1.5°C.

This assessment has been given by IPCC on 8th August, 2019.

5.4 Conclusion

IPCC found that in order to take temperatures at around 1.5 degrees Celsius, carbon emissions must be profoundly reduced over the next decade, to just 45 percent of levels in 2010.

It can be concluded that limiting Earth's warming to just 1.5 degrees Celsius (2.7 degrees Fahrenheit) above pre-Industrial era temperatures would require "rapid, far-reaching and unprecedented changes in all aspects of society."

5.5 Summary

The special report on Global Warming of 1.5°C was approved by the iPCC report of United Nation. It works to tackle climate change. Ninety-one authors and review editors from 40 countries prepared the IPCC report in response to an invitation rom the United Nations Framework Convention on Climate Change (UNFCCC).

The report's full name is Global Warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

The reports highlights a number of climate change impacts that could be avoided by limiting global warming to 1.5°C compared to 2°C, or more. This report can be divided into five groups. Such as-

1. First assessment report

- This report says that emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases, resulting on average in an additional warming of the Earth's surface.

- They predict that global mean temperature will increase by about 0.3 °C per decade during the 21st century.

2. Second assessment report-

- Greenhouse gas concentrations have continued to increase
- Anthropogenic aerosols tend to produce negative radiative forcing.
- Climate is expected to continue to change in the future (increasing realism of simulations increases confidence; important uncertainties remain but are taken into account in the range of model projections).

3. Third assessment report-

- Observations show Earth's surface is warming. Globally, 1990s very likely warmest decade in record. Atmospheric concentrations of anthropogenic (i.e., human-emitted) greenhouse gases have increased substantially.
- Ecosystems and species are vulnerable to climate change and other stresses (as illustrated by observed impacts of recent regional temperature changes) and some will be irreversibly damaged or lost.
- Greenhouse gas emission reduction (mitigation) actions would lessen the pressures on natural and human systems from climate change.
- Adaptation (to the effects of climate change) has the potential to reduce adverse effects of climate change and can often produce immediate ancillary benefits, but will not prevent all damages. An example of adaptation to climate change is building levees in response to sea level **rise.**

4. Fourth assessment report-

- Impacts of climate change will very likely increase due to increased frequencies and intensities of some extreme weather events.
- Some planned adaptation (of human activities) is occurring now; more extensive adaptation is required to reduce vulnerability to climate change.
- Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt.
- Many impacts (of climate change) can be reduced, delayed or avoided by mitigation.

5. Fifth assessment report-

- Human influence on the climate system is clear. It is extremely likely (95-100% probability) that human influence was the dominant cause of global warming between 1951-2010.
- The overall risks of climate change impacts can be reduced by limiting the rate and magnitude of climate change.
- Without new policies to mitigate climate change, projections suggest an increase in global mean temperature in 2100 of 3.7 to 4.8 °C, relative to pre-industrial levels (median values; the range is 2.5 to 7.8 °C including climate uncertainty).

IPCC report of 2018-

- Projected impacts at a global average warming of 1.5°C and higher levels of warming. Global wanning of 1.5°C is associated with global average surface temperature.
- Climate adaptation refers to the actions taken to manage impacts of climate change by reducing vulnerability and exposure to it's harmful effects and exploiting any potential benefits.
- Ambitious mitigation actions are indispensable to limit warming to 1.5°C while achieving sustainable development and poverty eradication.

5.6 Glossary

Adverse- unfavorable

Assessment- evaluation

Detection- identification

Discernible- determinable

Effective- useful, workable

Enhanced- improved, raised

Fluxes- flow per unit time per unit area

Pledges- promise, plight

Potential- possibility, expectation

Robust- powerful

Simulation- when a number of parameters are assessed together

Stabilize- rest

Unequivocal- definite, direct ;

Unprecedented- new

5.7 Model questions

A. Very short answer type question **Marks:- 1**

1. What is the full form of IPCC?
2. In which year IPCC was established?
3. What is the full form of WMO?
4. What is the full form of UNEP?
5. What is the main objective of UNFCCC on climate change?
6. In which year FAR was completed?
7. How many reports were given by IPCC?
8. In which year SAR and TAR was completed?
9. What is AR 5? How many groups are there in AR 5?
10. What is the full form of IPCC report of 2019?

B. Short answer type question **Marks:- 3**

1. Discuss the major findings of FAR.
2. What is the major theme of SAR?
3. Why TAR was important?
4. Why AR 4 was important?
5. Explain 2018 1PCC report briefly.
6. Briefly discuss the 2019 IPCC report.

C. Answer the following question **Marks:- 5**

1. Why AR 4 was important in IPCC report?
2. Summarize fifth assessment report of IPCC.
3. What is SPCC? What are the main objectives of IPCC?
4. What is the major findings of 2018 report?
5. Briefly discuss the major assessment reports of IPCC.

5.8 References

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MODULE : 2

Unit : 6 ❑ CLIMATE CHANGE AND VULNERABILITY: PHYSICAL, EONOMIC AND SOCIAL

6.0 Introduction of Climate change

Climate change is any significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over a significant period of time. Climate change is about abnormal variations to the climate, and the effects of these variations on other parts of the Earth.

The global climate system will continue to change for centuries because of both past and future emissions of greenhouse gases. Heat waves, floods and other impacts on ecosystems, human health and economy are likely to become more severe in the coming decades. Climate impact, risks and vulnerability assessments are used to identify the nature and magnitude of these impacts for natural systems and human society.

6.1 Objectives

i. To know the effect of climate change

ii. To know what is vulnerability

iii. To know types of vulnerability

iv. To know relation between vulnerability and climate change

6.2 Vulnerability

Vulnerability refers to the degree to which people or the things they value are susceptible to, or are unable to cope with, the adverse impacts of climate change. There are three dimensions of vulnerability to climate change: exposure, sensitivity, and adaptive capacity.

The impacts of climate change will vary between region to region, sector to sector and even within sectors. Understanding the specific vulnerability and risks is essential for planning and implementing adaptation actions at the regional level. The regional impacts of climate change also depend on the development of environmental, socio-economic, political and technological conditions at the regional scale. For example, humans can increase their vulnerability by urbanization of coastal flood plains, by deforestation of hill slopes or by constructing buildings in risk-prone areas. On the other hand, they can decrease their vulnerability by building institutional and technical capacity to address climatic hazards.

Vulnerability and risk assessment is compulsory in order to plan and implement adaptation measures, and to prioritize resources. They identify which regions, sectors or system components are particularly affected by climate change, and where there is an urgent need to adapt.

6.3 Types of Vulnerability

Physical Vulnerability :

Vulnerability to climate change is a vulnerability to environmental shocks resulting from climate change. These shocks are here considered as the physical expression of climate change. They essentially appear through the increase in the number and intensity of droughts, floods, and storms, as well as through the rise in sea level for low-lying coastal areas, level regions; they are reflected by the change in the mean values of climatic variables (such as temperature or rainfall), and by related changes in the instability of these variables.

Economic Vulnerability:

The word "vulnerability' has been used with various meanings and by many researchers in food security, natural hazards, disaster risk, public health, global environment, and climate change or development economics. Economic vulnerability can be seen to consist of three main components: shock, exposure and resilience Shocks are exogenous and generally unforeseen events (external e.g. the instability of exports, or natural, e.g. typhoons, hurricanes, earthquakes, droughts). Exposure corresponds to factors on which the direct impact of shocks depends. Resilience is the capacity to react to shocks. A weak resilience is a part of the general vulnerability Assessments.

Social Vulnerability:

Social and demographic groups, across a wide range of geographical locations, are the most vulnerable to climate change impacts within four wellbeing impacts: health, safety, food security and displacement. Climate change is expected to exacerbate current vulnerabilities and inequalities. For example- deficiencies in early childhood may limit future educational and income generation opportunities. Evidence of clear threshold is rare and is mainly related to the vulnerability of different age groups, household income level and the impacts of different degrees of global warming.

Thus this physical, economic and social vulnerability are the impacts of climate in various ways. Flood, drought or different climatic hazards affect physical, social and economic issues in various ways. For example, flood damages buildings and livelihood, agricultural lands physically, and the loss of these properties is called as economic losses or vulnerability. Then for this hazard (flood) hunger, poverty etc. can be seen in the society that is called social vulnerability.

6.4 Impacts of various Climatic hazards

Flood

A flood is an overflow of water that submerges land that is usually dry. 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.

- Primary or physical effects of flooding includes loss of life and damage to buildings and other structures, including bridges, sewerage systems, roadways, canals, agricultural land or farm land.
- Economic hardship due to a temporary decline in tourism, rebuilding costs, or food shortages leading to price increases is a common after-effect of severe flooding. Loss of property occurs due to flooding.
- Flood waters typically inundate farm land, making the land unworkable and preventing crops from being planted or harvested, which can lead to shortages of food both for humans and farm animals. The impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries. Thus it is the social effects of flooding.

Drought

A drought or 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.

- Droughts physically destroy land or soil. Mainly agricultural land is very much affected by it. It decreases fertility of soil.

  In the case of environmental effects: lower surface and subterranean water-levels, lower flow-levels (with a decrease below the minimum leading to direct danger for amphibian life), increase pollution of surface water, the drying out of wetlands, more and larger fires, higher deflation intensity, loss of biodiversity, worse health of trees and the appearance of pests and various diseases.

- Economic losses include lower agricultural, forests, game and fishing output, higher food-production costs, lower energy-production levels in hydro plants, losses caused by depleted water tourism and transport revenue, problems with water supply for the energy sector and for technological processes in metallurgy, mining, the chemical, paper, wood, foodstuff industries etc., disruption of water supplies for municipal economies.
- Social costs include the negative effect on the health of people directly exposed to this phenomenon (excessive heat waves), possible limitation of water supplies, increased pollution levels, high food-costs, stress caused by failed harvests, etc. This explains why droughts and fresh water shortages operate as a factor which increases the gap between developed and developing countries.

Storm

A storm is any disturbed state of an environment or in an astronomical body's atmosphere especially affecting its surface, and strongly implying severe weather. It may be marked by significant disruptions to normal conditions such as strong wind, tornadoes, hail, thunder and lightning (a thunderstorm), heavy precipitation (snowstorm, rainstorm), heavy freezing rain (ice storm), strong winds (tropical cyclone, windstorm), or wind transporting some substance through the atmosphere as in a dust storm, blizzard, sandstorm, etc.

- Strong winds from any storm type can damage or destroy vehicles, buildings, bridges, and other objects, turning loose debris into deadly flying projectiles.
- Hail can cause serious damage, notably to automobiles, aircraft, skylights, glass-roofed structures, livestock, and most commonly, farmers' crops. Wheat, corn, soybeans, and tobacco are the most sensitive crops to hail damage. Hail is one of the most significant thunderstorm hazards to aircraft. When hail stones exceed 0.5 inches (13 mm) in diameter, planes can be seriously damaged within seconds.
- Lightning produces a concentrated amount of extreme heat. It causes wildfire which can devastate vegetation and the biodiversity of an ecosystem.
- Skiing, snowboarding, snowmobiling, and snowshoeing depend upon snow. Where snow is scarce but the temperature is low enough, snow cannons may be used to produce an adequate amount for such sports.

- Snow cover is considered a general danger to hiking since the snow obscures landmarks and makes the landscape itself appear uniform.
- Storm also causes flooding and it has a great impact in physical, economic and social cases.

Sea level rise

Since the beginning of the 20th century, the average global sea level has been rising. Between 1900 and 2016, the sea level rose by 16-21 cm. More precise data gathered from satellite radar measurements reveal an accelerating rise of 7.5 cm from 3.0 cm during 1993 to 2017, which is approximately 30 cm rise per century. This acceleration is due mostly to human-caused global warming.

- The physical impacts include increased coastal erosion, higher storm-surge flooding, inhibition of primary production processes, more extensive coastal inundation, changes in surface water quality and groundwater characteristics.
- The economic impacts are increased loss of property and coastal habitats, increased flood risk and potential loss of life, loss of non-monetary **cultural** resources and values, on agriculture and aquaculture through decline in **soil** and water quality, and loss of tourism, recreation, and transportation functions.
- Human habitation can damage through this causes so that the impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries are happened.

6.5 Conclusion

From above mention points it can be concluded that climatic variables or hazards affect the physical, economic as well as social system of the environment which are interrelated.

6.6 Summary

Vulnerability refers to the degree to which people or the things they value are susceptible to, or are unable to cope with, the adverse impacts of climate change.

Vulnerability are three types mainly, physical, economic and social. Climate change and vulnerability are interrelated.

The physical, economic and social vulnerability are the impacts of climate in various ways. Flood, drought or different climatic hazards affect physical, social and economic issues in various ways.

- Primary or physical effects of flooding includes loss of life and damage to buildings and other structures, including bridges, sewerage systems, roadways, canals, agricultural land or farm land.
- Economic hardship due to a temporary decline in tourism, rebuilding costs, or food shortages leading to price increases is a common after-effect of severe flooding. Loss of property occurs due to flooding.
- Droughts physically destroy land or soil.
- Lightning produces wildfire which can devastate vegetation and the biodiversity of an ecosystem.
- Skiing, snowboarding, snowmobiling, and snowshoeing depend upon snow. Where snow is scarce but the temperature is low enough, snow cannons may be used to produce an adequate amount for such sports.
- The physical impacts include increased coastal erosion, higher storm-surge flooding, inhibition of primary production processes, more extensive coastal inundation, changes in surface water quality and groundwater characteristics
- Human habitation can damage through this causes so that The impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries.

6.7 Glossary

Devastated- devastating, ruined

Exposure- subjected to some phenomenon

Inhibition- prohibition, ban

Inundation- flood

Magnitude- hugeness, amount

Resilience- elasticity

Significant- important, serious

Susceptible- prone to something

Substantial- mentionable

6.8 Model question

A. Very short answer type question **Marks:- 1**

1. Define climate change.
2. Define vulnerability.
3. Why do the vulnerability and risk management important?
4. What do you mean by physical vulnerability?
5. What are the major components of economic vulnerability?
6. 'Four wellbeing'- What are they?
7. Define flood.
8. Define drought.
9. What is the trend of sea level rise per century?
10. How many types of vulnerability are linked with climate change?

B. Short answer type of question **Marks:- 3**

1. 'Global climate system will continue to change for centuries'- explain briefly.
2. Why does the vulnerability assessment essential?
3. How physical vulnerability impacts on social and economic vulnerability?
4. Explain the impacts of flood.
5. Explain the impacts of drought.
6. How sea level rise impacts on social, physical and economic vulnerability?

C. Answer the following question **Marks:- 5**

1. How climate change is related to vulnerability?
2. Explain the three types of vulnerability of the environment.
3. Explain the impact of various climatic hazards.

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Unit : 7 □ IMPACT OF CLIMATE CHANGE: AGRICULTURE AND WATER; FLORA AND FAUNA; HUMAN HEALTH AND MORBIDITY

- **Human health**
- **Society**

7.4.4 Conclusion

7.4.5 Summary

7.4.6 Glossary

7.4.7 Model question

7.4.8 Reference

7.5 Impact of climate change on flora and fauna

7.5.1 Introduction

7.5.2 Objectives

7.5.3 Effect of climate change on flora

- **Effect of CO_2**
- **Effect of temperature**
- **Effects of water**

7.5.4 Direct impacts on plants

- **Changes in distribution**
- **Changes in life cycle**
- **Changes in genetic diversity**

7.5.5 Indirect impacts on plants

7.5.6 Effect on fauna

7.5.7 Effect of climate change on wild life

- **Pollinators**
- **Insects**
- **Birds**
- **Land mammals**

7.0 Introduction

Climate is not static but rather a fairly dynamic entity. In every part of the world one year, one decade or one century differs from another. It is the long-term alteration of

temperature and normal weather patterns in a place. This could refer to a particular location or the planet as a whole. Climate change is currently occurring throughout the world as a result of global warming. Climate has an immense impact on agricultural system of a region.

