

CLIMATE CHANGE: CAUSES AND IMPACTS

Manash Laha*¹

*¹State Aided College Teacher, Department Of Geography, Islampur College, West Bengal, India.

DOI : <https://www.doi.org/10.56726/IRJMETS51857>

ABSTRACT

Climate is the average weather condition of a large area over 30-35 years. At present, a major change in this climate is being noticed. There are different causes behind it. These climate change issues are very complex. Causes can be broadly divided into three categories. Namely - Astronomical observations - including solar variability, elliptical orbit changes, orbital shape changes, solar heating, changes in Earth's temperature and changes in cosmic rays. Secondly Atmospheric causes -Heat retention is caused by some atmospheric gases, such as gaseous water vapour (not droplets), carbon dioxide, methane(CH₄), N₂O and a few other miscellaneous gases. Mainly due to various human activities, anthropogenic emissions from industry, fossil and biofuel emissions, transportation and ships etc., massive temperature rise is observed. Thirdly, tectonic theory - the movement of the continents, the change in the flow of ocean currents, the temperature difference due to eruption due to plate movement is one of the theories. Which indicates climate change. In addition to the facts, the effects of climate change are discussed. Seawater inflation due to temperature variations due to the effect of various gases affects marine biodiversity, life and livelihoods of coastal communities. Snowmelt, which greatly affects the intensity of cyclones, is discussed in detail.

Keywords: Causes Of Climate Change, Contribution Of Different Activities In Global Warming, Causes Of Factor In Climate Change- Astronomical Causes, Atmospheric Causes, Tectonic Causes, Impact- The Rise Of CO₂, IPCC Assessment Report, Impact On Ocean. Anthropogenic Impact On Climate, Climate Change Adaptation And Mitigation: Future Direction.

I. INTRODUCTION

The possibility of global warming is extensively debated over the recent years. Many have noticed that nearly all societies are burning increasing quantities of