7.1 Objectives

i. To know the effect of climate change on agriculture,

ii. To find out the relationship between climate change and crop growth,

iii. To know the changes in farming practices and technology due to climate change,

iv. To know the effect of CO_2 on crops.

7.2 Definition and Level of Climate Change

Climate change refers to significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer.

Three main levels of climate change impacts are as follows

- The global increase in temperatures can influence the physical, biological and human systems.
- First, variations in the physical systems of the planet may be observed in the melting of the ice in the poles, which at the same time cause glacial regression, snow melting, warming and thawing of permafrost, flooding in rivers and lakes, droughts in rivers and lakes, coastal erosion, sea level rise and extreme natural phenomena.
- In the biological systems, there is death of flora and fauna in terrestrial and marine ecosystems, wildfires and flora and fauna displacement, searching for better life conditions.
- In human systems, climate change affects and destroys crops and food production, causes disease and death, destruction and loss of economic livelihoods and migration of climate refugees.

7.3 Impact of Climate change on Agriculture

7.3.1 Introduction

Agriculture is highly dependent on the climate. Increases in temperature and carbon dioxide (CO2) can increase some crop yields in some places. Changes in the frequency and severity of droughts and floods may pose challenges for farmers and threaten food safety. Overall, climate change could make it more difficult to grow crops. The effects of climate change also has to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology

7.3.2 Impacts on Crops

For any particular crop, the effect of increased temperature will depend on the crop's optimal temperature for growth and reproduction. In some areas, warming may benefit the types of crops that are typically planted there, or allow farmers to shift to other crops that are currently grown in warmer areas. Conversely, if the higher temperature exceeds a crop's optimum temperature, yields will decline.

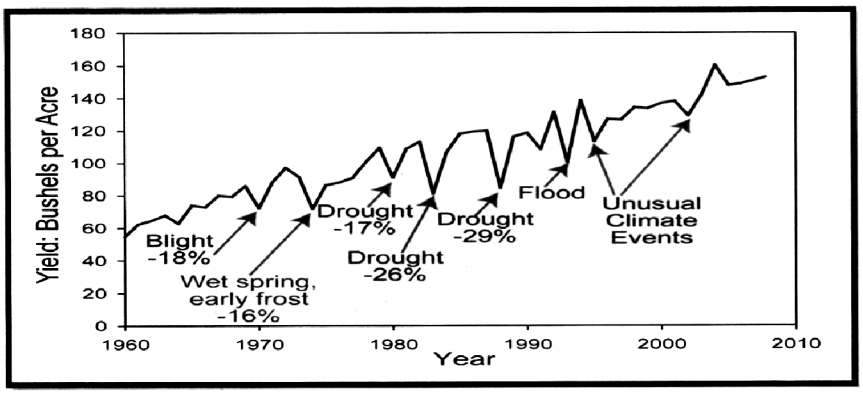

Fig : Extreme weather events have caused significant yield reductions in some years. Source : USGCRP (2009).

- Higher CO_2 levels can affect crop yields. Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth. However, other factors, such as changing temperatures, ozone, and water and nutrient constraints, may counteract these potential increases in yield. For example, if temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield increases may be reduced or reversed. Elevated CO_2 has been associated with reduced protein and nitrogen content in alfalfa and soybean plants, resulting in a loss of quality. Reduced grain and forage quality can reduce the ability of pasture and rangeland to support grazing livestock.
- More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields. Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation when more is needed.
- Many weeds, pests, and fungi thrive under warmer temperatures, wetter climates, and increased CO_2 levels. The ranges and distribution of weeds and pests are likely to increase with climate change. This could cause new problems for farmers' crops previously unexposed to these species.
- Though rising CO_2 can stimulate plant growth, it also reduces the nutritional value of most food crops. Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most plant species, including wheat, soybeans, and rice. This direct effect of rising CO_2 on the nutritional value of crops represents a potential threat to human health. Human health is also threatened by increased pesticide use due to increased pest pressures and reductions in the efficacy of pesticides
- According to Venkateshwarlu, former director at the ICAR Central Research Institute for Dry land Agriculture (ICAR-CRIDA), in India climate change has about 4-9 per cent impact on agriculture each year. As agriculture contributes 15 per cent to India's GDP, climate change presumably causes about 1.5 per cent loss in GDP.

7.3.3 How different crops react to climate change

Highlighting the impact of climate change on crops, he explained how rice, wheat, maize and sorghum are the worst hit by this phenomenon. By 2030, rice and wheat

are likely to see about 6-10 per cent reduction in yields. He also gave examples of crops like potatoes, soybean, chickpea and mustard, on which climate change will have a neutral or positive impact.

7.3.4 Conclusion

Climate change increases the level of CO_2 and occurrence of flood as well as decreases water supply. Due to this, agricultural production has changed, affected and decreased. To increase production farmers used chemical fertilizer, pesticide, for this reason human health is also affected badly.

7.3.5 Summary

Agriculture is highly dependent on the climate. Increases in temperature and carbon dioxide *(CO_2)* can increase some crop yields in some places. Climate change can effect agricultural production in many ways, such as-

- Higher CO_2 levels can affect crop yields. Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most plant species, including wheat, soybeans, and rice.
- More extreme temperature and precipitation can prevent crops from grouing. Extreme events, especially floods and droughts, can harm crops and reduce yields.
- Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier reduce the productivity.
- Though rising CO_2 can stimulate plant growth, it also reduces the nutritional value of most food crops.

7.3.6 Glossary

Dynamic- ongoing

Efficacy- working efficiency

Optimal- favorable

Presumably- may be

Refugees- displaced person

Several- different, various

Static- fixed, still

Unexposed- hidden

7.3.7 **Model questions**

A. Very short answer type question Marks:- 1

1. Define climate change.
2. Which gas can increase the crop yield?
3. which gas can stimulate crop growth?
4. Write the full form of CRIDA.
5. Who was the director of CRIDA?

B. Short answer type question Marks:- 3

1. Write the impacts of climate change.
2. How climatic condition decrease the agriculture productivity?
3. Write the impacts of climate change on different crops.

C. Answer the following question Marks:- 5

1. write the impacts of climate change on agriculture.

7.3.8 References

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7.4 Impact of Climate change on Water

7.4.1 Introduction

Water is a transparent, tasteless, odorless, and colorless chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. It is vital for all known forms of life, even though it provides no calories or organic nutrients.

7.4.2 Objectives

i. To know the effect of climate change on water resource.
ii. To know the major causes of water scarcity and it's harmful effects.
iii. To know impact of water scarcity on environment as well as on human beings.

7.4.3 Importance

There are various uses of water, such as

- For drinking purpose and household requirement
- For survival of plants, agriculture, bio-eco system
- For industrial production, constructional activities, and transport system

Water resources are important to both society and ecosystems. We depend on a reliable, clean supply of drinking water to sustain our health. We also need water for agriculture, energy production, navigation, recreation, and manufacturing. Many of these uses put pressure on water resources, stresses that are likely to be exacerbated by climate change.

Water Cycle

The water cycle (shown in the following figure) is a delicate balance of precipitation, evaporation, and all of the steps in between. Changes in the amount of rain falling during storms provide evidence that the water cycle is already changing. As temperatures rise, people and animals need more water to maintain their health and thrive. Many important economic activities, like producing energy at power plants, raising livestock, and growing food crops, also require water. The amount of water available for these activities may be reduced as earth warms and increased competition among the bio components for water resources.

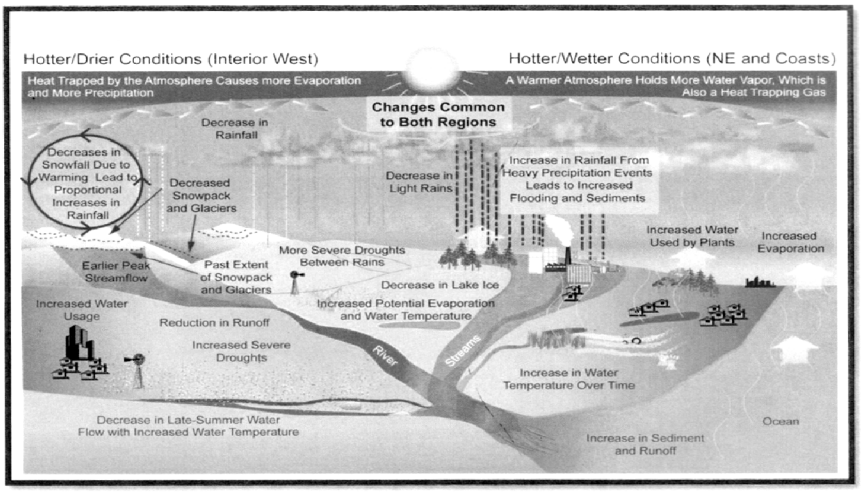

Fig- Projected changes in the water cycle. Source: LSGCRP 2009

Water Supply

Due to climate change and increase rate of global warming water supply reduced day by day. Due to this cause not only human beings but also biosphere faces severe problems.

Water quality

Water quality could suffer in areas experiencing increase in rainfall. For example, in the Northeast and Midwest, increase in heavy precipitation events could cause problems for the water infrastructure, as sewer systems and water treatment plants are overwhelmed by the increased volumes of water. Heavy downpours can increase the amount of runoff into rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste, and other materials into water supplies, making them unusable, unsafe.

Impacts

The impacts of climate change on water availability and water quality will affect many sectors, including energy production, infrastructure, human health, agriculture, and ecosystems.

- Agriculture
- Ecosystem
- Energy
- Human health
- Society

Agriculture

Agricultural production depends on water. It increases the food production by increasing soil moisture and fertility. Due to water shortage or scarcity, drought occurs. Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation when more is needed.

Ecosystem-Ecosystems of small, shallow lakes are known as "prairie potholes" or "playa lakes." These wetlands provide essential breeding habitat for most species. A permanently wanner, drier future may lead to a threshold change—a dramatic drop in the prairie potholes that host waterfowl populations, which subsequently provide highly valued hunting and wildlife viewing opportunities.

when coral reefs become stressed from increased ocean temperatures, they expel microorganisms that live within their tissues which are essential to their health. This is known as coral bleaching. As ocean temperatures warm and the acidity of the ocean increases, bleaching and coral die-offs are likely to become more frequent. Chronically stressed coral reefs are less likely to recover.

Energy

Energy and water systems are inter-connected. Energy is needed to pump, transport, and treat drinking water and wastewater. Cooling water is needed to run many of today's power plants. Hydroelectricity (electricity produced by running water) is itself an important source of power throughout the world.

Changes in precipitation, increased risk of drought, reduced snowpack, and changes in the timing of snowmelt in spring will influence our patterns of energy and water use. For example:

- More frequent and severe heat waves will likely increase the demand for electricity in some areas. At the same time, these areas are likely to experience reduced water supplies due to increased temperature and evaporation, as well as possible decreased rainfall. Since water is necessary for electricity production, these combined effects could stress water resources.
- Hydroelectric power plants are sensitive to the volume and timing of stream flows. In some regions, especially during times of increased rainfall, dam operators may have to allow some water to bypass the electric turbines to prevent downstream flooding.
- Growing crops for biomass and bioiiiel energy could stress water resources in certain regions.
- Rising temperatures, increased evaporation, and drought may increase the need for energy-intensive methods of providing drinking and irrigation water.

Human health-

- Climate impacts can affect exposure to waterborne pathogens (bacteria, viruses, and parasites such as Cryptosporidium and Giardia); toxins produced by harmful algal and cyan bacterial blooms in the water; and chemicals that end up in water from human activities.

- Changing water temperatures mean that waterborne Vibrio bacteria and harmful algal toxins will be present in the water or in seafood at different times of the year, or in places where they were not previously threats.

Society

Climate change could affect our society through impacts on a number of different social, cultural, and natural resources. For example, climate change could affect human health, infrastructure, and transportation systems, as well as energy, food, and water supplies.

Climate change is projected to increase the frequency and intensity of extreme weather events, such as droughts, and floods. These changes are likely to increase losses to property and crops, and cause costly disruptions to society. Escalating losses have already affected the availability and affordability of insurance in vulnerable areas.

7.4.4 Conclusion

Water is known as 'Life'. Due to climate change it gets scarce and it's impacts are furious. Due to less water availability drought occurs beside due to heavy rainfall some region faces flood. Both are hazards and are not helpful to the environment. So not only plants or aquatic life but the whole atmosphere, ecosystem all faces a furious problem and some of them were extinct.

7.4.5 Summary

Climate change causes water scarcity. Due to this not only plant life but many others faces serious problem such as.

- Agriculture
- Ecosystem
- Energy
- Human health
- Society

The above points are illustrated below:

1. Agricultural production depends on water. It increases the food production by increasing soil moisture and fertility. Due to water shortage or scarcity drought occurs. Thus the land becomes infertile.

2. Ecosystem of water bodies get destroyed or extinct due to less water availability.
3. Coral reefs become stressed from increased ocean temperatures as well as increased acidity.
4. Rising temperatures, increased evaporation, and drought may increase the need for energy-intensive methods of providing drinking and irrigation water.
5. High temperature and humidity may augment waterborne pathogens (bacteria, viruses, and parasites such as Cryptosporidium and Giardia), toxins produced by harmful algae and cyano bacteria mix in the water. Toxic chemicals are deposited in the water system which make it unusable.
6. Climate change is projected to increase the frequency and intensity of extreme weather events, such as droughts, and floods. These changes are likely to increase losses to property and crops, and cause costly disruptions to society.

7.4.6 Glossary

Chronically- longer time

Constituent- component

Enormous- abundant

Escalating- increase rapidly Exacerbated- enhance Expel- push

7.4.7 Model questions

A. Very short answer type question **Marks:- 1**

1. Define water.
2. Write two important properties of water.
3. Define water cycle.
4. Which sectors are mainly affected by water scarcity?
5. What is 'Playa lakes'?
6. What is 'Coral bleeching'?
7. Write the name of water borne pathogens.
8. Name a bacteria which can change temperature of water.

9. Write the major cause of 'Coral bleeching'.

B. Short answer type question **Marks:- 3**

1. How is agriculture affected by water scarcity?
2. Why does the coral reef become stressed? Explain **in brief**
3. Explain the role of water resources to produce energy.
4. How human health can be affected by water borne pathogens?
5. Explain water cycle. What is the effect of climate change on water cycle?

C. Answer the following question **Marks:- 5**

1. Explain the effect of climate change on water.
2. How water scarcity creates the problem in different sectors of the environment?

7.4.8 References

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7.5 Impact of Climate Change on Flora and Fauna

7.5.1 Introduction

7.5.2 Objectives

7.5.3 Effect of climate change on flora

- **Effect of CO_2**
- **Effect of temperature**
- **Effects of water**

7.5.4 Direct impacts on plants

- **Changes in distribution**
- **Changes in life cycle**
- **Changes in genetic diversity**

7.5.5 Indirect impacts on plants

7.5.6 Effect on fauna

7.5.7 Effect of climate change on wild life

- **Pollinators**
- **Insects**
- **Birds**
- **Land mammals**
- **Marine life**

7.5.8 Conclusion

7.5.9 Summary

7.5.10 Glossary

7.5.11 Model questions

7.5.12 References

7.5.1 Introduction

Environmental conditions play a key role in defining the function and distribution of plants, in combination with other factors. Changes in long term environmental conditions that can be collectively coined climate change are known to have had enormous impacts on current plant diversity patterns; further impacts are expected in the future.

7.5.2 Objectives

i. To know the impact of climate change on flora and fauna in different regions,
ii. To know the climatic condition for which they become extinct.

7.5.3 The major effects of climate change on flora communities are given below:

Effects of CO_2

CO_2 concentrations have been steadily rising for more than two centuries. Increases in atmospheric CO_2 concentration affect the photosynthetic process, resulting in increase in plant water use efficiency, enhanced photosynthetic capacity and increased growth. Increased CO_2 can also lead to increased ratios in the leaves of plants or in other aspects of leaf chemistry.

Effects of Temperature

Increases in temperature raise the rate of many physiological processes such as photosynthesis in plants, for every 10°C increase in temperature, to an upper limit, depending on the type of plant. Extreme temperatures are harmful. The photosynthetic limit of temperature in most of the crop plant ranges in between 32-35°C. Beyond this range rate of photosynthesis decreases sharply.

Effects of Water

As water supply is critical for plant growth, it plays a key role in determining the distribution of plants. A change in water availability would show a direct correlation to the growth rates and persistence of plant species in that region. Water availability will have a direct impact on the soil moisture in an area. A decrease in soil moisture will have negative impacts on plant's growth, changing the dynamics of the ecosystem

as a whole. Plants rely not only on the total rainfall during the growing season, but also the intensity and magnitude of each rainfall event.

7.5.4 Direct Impacts on Plants

Changes in Distribution

Temperature and rainfall changes modify the characteristics of plants in a particular zone. There is a possibility of extinction of several species and emergence of other species. This led to changes in distribution of plant groups in a particular locality. There is already evidence that plant species are shifting their ranges in altitude and latitude as a response to changing regional climates.

For example- the environmental conditions required by some species, such as those in alpine regions may disappear altogether. The result of these changes is likely to be a rapid increase in extinction risk.

Changes in community composition are therefore also an expected product of climate change.

Changes in Life Cycle-

Changing environments are therefore expected to lead to changes in life cycle events, and these have been recorded for many species of plants. These changes have the potential to lead to the asynchrony between species, or to change in competition between plants.

For example- flowering times in British plants have changed, leading to annual plants flowering earlier than perennials, and insect pollinated plants flowering earlier than wind pollinated plants; with potential ecological consequences.

Changes in Genetic Diversity-

Species richness and species evenness play a key role in how quickly and productively an ecosystem can adapt to change. Genetic diversity is a main contributor of an ecosystem. An absence of genetic mutations and decrease in species richness greatly enhances the possibility of extinction.

Altering the environment puts stress on a plant to increase its phenotypic plasticity, causing species to change faster than predicted.

7.5.5 Indirect Impacts on Plants

Direct impacts may be easier to predict and conceptualize. It is likely that indirect impacts are equally important in determining the response of plants to climate change.

A species whose distribution changes as a direct result of climate change may 'invade' the range of another species or 'be invaded' for example, introducing a new competitive relationship or altering other processes such as carbon sequestration.

- The range of symbiotic fungi associated with plant roots may directly change as a result of altered climate, resulting in a change in the plant's distribution.
- A new grass may spread into a region, altering the fire regime and greatly changing the species composition.
- A pathogen or parasite may change its interactions with a plant, such as a pathogenic fungus becoming more common in an area where rainfall increases.
- Increased temperatures may allow herbivores to expand further into alpine regions, significant impact on the composition of alpine herb fields is observed.

7.5.6 Effect on Fauna

Climate change is also affecting our planet's ecosystems and biodiversity in many ways:

- Changes in climate and weather may force species to migrate into new areas. There is ample evidence already of species' ranges shifting as a result of changing conditions. Those that cannot escape their newly inhospitable surroundings (trees or species confined to mountain-tops and small islands are obvious examples) or adapt are likely to die off.
- Because species depend on each other for survival, individual extinctions and shifting ranges have a much wider knock-on effect, upsetting the delicate balance of our natural world. In a worst-case scenario, we could see food webs and ecosystems collapse completely.
- Changes in climate can threaten native species, as invasive ones (both predators and competitors) expand into their range, and may also create ideal conditions for disease outbreaks.
- Species that are already threatened (e.g. those hunted to the brink of extinction,

or confined to a few remaining pockets of habitat) and those that are highly sensitive to environmental change are particularly vulnerable to the extreme events, invasive species, disease outbreaks and further habitat loss resulting from climate change.

In addition, biodiversity is also exposed to the secondary, human-driven impacts of a changing climate., in the shape of displaced communities and changing behaviour in response to lower crop yields (such as agricultural expansion and increased reliance on wild resources).

7.5.7 Effects of Climate Change on Wildlife

Every species worldwide is affected by climate change. By 2100, an estimated 50% of the entire world's species could go extinct because of climate change.

According to **WWF,** the following wild animals are highly affected by climate change-

- Polar bear
- Snow leopard
- Asian Elephant
- Giant Panda
- Mountain Gorilla
- Tiger
- African Elephant
- Monarch Butterfly
- Green Sea Turtle
- Cheetah

Pollinators

Essential to the overall health of countless plants and ecosystems, pollinators are facing many of the same challenges of birds and other wildlife. In some cases, they are struggling to keep up with the rate of climate change and getting out of sync with earlier blooms of the plants they pollinate. For example-

- **Bumblebees-**

Bumblebees are influenced by climate change in two related ways: Rising

temperatures force populations northward to remain in cool climates and spring flowers bloom earlier than normal, leaving less time for bees to pollinate.

- **Monarch butterfly-**

Monarch butterfly populations in California have fallen by as much as 95% since the 1980s due to habitat loss, increasing use of pesticides and loss of milkweed populations, all related to climate change caused by humans.

Insects

Insects stand to suffer drastically from climate change. At the current rate of warming (2°C), roughly 18% of all insect species would be lost by 2100; if the planet were to warm by 3.2°C, that number would rise to 49%.

Birds

Warming temperatures, shifting seasons, changing precipitation, and rising sea levels are disrupting the behavior of our feathered friends and the ecosystems that support them. For example-

- **Adelie Penguin-**

These birds live in the Antarctic and feed on krill (found under the ice sheets). As the ice melts, krill populations decrease and the penguins have to migrate from **their** natural habitat in an attempt to find alternative food sources. This influences their breeding patterns negatively.

- **Oceanic birds-**Oceanic bird species are directly threatened by rising sea levels due to climate change. Rising waters can submerge their coastal habitats and nests completely.

Land Mammals

Less mobile than birds, land mammals often face more obstacles when adapting to changes in their ecosystems. Lakes keep land mammals from migrating lo suitable climates as they need to.

Additional stressors, like an increasing abundance of ticks, disease, and pests are major risk factors. For example-

- **Cheetahs-**

The African cheetah is the world's fastest animal but is racing against its against near-threatened status in the face of climate change. In some areas, the cheetahs'

prey populations are declining, and as a result, the cheetahs have had to change their diets.

A rise in temperatures has affected this big cat's ability to reproduce. Male cheetahs have shown lowered testosterone levels and a sperm count almost ten times lower than house cat.

- **Giraffes-**

Giraffes have seen their population decline by 40% in the last 30 years. In addition to illegal poaching, two the most pressing dangers are shrinking habitat and fewer acacia trees (their main food source) due to climate change.

- **Giant Panda Beer-**

Climate change is causing a major wipe-out of bamboo in their natural habitat in China. Apart from being the bears' staple diet, bamboo also provides them with shelter from the elements.

- **Asian Elephants**

Asian elephant habitat is negatively impacted by both lower rainfall and higher temperatures. Together, these threats have decreased the reproductive capacity of an already endangered species.

In order to survive, they need to drink a great amount of fresh water daily. Climate changes and global warming makes it more difficult for elephants to get the water they need. Warmer temperatures also create favorable conditions for invasive plants to thrive and outmatch the elephants' regular food sources.

- **Great Apes-**

Great apes of Southeast Asia, perhaps the most endangered ape species, are in jeopardy of extinction due to deforestation caused by climate change with nearly 75% of forest cover at risk of deforestation.

- **Polar Beers-**

Climate change and global warming result in less Arctic sea ice for the bears to hunt seals on. This reduces their access to food sources and threatens their habitat and overall survival.

Marine Life

Marine life faces challenges from warming waters and ocean acidification. Warming waters alter the latitude and depth at which certain species are able to survive, so many species are moving deeper or farther north in the Atlantic to find cold water. More acidic oceans keep crustaceans, coral, and other organisms from developing. Marine species affected by climate change include plankton - which forms the basis of marine food chains - corals, fish, polar bears, walruses., seals, sea lions, penguins, and seabirds. For example-

- **Green Turtle-Green**

turtles are very sensitive to changes in temperatures.

A baby turtle's gender depends on the temperature of the sand where the eggs are laid. The warmer areas produce female turtles. With climate change causing an increase in temperatures, more females than males will hatch.

- **Whales-**

Whales rely on specific ocean temperatures for their migration, feeding, and reproductive habits. As sea temperatures rise, these changes disrupt habits necessary for whale survival.

- **Sharks-**

Sharks have difficulty in hunting and a higher embryo mortality rate as ocean temperature and acidity rise worldwide. In the Pacific Ocean, rising temperatures force sharks northward by an average of 30 kilometers annually, disrupting ecosystems that depend on sharks.

- **Coral Reefs-**

Coral reefs are endangered due to rising sea temperatures. In the last three years alone, 72% of the world's coral reefs protected by UNESCO experienced severe heat stress. Sustained heat stress causes coral bleaching, an often deadly occurrence in which coral starves from a loss of nutrition.

7.5.8 Conclusion

In conclusion it can be said that due to global warming the temperature of the earth is increased. In the earth every organisms need a favorable condition to live,

when this condition is not favorable they can not live. According to Darwin, " it is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change." So organism which can bear the climate change they can live till date but who are not able to cope with the change they will extinct.

7.5.9 Summary

Climate changes effect flora and fauna in various ways, such as-

Impact on flora-

- Plant species are shifting their ranges in altitude and latitude as a response to changing regional climates.
- Changing environments are therefore expected to lead to changes in life cycle events, and these have been recorded for many species of plants.
- Since genetic diversity is a main contributor of an ecosystem, an absence of genetic mutations and decrease in species richness greatly enhances the possibility of extinction.
- The range of symbiotic fungi associated with plant roots may directly change as a result of altered climate, resulting in a change in the plant's distribution.
- A new grass may spread into a region, altering the fire regime and greatly changing the species composition.
- A pathogen or parasite may change its interactions with a plant, such as a pathogenic fungus becoming more common in an area where rainfall increases.
- Increased temperatures may allow herbivores to expand further into alpine regions, significant impacting the composition of alpine herb fields.

Impact on fauna

Climate change is also affecting our planet's ecosystems and biodiversity in many ways:

- Changes in climate and weather may force species to migrate to new areas. There is ample evidence already of species' ranges shifting as a result of changing conditions. Those that cannot escape their newly inhospitable surroundings (trees or species confined to mountain-tops and small islands are obvious examples) or adapt are likely to die off.
- Because species depend on each other for survival, individual extinctions and

shifting ranges have a much wider knock-on effect, upsetting the delicate balance of our natural world. In a worst-case scenario, we could see food webs and ecosystems collapse completely.

- Changes in climate can threaten native species, as invasive ones (both predators and competitors) expand into their range, and may also create ideal conditions for disease outbreaks.

7.5.10 Glossary

Abundance- enough

Coined- invent, build

Collapse- fall, decline

Consequences- result

Correlation- interrelation

Drastically- in a drastic manner

Inhospitable- difficult to live

Invade- attack

Magnitude- enormity, hugeness

Outbreaks- appearance

Rely- count on

Staple- main

7.5.11 Model question

A. Very short answer type question **Marks:- 1**

1. List the major effects of climate change.
2. Which process of plants is affected by Co2 concentration?
3. In which condition plant growth depends?
4. Which region of the world became extinct due to the changes in distribution?
5. What is the main contributor of an ecosystem?
6. Who are invasive species?
7. Which animals are highly affected by climate change?

8. How many percentage of insects are lost due to climate change by 2100?
9. Which birds mainly feed on krill?
10. Which land mammal is in near-threatened states?
11. Why giant panda beer is going to be extinct?
12. Name the mostly needed things for the survival of elephants?
13. Which species of apes are most endangered nowadays?
14. Why green turtles are very much sensitive to changes in temperature?
15. Why coral reefs are became endangered?

B. Short answer type question **Marks:- 3**

1. What are the direct impacts of climate change on plants?
2. What are the indirect impacts of climate change on plants?
3. Write the major impacts of climate change on flora in brief.
4. How climate change affects the bio-diversity and ecosystem?
5. How climate change affects pollinators and insects?
6. Write the impact of climate change on different land mammals.
7. Write the impact of climate change on marine life.

C. Answer the following question **Marks:- 5**

1. How climate change affects on flora and fauna?
2. Write the direct and indirect impacts of climate change on flora.
3. Write the effects of climate change on different wild animals.

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7.6 Impact of climate change on Human health and Morbidity

7.6.1 Introduction

Human health has always been influenced by climate and weather. Changes in climate and climate variability, particularly changes in weather extremes, affect the environment that provides us with clean air, food, water, shelter, and security. Climate change, together with other natural and human,made health stressors. threatens human health and well-being in numerous ways.

7.6.2 Objectives

i. To know the impact of climate change on human beings
ii. To know the relationship between the disease development and climate

7.6.3 Global climate change

Over the last 50 years, the global climate is changing as the Earth becomes warmer. Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. Human activities have released sufficient quantities of carbon dioxide and greenhouse gases to affect global climate.

7.6.4 Greenhouse Gases

Gases that trap heat in the atmosphere are called greenhouse gases. Many greenhouse gases occur naturally in the atmosphere, such as carbon dioxide, methane, water vapor, and nitrous oxide, while others are synthetic. Those that are man-made include the chlorofluorocarbons {CFCs), hydro fluorocarbons (HFCs) and per fluorocarbons (PFCs), and sulfur hexafluoride (SFs). Emissions of these gases have risen because of increased use of fossil fuels (such as coal, oil and natural gas).

7.6.5 Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as 'a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

In the last 130 years, the world has warmed by approximately O.S5°C. Each of the last 3 decades has been successively warmer than any preceding decade since 1850.

There are significant impacts of climate change in the form of changing weather pattern, rising sea levels, melting of glaciers, forest fires, changing precipitation patterns and more extreme weather events, such as Kashmir floods (2014), Uttarakhand flash floods (2013), Tsunami (2004) are some vivid examples. Globally an estimated 12.6 million deaths are caused by avoidable environmental risk factors every year.

Vulnerability is the tendency or predisposition to be adversely affected by climate-related health effects, and encompasses three elements: exposure, sensitivity or susceptibility to harm, and the capacity to adapt or to cope with.

The three elements of vulnerability are as follows:

- **Exposure** is contact between a person and one or more biological, psychosocial, chemical, or physical stressors, including stressors affected by climate change.

Contact may occur in a single instance or repeatedly over time, and may occur in one location or over a wider geographic area.

- **Sensitivity** is the degree to which people or communities are affected, either adversely or beneficially, by climate variability or change.
- **Adaptive capacity** is the ability of communities, institutions, or people to adjust to potential hazards, to take advantage of opportunities, or to respond to consequences. A related term, resilience, is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

7.6.6 Climate change can affect human health in a number of ways:

Climate change affects the social and environmental determinants of health - clean air, safe drinking water, sufficient food and secure shelter- for instance, changing the severity and frequency of health problems already existing in that area, creating unanticipated health problems in places where they have not previously occurred, disturbing food-producing ecosystem and increasing the frequency of extreme weather events.

Between 2030 and 2050, climate change is expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.

1. Certain groups have higher susceptibility to climate-sensitive health impacts owing to their age (children and elderly), gender (particularly pregnant women), social marginalization (associated in some areas with indigenous populations, poverty or migration status), or other health conditions like HIV. The socioeconomic costs of health problems caused by climate change are considerable.
2. Many infectious diseases, including water-borne ones, are highly sensitive to climatic conditions. For example- diarrhea.
3. Climate change lengthens the transmission season and expands the geographical range of many diseases like malaria and dengue.
4. Climate change will bring new and emerging health issues, including heat waves and other extreme events. Heat stress can make working conditions unbearable and increase the risk of cardiovascular, respiratory and renal diseases. Additionally, it is estimated that 22.5 million people are displaced annually by climate or weather-related disasters. Climate-induced human mobility has a socioeconomic cost and can affect mental and physical health.

5. Malnutrition and under nutrition were highlighted as a concern for a number of developing countries in Africa, Asia and Latin America, which discussed the impacts of climate change on food security, particularly in relation to floods and drought

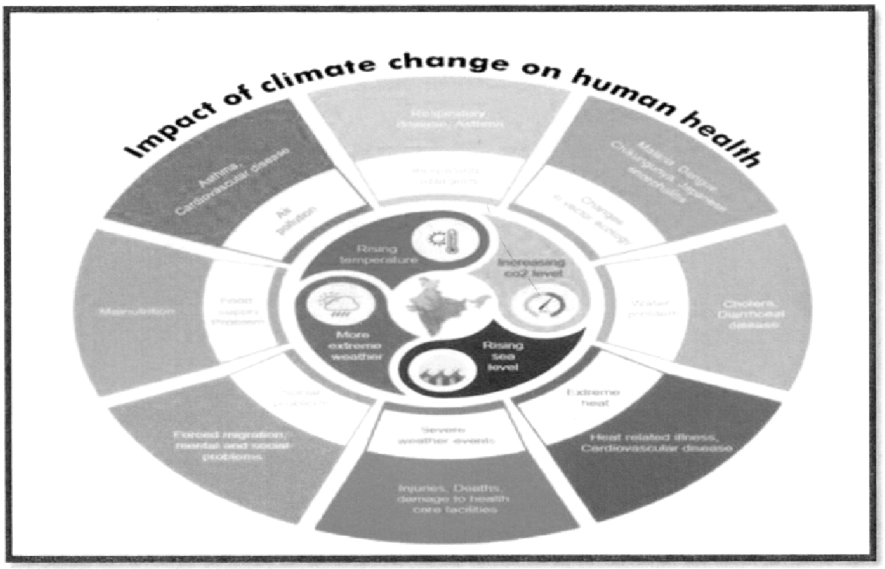

Fig: Impact of Climate Change on Human Health

7.6.7 Climate change and health in India

The effect of climate change on human health in India is a broad topic, covering areas from extreme weather events to shifts in vector-borne diseases.

Floods create numerous health consequences. For example, if floodwaters become contaminated with human or animal waste, the rate of faecal-oral disease transmission might increase, allowing diarrheal disease and other bacterial and viral illnesses to flourish. For example, after flooding in West Bengal in 1988, cholera was thought to be the cause of an outbreak of diarrhea that resulted in 276 deaths. -

Rising sea-surface temperatures are expected to increase tropical cyclone intensity and the height of storm surges. Although cyclones originating in the Bay of Bengal and the Arabian Sea have decreased in frequency since 1970, these have increased in intensity, causing significant damage in India and Bangladesh.

Public health effects of cyclones include diseases and illnesses associated with the loss of clean water, hygiene, and sanitation, loss of shelter and belongings, population displacement, toxic exposures, and hunger and malnutrition risk due to food scarcity.

Watcn borne disease

A warmer climate could cause water-borne diseases to become more frequent, including cholera and diarrhea! diseases such as giardiasis, salmonellosis, and cryptosporidiosis Diarrhoeal diseases are already a major cause of morbidity and mortality in South Asia, particularly among -children. With the rising of ambient temperature, bacterial survival time and proliferation and the incidence of diarrheal diseases might further increase.

Cholera is a well-known water-borne diarrheal disease that has afflicted humankind since ancient times. Outbreaks of cholera have occurred in India. Bangladesh, and more recently, in Latin America and Africa. The discovery of *Vibrio cholerae* in the natural environment, with a dormant state between epidemics, changed the understanding that this disease had only a human reservoir. A relationship has been observed between increase in sea-surface temperature and the onset of cholera epidemics, with the cholera outbreaks following the seasonal rise and fall in sea-surface height and temperature. Increases in cholera bacterial populations associated with plankton blooms in spring and summer have been noted off the coasts of Bangladesh.

Malaria

Malaria is one of the most serious and complex public health problems. About 400-500 million cases of malaria and more than 1 million malaria-related deaths occur globally each year. Several factors of malaria spread are- the emergence of insecticide and drug resistant strain, human population growth and movement, land-use change, and deteriorating public health infrastructure. Changes in temperature, rainfall, humidity, and immunity levels also affect malaria transmission. All these factors can interact to affect adult mosquito densities and the development of the *Plasmodium* parasite within the mosquito. For example, deforestation might elevate local temperatures and changes in housing types might change indoor temperatures where vectors spend most of the time resting. Deforestation, vegetation clearance, and irrigation can form open pools preferred by malaria vectors and thus increase transmission.

Currently, all of India's population is at risk for contracting malaria except for those in the areas above 1700 m above sea surface. More than 973 million persons are exposed to vector-borne malarial parasites in India, and in 1998 an estimated 577,000 disability adjusted life years (DALYs) were lost due to malaria.

Other Vector borne disease or Zoonotic disease-

Climate change might affect other diseases endemic to South Asia. These include mosquito-borne diseases such as chikungunya fever and dengue, parasitic diseases such as leishmaniasis, lymphatic flfariasis and onchocerciasis, and tick-borne diseases, which may exhibit changes in transmission intensity or shifts in their geographical ranges due to the impact of climate on the relevant vector populations. Climatic factors might also influence human plague, a bacterial disease carried by rodents and transmitted by flies. Temperature and rainfall are important determinants of rodent population abundance and distribution. Combined with the influence of temperature and humidity on fly survival and development, changes in any of these climatic components may result in changes in plague incidence. Recent increase in dengue infection in the country is thought to be the result of increase temperature and erratic rainfall.

Effects of Temperature

Climate change including heat waves, cold spells, and other extreme events will bring new and emerging health issues. Heat stress can make working conditions unfavorable and increase the risk of cardiovascular, respiratory and renal diseases and heat related illnesses. With 1.5°C warming, 350 million more people could be exposed to deadly heat stress by 2050

Effects of Air pollution

Extreme heat can trigger asthma and other respiratory diseases. Climate change may affect human health by increasing ground-level ozone and/or particulate matter air pollution. Ground-level ozone (a key component of smog) is associated with many health problems, including diminished lung function, increased hospital admissions and emergency department visits for asthma, and increases in premature deaths.

Fossil fuel combustion (for power, transportation and industry) responsible for climate change is also a major contributor to air pollution, which causes 7 million premature deaths worldwide every year. Black carbon, produced by inefficient combustion in sources such as cooking stoves and diesel engines, is the second greatest contributor to global warming. Over 90% of the urban population of the world breathes air that exceeds WHO's (World Health Organization) guideline levels for outdoor air pollution.

Climate impacts in India will not be uniform. Those of low socio-economic status will likely to be the most affected by the health impacts of climate change, as they have the least adaptive capacity. As India's economy continues to expand, the growing middle class presents a unique situation. While rising out of poverty will improve sanitation levels and living conditions, thus increasing resilience to infectious diseases, it will also lead to higher consumption patterns that can initiate new health problems while leading to more carbon pollution.

7.6.8 Conclusion

In conclusion, it can be said that not only other organisms, human beings also very much affected by climate changes. Various diseases occurred due to climate changes that are mentioned above.

7.6.9 Summary

Human health can be negatively affected by climate change. Low socio-economic status will likely to be the most affected by the health impacts of climate change, as they have the least adaptive capacity.

It is estimated that, between 2030 and 2050,' climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.

1. Certain groups have higher susceptibility to climate-sensitive health impacts owing to their age (children and elderly), gender (particularly pregnant women), social marginalization (associated in some areas with indigenous populations, poverty or migration status), or other health conditions like HIV.
2. Many infectious diseases, including water-borne ones, are highly sensitive to climatic conditions. For example- diarrhea.
3. Climate change lengthens the transmission season and expands the geographical range of many diseases like malaria and dengue.
4. Malnutrition and under nutrition were highlighted as a concern for a number of developing countries in Africa, Asia and Latin America, which discussed the impacts of climate change on food security, particularly in relation to floods and drought.

7.6.10 Glossary

Alter- change Broad- wide

Dormant- which is not expressed

Encompasses- surround, enclose

7.6.11 Model question

A. Very short answer type question **Marks:- 1**

1. What is the full form of 'WHO'?
2. Which disease is mainly caused by Hood?
3. what are the main elements of vulnerability?
4. Write the full form of DALYs.
5. What do you mean by Exposure?
6. What do you mean by Adaptive capacity?
7. How many people are displaced annually by climate or weather-related disasters?
8. Write the full form of CFCs, HFCs and PFCs.
9. Write the full form of UNFCCC.
10. Name a most infectious disease.

B. Short answer type question **Marks:- 3**

1. what is vulnerability? Write about the elements of vulnerability.
2. How climate change can effect human health?
3. Write the problem related with human health?
4. How malaria is increasing day by day?
5. How air pollution is related with human health?

C. Answer the following question **Marks:- 5**

1. Write about the effect of climate changes and different diseases of India.
2. How climate change can affect human health?

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Unit : 8 ◻ GLOBAL INITIATIVES TO CLIMATE CHANGE MITIGATION- KYOTO PROTOCOL, CARBON TRADING, CLEAN DEVELOPMENT MECHANISM

8.1.0 Introduction

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the consensus that (part one)

global warming is occurring and (pail two) it is extremely likely that human-made CO_2 emissions have predominantly caused it. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. There are currently 192 parties (Canada withdrew from the protocol, effective from December 2012) to the Protocol.

8.1.1 Objectives

The Kyoto Protocol implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system"

8.1.2 Principle

The Protocol is based on the principle of common but differentiated responsibilities:

- It acknowledges that individual countries have different capabilities in combating climate change, due to economic development, and
- To reduce current emissions from developed countries on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

8.1.3 Importance

The Kyoto Protocol is significant because, uniike previous negotiations on climate change, which had only suggested that governments voluntarily reduce their emission of greenhouse gases, it contains concrete mandatory aims for the countries which have signed it.

8.1.4 Purpose

- To decrease the dependency on natural resources in developing countries.
- To limit and decrease the world-wide emission of greenhouse gases.
- To encourage the growth of a global economy by creating a single world currency.
- To shed the light on human abuses in different countries by political unrest.
- To study the various indicators of democracy in different countries

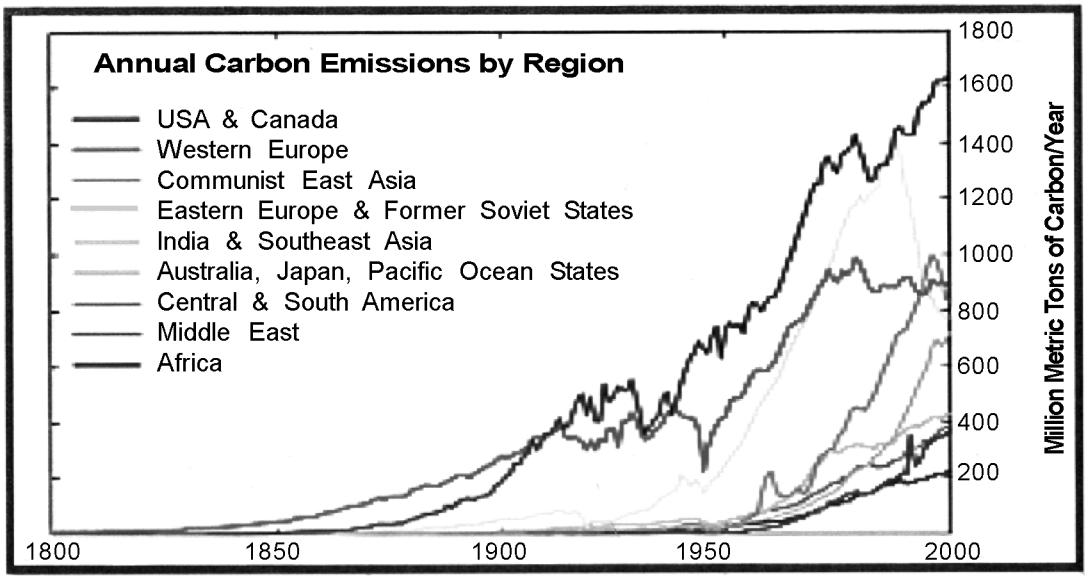

Fig : Annual Carbon emission by different region

8.1.5 Mechanism of Kyoto Protocol

1. Intergovernmental Emissions Trading-

The design of the European Union Emissions Trading Scheme (EU ETS) implicitly allows for trade of national Kyoto obligations to occur between participating countries.

One of the environmental problems with IET is the large surplus of allowances that are available. Russia, Ukraine, and the new EU-12 member states (the Kyoto Parties Annex I Economies-in-Transition, abbreviated "IET": Belarus. Bulgaria, Croatia, Czech Republic, Estonia. Hungary, Latvia, Lithuania, Poland. Romania. Russia. Slovakia, Slovenia, and Ukraine) have a surplus of allowances.

OECD countries with a deficit could meet their Kyoto commitments by buying allowances from transition countries with a surplus.

2. Green Investment Scheme-

A Green Investment Scheme (GIS) refers to a plan for achieving environmental benefits from trading surplus allowances (AAUs) under the Kyoto Protocol.

The Green Investment Scheme (GIS), a mechanism in the framework of International

Emissions Trading (IET), is designed to achieve greater flexibility in reaching the targets of the Kyoto Protocol while preserving environmental integrity of IET.

3. Trade in AAUs-

World Bank (2011) reported that Latvia has stopped offering AAU sales because of low AAU prices. In 2010, Estonia was the preferred source for AAU buyers, followed by the Czech Republic and Poland.

Japan's national policy to meet their Kyoto target includes the purchase of AAUs sold under GISs. In 2010, Japan and Japanese firms were the main buyers of AAUs.In terms of the international carbon market, trade in AAUs are a small proportion of overall market value.

In 2010, 97% of trade in the international carbon market was driven by the European Union Emission Trading Scheme (EU ETS). However, firms regulated under the EU ETS are unable to use AAUs in meeting their emissions caps.

4. Clean Development Mechanism-

Between 2001, which was the first year Clean Development Mechanism (COM) projects could be registered, and 2012, the end of the first Kyoto commitment period, the COM is expected to produce some 1.5 billion tons of carbon dioxide equivalent {COse) in emission reductions. Most of these reductions are through renewable energy commercialization, energy efficiency, and fuel switching (World Bank, 2010, p. 262). By 2012, the largest potential for production of CERs are estimated in China (52% of total CERs) and India (16%). CERs produced in Latin America and the Caribbean make up 15% of the potential total, with Brazil as the largest producer in the region (7%).

5. Joint Implementation

The formal crediting period for Joint Implementation (JI) was aligned with the first commitment period of the Kyoto Protocol, and did not start until January 2008 (Carbon Trust, 2009, p. 20).

In November 2008, only 22 Jl projects had been officially approved and registered. Here it can say that emission savings include cuts in methane, HFC, and N_2O emissions.

8.1.6 Success

The headline results tell us that between 1990 and 2012 the original Kyoto Protocol

parties reduced their COi emissions by 12.5%, which is well beyond the 2012 target of 4.7% (COa only, rather than greenhouse gases, and including Canada). The Kyoto Protocol was therefore a huge success.

8.1.7 Conclusion

In conclusion it can be said thai, The Kyoto Protocol is significant because, it only suggested the governments voluntarily reduce their emission of greenhouse gases, it contains concrete mandatory aims for the countries which have signed it.

8.1.8 Summary

The Kyoto Protocol, also known as the Kyoto. Its an international treaty among industrialized nations that sets mandatory limits on greenhouse gas emissions.

The greenhouse effect is the warming effect of the sun on greenhouse gases, such as carbon-di-oxide, that act to trap this heat in our atmosphere.

Causes

- Greenhouse gas
- Carbon-di-oxide, methane, nitrous oxide
- Hydrofluorocarbons and perfluorocarbons

Effects

- Increase the average global mean temperature.
- Rise in sea levels
- Erratic changes in climate

Kyoto Mechanism

1. International Emissions Trading (IET)

- Under this mechanism an Annex I party may transfer Kyoto units to acquire units from another Annex 1 party.
- A party may acquire an unlimited number of units. .
- Emissions tradings does not affect the total assigned amount of Annex I parties collectively, rather, it re-distributes the assigned amount among them.

- The number of units that a party may transfer to other parties is limited by the party's commitment period reserve (CPR).

2. Joint Implementation

- It is a project-based mechanism by which one Annex I party can invest in a project that reduces emissions or enhances sequestration in another Annex I party, and receive credit for the emission reductions or removals achieved through that project.
- The unit associated with JI is called an emission reduction unit (ERU).
- The total projected emission savings from JI by 2012 are about one-tenth that of the COM.
- Russia accounts for about two-thirds of these savings, with the remainder divided up roughly equally between the Ukraine and the EU's new member states.

3. Clean Development Mechanism

- COM credits may be generated from emission reduction projects or from aforestation and reforestation projects in non-Annex I parties.
- COM projects result in three types of Kyoto units
- Certified emission reduction (CER)
- Temporary CERs
- Details of the agreement
- National emission targets exclude international aviation and shipping
- Land use and forestry can be used in meeting targets.
- Per capita emission.
- Relatively low emission in developing countries.
- Largest share of emissions originated in developed countries.
- Developed countries have to pay billions of dollars and supply technology to other countries for climate related studies. E.g. The Adaptation Fund
- It will also be suspended from making transfers under an emissions trading programme.

Emissions as a percentage of the global total, per capita emissions in tons of GHG per capita

Country	Percentage
China	15
United States	16
European Union	11
Indonesia	6
India	5

8.1.9 Glossary

Combating- in opposition
Effective- workable
Mandatory- compulsory
Negotiations- interlocution
Onset- beginning
Voluntarily- willingly

8.1.10 Model questions

A. Very short answer type question **Marks:- 1**

1. In which year Kyoto Protocol was implemented?
2. When Kyoto Protocol was adopted by Kyoto, Japan?
3. How many parties are there in Kyoto Protocol ?
4. What is the main objectives of Kyoto Protocol ?
5. Write any two principles of Kyoto Protocol ?
6. Why Kyoto Protocol is important?
7. Write the full form of EUETS.
8. Write the full form of CIS using in Kyoto Protocol ?
9. Write the full form of IET.
10. When JI was implemented?

B. Short answer type question **Marks:- 3**

1. Write about the objectives and principles of Kyoto Protocol.
2. What are the Intergovernmental emission trading?
3. Write about the main purpose of Kyoto Protocol.
4. How trade in AAUs is related with Kyoto Protocol ?
5. What do you mean by JI in Kyoto Protocol ?

C. Answer the following question **Marks:- 5**

1. Write about the objectives, principles, importance and success of Kyoto Protocol.
2. What are the mechanisms of Kyoto Protocol?
3. In which purposes the Kyoto Protocol was implemented?

8.1.11 References

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8.2 Carbon Trading

8.2.1 Introduction

Carbon trading is the process of buying and selling permits and credits to emit carbon dioxide. -It has been a central pillar of the EU's efforts to slow climate change. The world's biggest carbon trading system is the European Union Emissions Trading System (EU ETS). It is beset with problems and corruption and yet countries such as Brazil and China continue to pursue carbon trading as a way to tackle rising emissions.

It is widely believed that the release of carbon dioxide is the main contributor to social and environmental problems, particularly global warming. This type of pollution is deemed as a negative externality, which imposes cost on the entire society and not on the certain individuals who are using or consuming polluting products, such as cars. And because certain carbon-intensive industries are creating negative externalities, the social cost of production should be greater than that of the private entities.

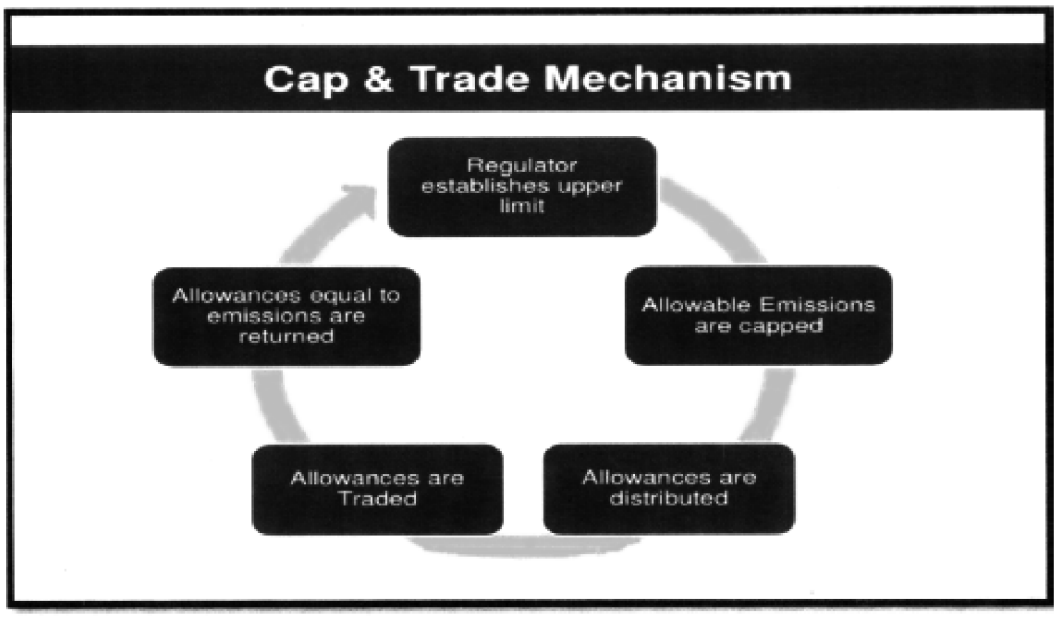


Fig : Cap and Trade Mechanism

8.2.2 Definition

Carbon trading is an approach used to control carbon dioxide (CO_2) pollution by providing economic incentives for achieving emission reductions. It is sometimes called cap and trade or carbon emissions trading.

Carbon trading is administered by a central authority such as a government or international organization which sets a limit or cap on the amount of CO2 that can be emitted.

Carbon trading began in response to the Kyoto Protocol, signed by 180 countries in 1997. The Kyoto Protocol, signed by ISO- countries in 1997, called for 37 industrialized countries to reduce their greenhouse gas emissions between the years 2008 to 2012 to levels that are 5% lower than those of 1990.

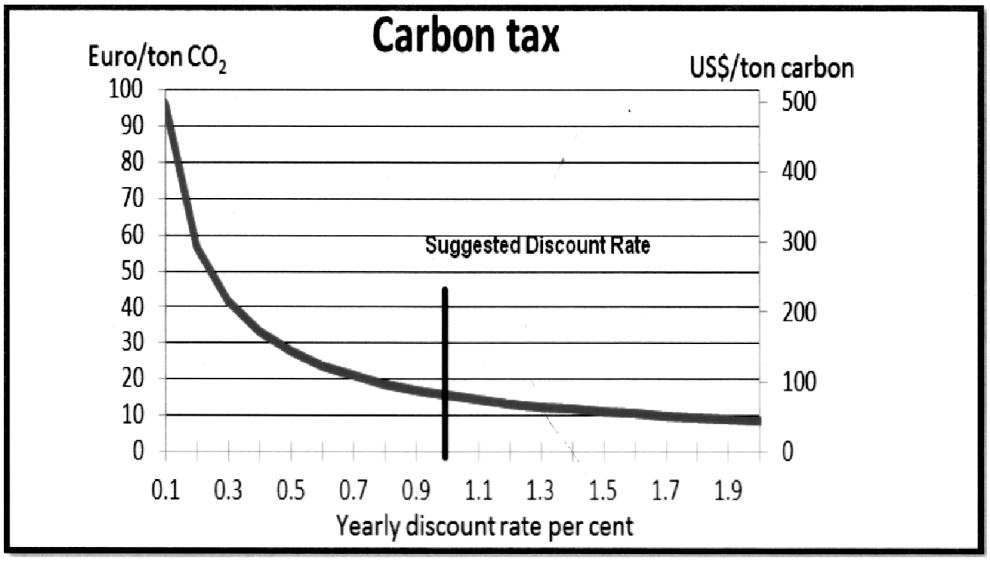
Article 17 of the Kyoto Protocol established emissions trading by allowing countries that have emission units to spare (emissions permitted to them but unused) to sell this excess capacity to countries that are over their emissions limits.

The units which may be transferred under Article 17 emissions trading, each equal to one tonne of CO2-equivalent, may be in the form of:

- An assigned amount unit (AAU) issued by an Annex I Party on the basis of its assigned amount pursuant to Articles 3.7 and 3.8 of the Protocol.
- A removal unit (RMU) issued by an Annex I Party on the basis of land use, land-use change and forestry (LULUCF) activities under Articles 3.3 and 3.4 of the Kyoto Protocol.
- An emission reduction unit (ERU) generated by a joint implementation project under Article 6 of the Kyoto Protocol.
- A certified emission reduction (CER) generated from a clean development mechanism project activity under Article 12 of the Kyoto Protocol.

8.2.3 Carbon Tax

Now, the carbon tax is employed to internalize such an externality, which means that the final price of goods should include the external and not just the private cost.



8.2.4 List of Advantages of Carbon Tax

1. It encourages people to find alternative resources-

- This can even result in more environment-friendly and ingenious ideas across various industries, from logistics to agriculture.
- This would be very helpful by the time the post-oil economy arrives, as it would make transition a lot faster and easier for those who are involved.

- Instead of relying heavily on fossil fuels and nuclear power, electricity would be generated from alternative sources, which are more eco-friendly and less polluting.
- The tax would also encourage people to cycle or walk to work, promoting a healthy lifestyle.

2. It helps with environmental conservation-

- The main objective of the conception of the carbon tax is to make sure those organizations and companies that emit large amounts of carbon dioxide CO_2 will reduce, if not eliminate, their emissions, which minimizes pollution and the impact of global warming.

3. It promotes socially efficient income-

- Both businesses and individuals will be paying the social cost of excess carbon dioxide through the carbon tax. This would prompt them to switch to means of gaining income that are socially efficient.

4. It helps to increase revenue-

- According to a 2011 report by the Congressional Budget Office, "A $20 per ton carbon tax would raise nearly $1.2 triliion over the next decade.[1]"
- This means that there would be plenty of opportunities to produce green energy to address the need for sustainable and less damaging power sources. The same revenue can be spent on repairing any damage caused by natural disasters and pollution.

8.2.5 List of Disadvantages of Carbon Tax

1. It imposes expensive administration costs-

- The carbon tax can be realty expensive, considering that the government would need a substantial amount of money for its implementation.
- It requires money to ensure it would function properly.
- It is difficult to determine the actual external cost and the tax amount that must be imposed, which requires more time, effort and money as well.

2. It causes a shift in production-

- It is highly possible that business establishments will move their operations to a region that has lower or no carbon tax—a place that is also known as "pollution haven"—which will have an impact on the economy

- This would mean that a significant number of workers would lose their jobs, causing unemployment.
- Carbon tax would not exactly stop carbon dioxide production, but would only change where and how it is produced.

3. It carries the risk of cost increases-

- This tax will increase the fossil fuel costs, which will consequently increase expenditures that are involved in the production of goods and delivery of services.
- For developing countries, this can spell bad news as it would be difficult for them to afford the slightest increase in energy costs.

4. It promotes covert operations-

- In this process one can produce carbon dioxide in a secretive way that could cause more environmental damage.
- It is very important to keep in mind that, unethical production of carbon dioxide and tax evasion is a very deadly combination.

8.2.6 Criticism

- Opposition to carbon trading has grown due to the belief that such approaches do little to help climate change and instead provide substantial profits for corporate greenhouse gas polluters.
- Critics point out failures in accounting, dubious science, and the negative impact of the carbon market on local communities.
- In addition, critics contend that carbon trading does not solve the overall pollution problem since net reduction would require fewer allowances rather than permitting groups that pollute less to sell their allowances to the highest bidder.

2.8.7 Conclusion

In conclusion, it can be said that, it is an approach used to control carbon dioxide pollution by providing economic incentives for achieving emissions reductions.

8.2.8 Summary

Carbon trading is an approach used to control carbon dioxide (CO_2) pollution by

providing economic incentives for achieving emissions reductions. It is sometimes called cap and trade or carbon emissions trading.

Carbon trading began in response to the Kyoto Protocol, signed by 180 countries in 1997.

The carbon tax is employed to internalize such an externality, which means that the final price of goods should include the external and not just the private cost.

Advantages

- It encourages people to find alternative resources
- It helps with environmental conservation
- It promotes socially efficient income
- It helps to increase revenue

Disadvantages

It imposes expensive administration costs

It causes a shift in production

It carries the risk of cost increases

It promotes covert operations

8.2.9 Glossary

Covert- undercover

Deemed- suppose

Entities- existence

Externality- externals x

Prompt- quick, rapid

Pursuant- following

Tackle- catch hold of

8.2.10 Model questions

A. Very short answer type question **Marks:- 1**

1. What is carbon trading?

2. What is deemed as a negative externality?
3. How many countries had signed in the 'Carbon trading'?
4. In which year carbon trading was signed?
5. What does the Article 17 said?
6. What do you mean by carbon tax?

B. Short answer type question **Marks:- 3**

1. Explain the Article 17.
2. What do you mean by carbon trading?
3. What are the advantages of carbon tax?
4. What are the disadvantages of carbon tax?
5. Why carbon trading was criticised?

C. Answer the following question **Marks:- 5**

1. Explain carbon trading and Article 17.
2. What is carbon tax?-explain about it.

8.2.11 References

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8.3 Clean Development Mechanism

8.3.1 Introduction

The Clean Development Mechanism (COM) is one of the Flexible Mechanisms defined in the Kyoto Protocol (IPCC, 2007) that provides for emissions reduction projects which generate Certified Emission Reduction units (CERs) which may be traded in trading schemes.

8.3.2 Objectives

i. To help developed countries fulfill their commitments to reduce emissions, and

ii. To assist developing countries in achieving sustainable development.

The COM, defined in Article 12 of the Protocol, was intended to meet two objectives:

- (1) to assist parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), which is to prevent dangerous climate change; and
- (2) to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments (greenhouse gas (GHG) emission caps).

8.3.3 Purpose

The purpose of the CDM is to promote clean development in developing countries, i.e., the "non-Annex I" countries (countries that aren't listed in Annex 1 of the Framework Convention).

The CDM is one of the Protocol's "project-based" mechanisms, in that the CDM is designed to promote projects that reduce emissions. The CDM is based on the idea of emission reduction "production".

The CDM is designed to start developing countries off on a path towards less pollution, with industrialized (Annex B) countries paying for the reductions.

The clean development mechanism was designed to meet a dual objective: to help developed countries fulfill their commitments to reduce emissions, and to assist developing countries in achieving sustainable development.

8.3.4 Methodology

Any proposed CDM project has to use an approved baseline and monitoring methodology to be validated, approved and registered. Monitoring methodology will set specific steps to determine monitoring parameters, quality assurance, and equipment to be used, in order to obtain data to calculate the emission reductions. Those approved methodologies are all coded-

AM - Approved Methodology

ACM - Approved Consolidated Methodology

AMS - Approved Methodology for Small Scale Projects

ARAM - Aforestation and Reforestation Approved Methodologies

Economies

- Improve the cost-effectiveness of GHG mitigation policies in developed countries
- Help to reduce "leakage" (carbon leakage) of emissions from developed to developing countries. Leakage is where mitigation actions in one country or economic sector result in another country's or sector's emissions increasing, e.g., through relocation of polluting industries from Annex I to non-Annex 1 countries.
- Boost transfers of clean, less polluting technologies to developing countries.

8.3.5 The Project Cycle in CDM

Every **COM** project has to go through a cycle before it is registered and CERs are issued to the project. There are seven steps in the project cycle-

1) Project design: the first step is the preparation of a project design document by the project participant detailing the project, the baseline and methodology and other **details** relevant to the project.

2) National Approval: the second step is securing the letter of approval from the Designated National Entity of the host party.

3) Validation: the project is independently evaluated by a designated operating entity on whether it meets the requirements of CDM.

4) Registration: validated projects are submitted to the CDM executive board for formal approval, which is called registration.

5) Monitoring: Measurement of actual emissions is done by the project participant according lo the approved methodology.

6) Verification: Is the independent review of the emission reductions claimed by the project participant by a designated operating entity.

7) CER issuance: Once the verification of the claimed emission reduction is done, the designated operating entity submits the verification report to the CDM board or the issuance of CERs.

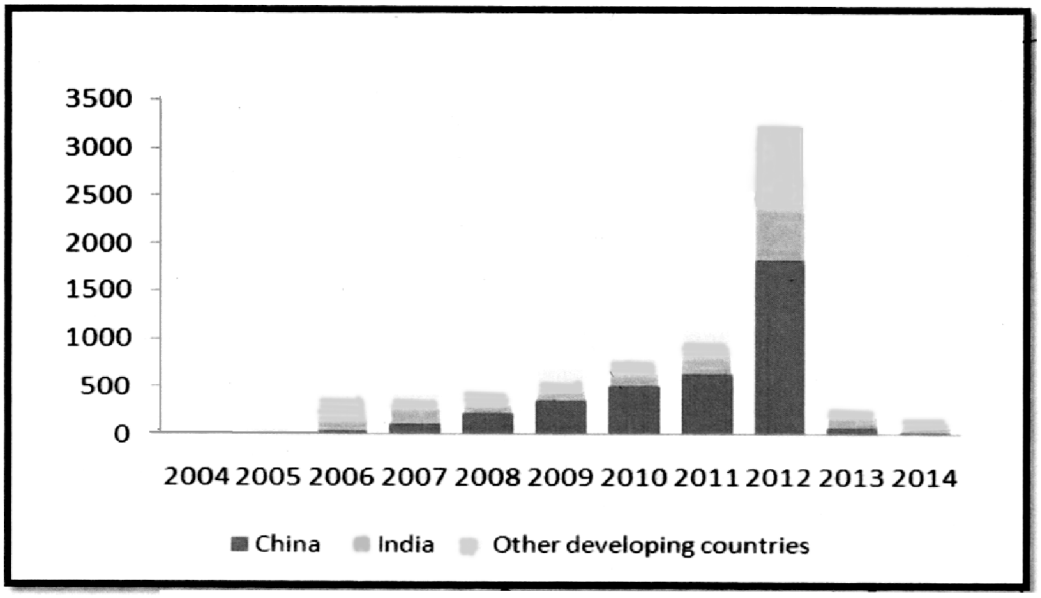

Fig : Number of Projects Registered (by year)

8.3.6 Difficulties with the CDM

Carbon leakage

In theory, leakage may be reduced by crediting mechanisms. The amount of leakage partly depends on the baseline against which credits are granted. The current CDM approach already incorporates some leakage. Thus, reductions in leakage due to the CDM may, in fact be small or even non-existent.

Additionality, transaction costs and bottlenecks

In order to maintain the environmental effectiveness of the Kyoto Protocol, emission savings from the CDM must be additional. Without additionality, the CDM amounts to an income transfer to non-Annex I countries. Additionality is however, difficult to prove, the subject of vigorous debate.

According to the World Bank (2010), there are significant constraints to the continued growth of the CDM to support mitigation in developing countries.

Incentives

The CDM rewards emissions reductions, but does not penalize emission increases. It therefore comes close to being an emissions reduction subsidy. This can create a

perverse incentive for firms to raise their emissions in the short-term, with the aim of getting credits for reducing emissions in the long-term.

Local resistance

While the C in COM stands for Clean, most projects might be better defined with the B from Big, from large hydropower to HFC or waste to energy and clean coal projects (which all together make the majority of credits generated through COM). The argument in favor of the COM is that it brings development to the South. However, in all continents the mainly Big Development it stands for is resisted by local people in those countries.

8.3.7 Benefits

The CDM offers opportunities for sustainable development but also brings important co-benefits, such as

- Poverty reduction,
- Access to energy efficient lighting and cooking,
- Improvement of air quality and living conditions,
- Reduction of costs and
- Generate jobs and skills.

8.3.8 Conclusion

In conclusion it can be said that it provides for emissions reduction projects which generate Certified Emission Reduction units (CERs).

8.3.9 Summary

- It allows country with emission-reduction commitment to implement an emission reduction project in developing countries.
- Such projects can earn saleable certified emission reduction (CER) credits.
- Each CER is equivalent to one ton of carbon-di-oxide which can then be counted towards meeting Kyoto targets.

8.3.10 Glossary

Dual- double

Entity- presence Relevant- topical Subsidy- co-operator

8.3.11 Model questions

A. Very short answer type question **Marks:- 1**

1. Why the CDM project was intended?
2. Which countries are called 'non-Annex 1'?
3. Name the full form of ARAM.
4. What do you mean by leakage in this CDM project context?
5. How many project cycle are there in CDM?

B. Short answer type question **Marks:- 3**

1. What are the main Purposes Of CDM?
2. Describe in brief about the project cycle of CDM.
3. Write the benefits of CDM.
4. Which methodology was adopted by CDM?

C. Answer the following question **Marks:- 5**

1. Write the objectives and purposes of CDM.
2. Write about the project cycle of CDM.
3. What are the major difficulties of CDM?

8.3.12 References

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8.4 COP (Conference of Parties)

8.4.1 Introduction

8.4.2 Objectives

8.4.3 The brief summary of COP

- **COP 1**
- **COP 2**
- **COP 3**
- **COP 4**
- **COP 5**
- **COP 6**
- **COP 7**
- **COP 8**
- **COP 9**
- **COP 10**
- **COP 11**
- **COP 12**
- **COP 13**
- **COP 14**
- **COP 15**
- **COP 16**
- **COP 17**
- **COP 18**
- **COP 19**
- **COP 20**
- **COP 21**
- **COP 22**
- **COP 23**
- **COP 24**
- **COP 25**
- **COP 26**

8.4.4 Conclusion

8.4.5 Glossary

8.4.6 Model questions

8.4.7 References

8.4.1 Introduction

The United Nations Climate Change Conferences are yearly conferences held in the framework of the United Nations Framework Convention on Climate Change (UNFCCC). They serve as the formal meeting of the UNFCCC Parties (Conference of the Parties, COP) to assess progress in dealing with climate change, and beginning in the mid-1990s, to negotiate the Kyoto Protocol to establish legally binding obligations for developed countries to reduce their greenhouse gas emissions.

8.4.2 Objectives

i. To assess progress in dealing with climate change, beginning in the mid-1990s,

ii. To negotiate the Kyoto Protocol to establish legally binding obligations for developed countries to reduce their greenhouse gas emissions.

8.4.3 The Brief Summary of the work of UNFCCC

COP 1

The first UNFCCC Conference of the Parties took place from 28 March to 7 April 1995 in Berlin, Germany.

It concerns about the adequacy of countries' abilities to meet commitments under the Body for Scientific and Technological Advice (BSTA) and the Subsidiary Body for Implementation (SBI). It works on climate change action.

COP 2

COP 2 took place in July 1996 in Geneva, Switzerland on 18 July 1996. The following points were taken in this meeting:-

1. Accepted the scientific findings on climate change proffered by the Intergovernmental Panel on Climate Change (IPCC) in its second assessment (1995).

2. Rejected uniform "harmonized policies" in favor of flexibility.

3. Called for "legally binding mid-term targets".

COP 3

COP 3 took place in December 1997 in Kyoto, Japan. After intensive negotiations,

1. It adopted the Kyoto Protocol, which outlined the greenhouse gas emissions reduction obligation for Annex I countries.

2. Emissions trading, clean development mechanism and joint implementation was taken in this meeting.

COP 4

COP 4 took place in November 1998 in Buenos Aires, Argentina.

1. The remaining issues unresolved in Kyoto would be finalized at this meeting.

2. The parties adopted a 2-year "Plan of Action" to advance efforts and to devise mechanisms for implementing the Kyoto Protocol, to be completed by 2000.

3. During COP4, Argentina and Kazakhstan expressed their commitment to take on the greenhouse gas emissions reduction obligation.

Cop 5

COP 5 took place between 25 October and 5 November 1999, in Bonn, Germany. It was primarily a technical meeting, and did not reach major conclusions.

COP 6

COP 6 took place on 13-25 November 2000, in The Hague, Netherlands.

These included major controversy over the United States' proposal to allow credit for carbon "sinks" in forests and agricultural lands 'that would satisfy a major proportion of the U.S. emissions reductions in this way;

Cop 6

COP 6 negotiations resumed on 17—27 July 2001, in Bonn, Germany. The agreements included:

1. **Flexible mechanisms:** The "flexibility mechanisms" which the United States had strongly favored when the Protocol was initially put together, including emissions trading, joint implementation (JI), and the Clean Development Mechanism (COM) which allows industrialized countries to fund emissions reduction activities in developing countries as an alternative to domestic emission reductions. One of the key elements of this agreement was that there would be no quantitative limit on the credit a country could claim from use of these mechanisms provided domestic action constituted a significant element of the efforts of each Annex B country to meet their targets.

2. **Carbon sinks:** It was agreed that credit would be granted for broad activities that absorb carbon from the atmosphere or store it, including forest and cropland management, and re-vegetal ion, with no over-all cap on the amount of credit that a country could claim for sinks activities.
3. **Compliance:** Final action on compliance procedures and mechanisms that would address non-compliance with Protocol provisions was deferred to COP 7, but included broad outlines of consequences for failing to meet emissions targets that would include a requirement to "make up" shortfalls at 1.3 tons to 1, suspension of the right to sell credits for surplus emissions reductions, and a required compliance action plan for those not meeting their targets.
4. **Financing:** There was agreement on the establishment of three new funds to provide assistance for needs associated with climate change:

   (1) a fund for climate change that supports a series of climate measures;

   (2) a least-developed-country fund to support National Adaptation Programs of Action; and

   (3) a Kyoto Protocol adaptation fund supported by a CDM levy and voluntary contributions.

A number of operational details attendant upon these decisions remained to be negotiated and agreed upon, and these were the major issues considered by the COP 7 meeting that followed.

COP 7

COP 7 meeting was held in Marrakech, Morocco from 29 October to 10 November 2001.

The main decisions at COP 7 included:

- Operational rules for international emissions trading among parties to the Protocol and for the CDM and joint implementation;
- A compliance regime that outlined consequences for failure to meet emissions targets but deferred to the parties to the Protocol, once it came into force, the decision on whether those consequences would be legally binding;
- Accounting procedures for the flexibility mechanisms;
- A decision to consider at COP 8 how to achieve a review of the adequacy of commitments that might lead to discussions on future commitments by developing countries.

Cop 8

Taking place from 23 October to 1 November 2002, in New Delhi COP 8 adopted the Delhi Ministerial Declaration that- called for efforts by developed countries to transfer technology and minimize the impact of climate change on developing countries.

COP 9

COP 9 took place on 1-12 December 2003 in Milan, Italy. The parties agreed to use the Adaptation Fund established at COP 7 in 2001 primarily in supporting developing countries better adapt to climate change.

COP 10

COP 10 took place on 6-17 December 2004 in Buenos Aires, Argentina.

1. COP10 discussed future challenges, with special emphasis on climate change mitigation and adaptation.

2. To promote developing countries better adapt to climate change, the Buenos Aires Plan of Action was adopted.

COP 11

COP 11/CMP 1 took place between 28 November and 9 December 2005, in Montreal, Quebec. Canada.

- It was the first Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP I) since their initial meeting in Kyoto in 1997.
- It was one of the largest intergovernmental conferences on climate change ever. The event marked the entry into force of the Kyoto Protocol.
- The Montreal Action Plan was an agreement to "extend the life of the Kyoto Protocol beyond its 2012 expiration date and negotiate deeper cuts in greenhouse-gas emissions".

Cop 12

COP 12/CMP 2 took place on 6-17 November 2006 in Nairobi. Kenya.

COP12, including in the areas of support for developing countries and clean development mechanism.

1. The parties adopted a five-year plan of work to support climate change adaptation by developing countries and

2. They agreed on the procedures and modalities for the Adaptation Fund.

3. They also agreed to improve the projects for clean development mechanism.

COP 13

COP 13/CMP 3 took place on 3-17 December 2007, at Nusa Dua, in Bali, Indonesia.

They adopt the Bali Action Plan.

COP 14

COP 14/CMP 4 took place on 1-12 December 2008 in Poznan, Poland.

1. Delegates agreed on principles for the financing of a fund to help the poorest nations cope with the effects of climate change.

2. They approved a mechanism to incorporate forest protection into the efforts of the international community to combat climate change.

3. Negotiations on a successor to the Kyoto Protocol were the primary focus of the conference.

COP 15

COP 15 took place in Copenhagen, Denmark, on 7-18 December 2009.

I. The overall goal for the COP 15/CMP 5 United Nations Climate Change Conference in Denmark was to establish an ambitious global climate agreement for the period from 2012 when the first commitment period under the Kyoto Protocol expires.

2. Kyoto agreement was undertaken up to the COPI5.

The conference did not achieve a binding agreement for long-term action.

The negotiations on extending the Kyoto Protocol had unresolved issues as did the negotiations on a framework for long-term cooperative action.

COP 16

COP 16 was held in Cancun, Mexico from 28 November to 10 December 2010.

1. The outcome of the summit was an agreement adopted by the states' panics that called for the US$100 billion per annum "Green Climate Fund" and a "Climate Technology Centre" and network.

2. It recognizes the IPCC Fourth Assessment Report goal of a maximum 2°C global warming and all parties should take urgent action to meet this goal.

3. It also agreed upon greenhouse gas emissions should peak as soon as possible,

4. Since social and economic development and poverty eradication are the first and overriding priorities of developing countries.

COP 17

The 2011 COP 17 was held in Durban, South Africa, from 28 November to 9 December 2011.

The conference agreed to a start negotiation on a legally binding deal comprising all countries, to be adopted in 2015, governing the period post 2020.

There was also progress regarding the creation of a Green Climate Fund (GCF) for which a management framework was adopted.

COP 18

Qatar hosted COP 18 which took place in Doha, Qatar, from 26 November to 7 December 2012.

The Conference produced a package of documents collectively titled The Doha Climate Gateway. The documents collectively contained:

1. The Doha Amendment to the Kyoto Protocol (to be accepted before entering into force) featuring a second commitment period running from 2012 until 2020 limited in scope to 15% of the global carbon dioxide emissions due to the lack of commitments of Japan, Russia, Belarus, Ukraine, New Zealand (nor the United States and Canada, who are not parties to the Protocol in that period) and due to the fact that developing countries like China (the world's largest emitter), India and Brazil are not subject to emissions reductions under the Kyoto Protocol.
2. Language on loss and damage, formalized for the first time in the conference documents.
3. The conference made little progress towards the funding of the Green Climate Fund.

COP 19

COP 19 was the 19th yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on -Climate Change (LJNFCCC) and

the 9th session of the Meeting of the Parties (CMP) to the 1997 Kyoto Protocol (the protocol having been developed under the UNFCCC's charter). The conference was held in Warsaw, Poland from 11 to 23 November 2013.

COP 20

On 1-12 December 2014, Lima, Peru hosted the 20th yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change(UNFCCC) and the I Oth session of the Meeting of the Parties (CMP) to the 1997 Kyoto Protocol (the protocol having been developed under the UNFCCC's charter). The pre COP conference was held in Venezuela.

COP 21

The COP 21 was held in Paris from 30 November to 12 December 2015.

Negotiations resulted in the adoption of the Paris Agreement on 12 December, governing climate change reduction measures from 2020. The adoption of this agreement ended the work of the Durban platform, established during COP17.

The agreement will enter into force (and thus become fully effective) on 4 November 2016. On 4 October 2016 the threshold for adoption was reached with over 55 countries representing at least 55% of the world's greenhouse gas emissions ratifying the Agreement.

COP 22

COP 22 was held in Marrakech, in the North-African country of Morocco, on 7-18 November 2016.

A focal issue of COP 22 is that of water scarcity, water cleanliness, and water-related sustainability, a major problem in the developing world, including many African states.

COP 23

COP 23 was held on 6-17 November 2017.

Fijian Prime Minister and incoming President of COP 23, Frank Bainimarama, on 13 April launched the logo for this year's United Nations Climate Change Conference, to be held at UN Campus, Bonn in November.

COP 24

COP 24 was held on 3-14 December 2018 in Katowice, Poland.

The Polish government of COP 24 will provide an opportunity for convincing other countries that Poland does not hamper the process of tackling dangerous climate change and that Poland is one of the leaders of this process.

COP 25

The 25th session of the Conference of the Parties (COP 25) to the UNFCCC was planned to take place from 11 to 22 November 2019 in Brazil.

COP 26

COP 26 is expected to take place from 9 to 19 November 2020, most likely in the UK, with preliminary talks to take place in Italy.

8.4.4 Conclusion

In conclusion it can be said that, the UNFCCC works on climate change. Its main goal is to stabilize greenhouse gas in the atmosphere at a level that will prevent dangerous human interference with the climate system.

8.4.5 Glossary

Claim- demand Compliance- willingness Levy- tax

Negotiate- organize Proffered- to give something Harmonize- unite

8.4.6 Model questions

A. Very short answer type question **Marks:- 1**

1. Write the objectives of COP.
2. When was the COP I was took place?
3. Where was COP 4 held?
4. How many agreements were there in COP 6?
5. Write the expected time of COP 26.

B. Short answer type question **Marks:- 3**

1. write the agreements of COP 6.

2. Write the COP 16 report.
3. Why COP 18 was important?
4. Write COP 12 report
5. Write the report of COP 7.

C. Answer the following question **Marks:- 5**

1. Why COP was important?
2. Write in brief the major important report of COP.

8.4.7 References

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8.5 Climate Fund

8.5.1 Introduction

The Green Climate Fund (GCF) is a fund established within the framework of the UNFCCC as an operating entity of the Financial Mechanism to assist developing countries in adaptation and mitigation practices to counter climate change. The GCF is based in Inchon, South Korea. It is governed by a Board of 24 members and supported by a Secretariat.

8.5.2 Objective

i. To mitigate climate change.
ii. To adapt with climate change.

8.5.3 Projects

The Green Climate Fund's vision is to support a shift to low-emission and climate-resilient development. The Fund identified eight impact areas which will deliver major mitigation and adaptation benefits.

Shifting to low-emission Sustainable Development pathways through-

1. Low-emission energy access and power generation.
2. Low-emission transport
3. Energy efficient buildings, cities and industries.
4. Sustainable land use and forest management.

Increasing Climate-resilient Sustainable Development for-

5. Enhanced livelihoods of the most vulnerable people, communities, and regions.
6. Increased health and well-being, and food and water security.
7. Resilient infrastructure and built environment to climate change threats.
8. Resilient ecosystem.

8.5.4 Issues

The process of designing the GCF has raised several issues, that are given below-

i. These include ongoing questions on how funds will be raised,
ii. The role of the private sectors.
iii. The level of "country ownership" of resources, and
iv. The transparency of the Board itself.
v. The Fund is also pledged to offer "balanced" support to adaptation and mitigation,
vi. It also drew praise for involving local communities in the formulation of an adaptation project, and
vii. To incorporate consumer protection into a plan for off-grid solar energy.

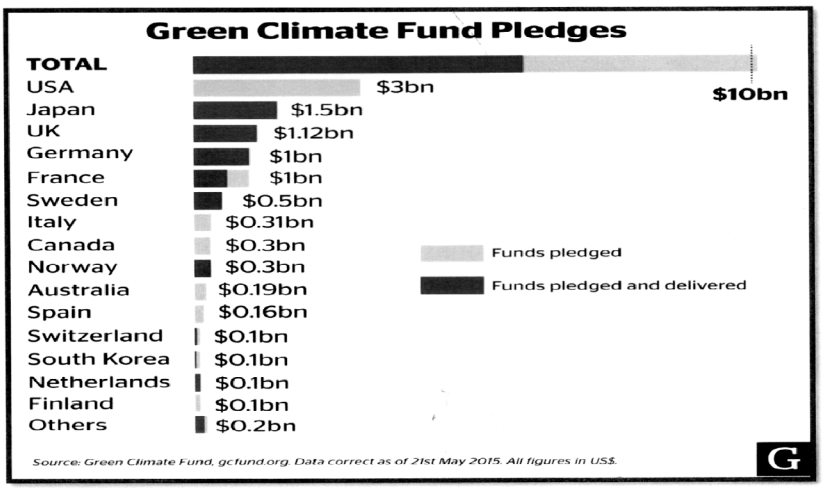

Fig : Green climate fund Pledges

8.5.5 Innovation

- To use public investment to stimulate private finance
- Climate-friendly investment for low emission
- Climate resilient development

8.5.6 Conclusion

In conclusion it can be said that it plays an important role in serving the agreement and supporting the goal of keeping climate challenge.

8.5.7 Summary

- The Green Climate Fund was given an important role in serving the agreement and supporting the goal of keeping climate challenge below 2 degrees Celsius.
- **GCF's** activities are aligned with the priorities of developing countries through the principle of country ownership, and the fund has established a direct modality so that national and sub-national organizations can receive funding directly, rather than only via international intermediaries.
- The fund pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, in particular Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States.
- GCF aims to analyze a flow of climate finance to invest in low emission and climate resilient development, driving a paradigm shift in the global response to climate change.

8.5.8 Glossary

Aligned-giving support to person or organization etc.

Assist- help, support

Entity- existence, presence

Resilient- elastic, lively

Stimulate- awake, excite

8.5.9 Model questions

A. Very short answer type question **Marks:- 1**

1. What is the full form of 'GCF'?
2. Why the 'GCF' has established?
3. What is the vision of 'GCF'? -
4. What is the main role of 'GCF' in the agreement?
5. What are the aims of 'GCF'?

B. Short answer type question **Marks:- 3**

1. Write about the projects of 'GCF'.
2. What are the issues of 'GCF'?
3. Write a summary on 'GCF'.
4. What are the innovation of 'GCF'?

C. Answer the following question **Marks:- 5**

1. Write about the work of 'GCF'.

8.5.10 References

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Unit : 9 ◻ NATIONAL ACTION PLAN (OF INDIA) ON CLIMATE CHANGE

9.1 Introduction

The National Action Plan on Climate Change (NAPCC) is a policy document prepared by the Prime Minister's Council on Climate Change. It has been prepared keeping in mind that India's economic requirements to tap its natural resources are to be tempered with the need to maintain ecological balance.

9.2 Objectives

i. To maintain ecological balance.

ii. To increase India's economic condition.

iii To develop the country by implementing improved technology.

iv. To protect the society.

9.3 Principles

The NAPCC is guided by the principles of

- **Protection-** of the poor and vulnerable sections of society through what is termed as an inclusive development strategy,
- **Achieving national growth-** through a qualitative change and economic direction that enhances ecological sustainability,
- **Demand side management**
- **Better technology-** that looks into aspects of mitigation or adaptation,
- **Market mechanism-** that rewards sustainable development,
- **Inclusivity-** that invites linkups with civil society and local government institutions

9.4 India's National Plan on Climate Change-

- The National Action Plan hinges on the development and use of new technologies.
- The implementation of the Plan includes public private partnerships and civil society action.

- The focus will be on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.
- There are Eight National Missions which form the core of the National Action Plan.

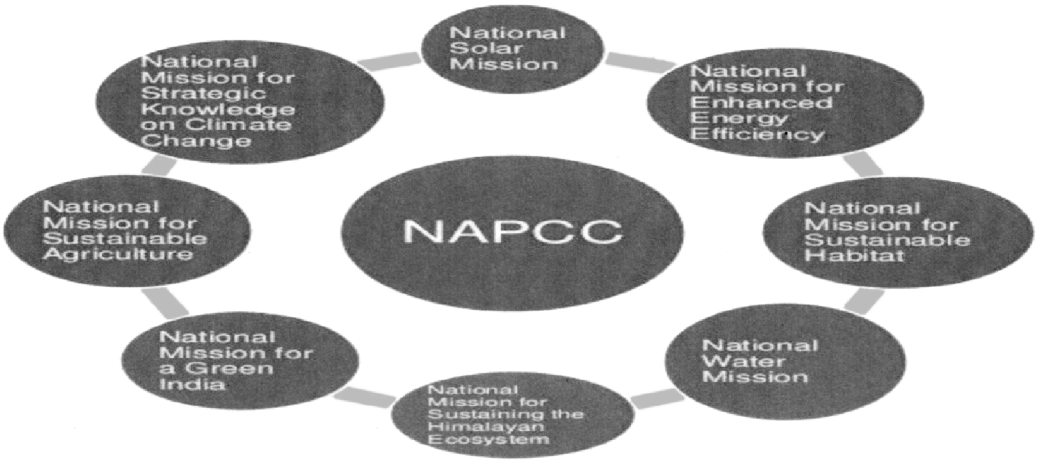

Fig : Different Missions of NAPCC

The Government of India launched National Action Plan on Climate Change (NAPCC) on 30th June, 2008 outlining eight National Missions on climate change to mitigate the problem.

1. National Solar Mission
2. National Mission On Sustainable Habitat
3. National Water Mission (NWM)
4. National Mission For Sustaining The Himalayan Ecosystem (NMSHE)
5. National Mission For A Green India
6. National Mission For Sustainable Agriculture (NMSA)
7. National Mission on Strategic Knowledge for Climate Change (NMSKCC)
8. National Bio-Energy Mission -

1. National Solar Mission

- The National Solar Mission is a major initiative to promote

ecologically sustainable growth while addressing India's energy security challenge.

- The Mission will adopt a 3-phase approach:

1. spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1,
2. the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and
3. the 13th Plan (2017-22) as Phase 3.

- At the end of each plan there will be an evaluation of progress.

Objectives

- To establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.
- To create an enabling policy framework for the deployment of 100,000 MW of solar power by 2022.
- To create favorable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.

National Mission for Enhanced Energy Efficiency (NMEFF)

- NMEEE seeks to strengthen the market for energy efficiency by creating conducive regulatory and policy regime.
- NMEEE has envisaged to foster innovative and sustainable business models to the energy efficiency sector.
- The NMEEE seeks to create and sustain markets for energy efficiency in the entire country which will benefit the country and the consumers".

2. National Mission on Sustainable Habitat-

- 'National Mission on Sustainable Habitat" seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste, modal shift towards public transport and conservation through appropriate changes in legal and regulatory framework.
- It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events.

3. National Water Mission (NWM)-

- Ensuring integrated water resource management for conservation of water, minimization of wastage and equitable distribution both across and within states.
- Developing a framework for optimum water use through increase in water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing, taking the National Water Policy (NWP) into consideration.
- Ensuring that a considerable share of water needs of urban areas is met through recycling of waste water.
- Meeting water requirements of coastal cities through the adoption of new and appropriate technologies such as low-temperature desalination technologies allowing use of ocean water.
- Revisiting NWP to ensure basin-level management strategies to deal with variability in rainfall and river flows due to climate change.
- Developing new regulatory structures to optimize efficiency of existing irrigation systems.

4. National Mission for Sustaining the Himalayan Ecosystem (NMSHE)-

- Develop a sustainable National capacity to continuously assess the health status of the Himalayan Ecosystem
- Assist Stales in the Indian Himalayan Region with their implementation of actions selected for sustainable development.

5. National Mission for a Green India-

- Increased forest/tree cover on 5 million hectares (ha) of forest/non-forest lands and improved quality of forest cover on another 5 million ha of non-forest/forest lands (a total of 10 million ha)
- Improved ecosystem services including biodiversity, hydrological services, and carbon sequestration from the 10 million ha of forest/non-forest lands mentioned above
- Increased forest-based livelihood income of about 3 million households, living in and around the forests
- Enhanced annual COi sequestration by 50 to 60 million tons in the year 2020.

National Mission on Seabuckthron-

- Seabuckthron plant is popularly known as Leh berries.
- The MoEF and DRDO have launched a major national initiative for sea buckthorn cultivation in the high-altitude, cold desert ecosystems.
- The initiative is one of many conservation measures for fragile high-altitude ecosystems.
- Seabuckthron also called the "Wonder plant" and "Ladakh gold".

Uses-

- It has multi-purpose medicinal and nutritional properties, and also helps in soil conservation and nitrogen fixation.
- Hardy, drought-resistant and tolerant to extreme temperatures from - 43° C to + 40° C, the plant has an extensive root system which can fix atmospheric nitrogen, making it ideal for controlling soil erosion and preventing desertification.
- The initiative is a part of Sub-Mission on Cold Desert Ecosystems under the Green India Mission — which is a part of the National Action Plan on Climate Change.

Importance-

- It helps in controlling soil erosion and in preventing desertification.
- It is a rich source of biodiesel.
- It has nutritional value and is well-adapted to live in cold areas of high altitudes.
- Its timber is of great commercial value.

6. National Mission for Sustainable Agriculture (NMSA)-

This mission supports the climatic adaptation in farming through the advancement of climate-resilient crops, the extension of climate insurance mechanisms, and other farming techniques.

The NMSA has identified key dimensions for

- Adaptation and mitigation
- improved Crop Seeds, Livestock and Fish Culture

- Water Efficiency
- Pest Management
- Improved Farm Practices
- Nutrient Management
- Agricultural Insurance
- Credit Support
- Markets
- Access to Information
- Livelihood Diversification

7. National Mission on Strategic Knowledge for Climate Change (NMSKCC)-

- Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science.
- Establishment of global technology watch groups with institutional capacities to carry out research on risk minimized technology selection for developmental choices
- Development of national capacity for modeling the regional impact of climate change on different ecological zones within the country for different seasons and living standards
- Establishing research networks and encouraging research in the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural ecosystems, biodiversity, coastal zones, etc.

8. National Bio-Energy Mission-

- The government is preparing a national bio-energy mission to boost power generation from biomass, a renewable energy source abundantly available in India.
- The national mission will aim at improving energy efficiency in traditional biomass consuming industries, seek to develop a bio-energy city project and provide logistics support to biomass processing units.
- It will also propose a GIS-based National Biomass Resource Atlas to map potential biomass regions in the country.

- According to estimates, biomass from agro and agro-industrial residue can potentially generate 25,000 M\V of power in India.

Focus-

It also focuses on the following themes:

- Research in key areas of climate science like monsoon dynamics, aerosol science etc,
- Global and regional climate modeling,
- Observational networks.
- Creation of research infrastructure

9.5 Other Initiatives

The NAPCC also describes other ongoing initiatives that are as follows

1. **Power generation:** The government is mandating the retirement of inefficient coal-fired power plants and supporting the research and development of Integrated Gasification Combined Cycle IGCC and supercritical technologies.
2. **Renewable energy:** Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources.
3. **Energy efficiency:** Under the Energy Conservation Act 2001, large energy-consuming industries are required to undertake energy audits and an energy-labeling program for appliances has been introduced.
4. **Proposals for health sector:** The proposed program comprises two main components, namely provision of enhanced public health care services and assessment of increased burden of diseases due to climate change.
5. **Implementation:** Ministries with lead responsibility for each of the missions are directed to develop objectives, implementation strategies, timelines, and monitoring and evaluation criteria to be submitted to the Prime Minister's Council on Climate Change. The Council will also be responsible for periodically reviewing and reporting on each mission's progress. To be able to quantify progress, appropriate indicators and methodologies will be developed to assess both avoided emissions and adaptation benefits.

9.6 Conclusion

The NAPCC focuses largely on mitigation, and leaves very little space for adaptation to changes that are already taking place, and affecting small farmers, traditional fisher folk, and forest-based communities. Its economic focus belies the basis in equity and 'inclusive and sustainable development strategy, sensitive to climate change' that is amongst the first statements of principles of the Plan.

Finally, the NAPCC, is not a Plan; it is a Public Relations document, meant to placate the West and is a wish list of possibilities.

9.7 Summary

The action plan outlines a number of steps to simultaneously advance India's development and climate change-related objectives. The National Action Plan on Climate Change (NAPCC) encompasses a range of measures. It focuses on eight missions, which are as follows-

1. **National Solar Mission:** The NAPCC aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil-based energy options, it also includes the establishment of a solar research center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.
2. **National Mission for Enhanced Energy Efficiency:** The NAPCC recommends mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-saving certificates, financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings, and agricultural sectors, and energy incentives, including reduced taxes on energy-efficient appliances.
3. **National Mission on Sustainable Habitat:** The NAPCC also aims at promoting energy efficiency as a core component of urban planning by extending the existing. Energy Conservation Building Code, strengthening the enforcement of automotive fuel economy standards, and using pricing measures to encourage the purchase of efficient vehicles and incentives for

the use of public transportation. The NAPCC also emphasizes on waste management and recycling.

4. **National Water Mission:** The NAPCC sets a goal of a 20% improvement in water use efficiency through pricing and other measures to deal with water scarcity as a result of climate change.
5. **National Mission for Sustaining the Himalayan Ecosystem:** This particular mission sets the goal to prevent melting of the Himalayan glaciers and to protect biodiversity in the Himalayan region.
6. **Green India Mission:** The NAPCC also aims at afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 to 33% of India's territory.
7. **National Mission for Sustainable Agriculture:** The NAPCC aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.
8. **National Mission on Strategic Knowledge for Climate Change:** To gain a better understanding of climate science, impacts, and challenges, the plan envisions a new Climate Science Research Fund, improved climate modeling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

9.8 Glossary

Assess- evaluate

Boost- aid, favour

Fragile- brittle, weak

Inclusive- covering all the services, facilities or items normally expected

Spanning- extend from side to side of

9.9 Model Question

A. Very short answer type question **Marks:- 1**

1. Write the full form of NAPCC.
2. Define NAPCC.
3. How many national mission are there in NAPCC?

4. Write the full form of NMSHE.

5. Write the full form of NMSKCC.

6. How many phase are there in National Solar' Mission?

7. What are the key dimension of NMSA?

8. What are the other initiatives of NAPCC?

B. Short answer type question **Marks:- 3**

1. What are the principles of NAPCC?

2. Why National Solar Mission is important?

3. What are the main objectives of NWM?

4. Write the National Mission for a Green India.

5. What are the objectives and focuses of National Bio-Energy Mission?

C. Answer the following question **Marks:- 5**

1. Write about the missions that are taken by the government of India on climate change.

2. What are the other initiatives that are taken by the government of India on climate change.

9.10 References

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Unit : 10 ◻ ROLE OF LOCAL BODIES ON CLIMATE CHANGE MITIGATION-AWARENESS AND ACTION PROGRAMMES.

10.1 Introduction

Climate change mitigation is actions to limit the magnitude and/or rate of long-term climate change. Climate change mitigation generally involves reductions in human (anthropogenic) emissions of greenhouse gases (GHGs).

Examples of mitigation include reducing energy demand by increasing energy

efficiency, phasing out fossil fuels by switching to iow-carbon energy sources, and removing carbon dioxide from Earth's atmosphere.

10.2 Objectives

i. To omit the problem due to climate change on the environment

ii. To save the ecosystem what plan has implemented by the government and local bodies.

10.3 Role of local bodies

Local level governments benefit from proximity to the community that makes them the most accessible authority when disaster strikes. Additionally, local level government possesses the most up-to-date knowledge on the local environment and population.

Combating climate change at the local level requires governments to create local climate change plans. Successful plans include both adaptation and mitigation elements.

- Combining spontaneous (based on indigenous knowledge) and planned (based on scientific thought) adaption strategies is an effective twin-track approach. It results in community-wide ownership and commitment to the adaption process thus ensuring more robust climate responses.
- Investing in social capital strengthens the ability of local governments to respond to climate change. Capacity building in terms of human resources, skills, knowledge, planning and negotiation capabilities of individuals and communities is an effective way of leveraging the scarce resources of local governments.
- Climate change preparedness is only effective if it is incorporated into existing local development plans.

  Central governments should support the development of local government climate change plans that incorporate both adaption and mitigation components. In case of acute vulnerability and weak central government, local governments should have recourse to international support.
- Focusing on adaption over mitigation can have two benefits. Adaption strategies are often less expensive and may result in mitigation effects. For ex-

ample, promoting energy saving mitigates the causes and saves financial resources to enable better adaption to the inevitable impacts of climate change.

- Mitigation can be investment intensive and countries can only make efforts according to their means. However, less expensive mitigation mechanisms such as land-use planning and carbon pricing bring high returns on investment, including climate stabilization.
- The most vulnerable local governments should have access to international funds to cover their adaptation costs through global or multilateral mechanisms and bilateral development assistance.

10.4 Mitigation Strategics

Local bodies or clubs or local areas can also work on climate change by maintaining the following points-

1. Ban on the use of plastics-

Plastic or polyethylene is harmful, not only for the health of human but also for the health of the biodiversity. Banning plastic from the environment will automatically reduce the levels of pollution to several folds.

A few steps can considerably reduce the amount of plastic pollution from our lives. These are:

- Using a recyclable cloth bag
- Discarding the plastic bottles and using glass, clay, stainless steel or copper bottles. :
- Replacing plastic lunchboxes with steel ones.

2. Use of alternative energy sources-

- Use of solar energy.
- Use of bio-fuel.
- Use of wind power.
- Use of hydro-power, energy from oceanic current.

3. Educating people-

Lack of awareness among the common people is also one of the major aspects of the misuse of resources which ultimately leads to pollution.

The government of every country should take up the responsibility of educating its citizens. People should be educated by the aid of documentaries, short films, advertisements and campaigns.

4. Public transport, always-

Using public transportation not only provides an easy solution to cope up with the pollution issue, but it also allows us to meet new people in our journey to the office. It also aids in reducing the traffic congestion on the streets thus allowing us to reach our destination faster.

Recently, the government of Luxembourg has waived all the fares of public transport in order to make their country less polluted and traffic free. This small step by the Luxembourg government can save gallons of fossil fuels and hence aid in slowing down the process of climate change.

5. Stop chopping the forests-

Deforestation is one of the major reasons why the quality of air has degraded to an all-time low. The loss of trees and other vegetation can cause climate change, desertification, soil erosion, fewer crops, flooding, increased greenhouse gases in the atmosphere, and a host of problems for indigenous people.

Due to the decline in the number of trees, the environment of the Earth has been adversely affected. Many flora and fauna are on the verge of extinction due to the loss of their natural habitat.

6. Suppress the population growth-

Overpopulation has overburdened our planet, not only in terms of space but also for food and water. It will soon emerge as the largest single threat to the ecology and biodiversity of the planet in the decades to come

The global climate disruption due to the buildup of hum an-generated greenhouse gases in the atmosphere will soon be a reality if left unchecked.

7. Unplug your devices

Almost all the devices that we use these days are battery operated and use electricity in some form or other, and we as careless beings often leave the chargers of the devices switched on and plugged. This leads to a continuous flow of energy without any use.

So, in order to stop this misuse, every individual should be made aware of the losses due to this simple act of carelessness, and they should be taught to switch off every plug before they leave their homes.

8. Switch to electric vehicles

The electric vehicle market is booming, and although the electric vehicles are quite expensive for the time being, these will soon provide an effective alternative for petrol and diesel operated vehicles. The use of the EVs would not only lessen the pollution on the Earth, but it will also decrease the traffic due to their tiny size.

Ensuring good health of our planet is for our own good. We've been exploiting the natural resources since long, but it is high time we realize the damage it has done to the planet and takes necessary steps to protect our only shelter.

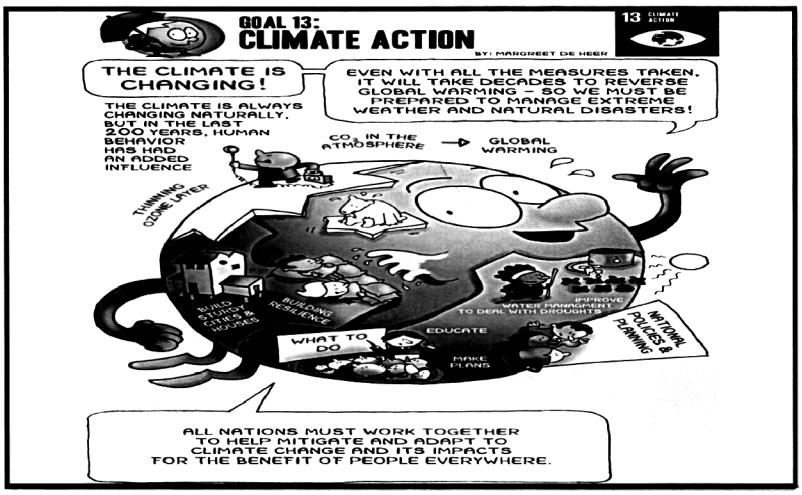

Fig : Climate Action

10.5 Awareness and Action Programme of Climate change of India

The Government of India launched National Action Plan on Climate Change (NAPCC) on 30th June, 2008 outlining eight National Missions on climate change to mitigate the problem. These include:

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat

4. National Water Mission
5. National Mission for Sustaining the Himalayan Eco-system
6. National Mission for a Green India
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change

This is explained in Module : 2, Unit 9 - National Action Plan (of India) on climate change.

10.6 Conclusion

In conclusion it can be seen that nowadays local bodies also helped to save the environment by taking new decisions. Government also take awareness programme which will be help to save the environment.

10.7 Summary

To reduce the effect of climate change, local bodies should take appropriate measures. Local level government possesses the most up-to-date knowledge on the local environment and population.

Local bodies or clubs or local areas can also works on climate change by adopting the following actions-

- They should announce to stop the use of plastic.
- They should encourage the people to use solar energy.
- They educate people about the negative impacts of climate change by television, media, news paper, journal, hand bill etc.
- They should ask the people for using public transport.
- They should ask the people to plant saplings for increasing green cover and also urge the people not to destroy trees.

Besides this, Government of India also promote action programme to mitigate this problems. The action plan of the GOI are as follows-

- National Solar Mission
- National Mission for Enhanced Energy Efficiency

- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Eco-system
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

10.8 Glossary

Bilateral- two-sided ‘

Booming- prosperous

Degraded- fallen down, decayed

Effective- useful, workable

Effort- attempt

Emerge- rise

Forego- forsake, give up

Inevitable- unavoidable Nook- crack Spontaneous- natural

10.9 Model Question

A. Very short answer type question **Marks: 1**

1. What is the full form of GHGs?

2. Give some examples of mitigation of climate change.

3. What is the full form of NAPCC?

4. When did NAPCC was formed?

5. Give some name of measures which are taken by local bodies to omit the climate change.

B. Short answer type question **Marks:- 3**

1. What role was played by local bodies to omit the climate change?

2. Write the mitigation strategies of climate change.
3. Which action programme was taken by government of India?

C. Answer the following question **Marks:- 5**

1. Explain the role of local bodies on climate change mitigation in brief.
2. Explain the mitigation strategies taken by local bodies on climate change.
3. What is NAPCC? Explain it's awareness and action programme.

10.10 References

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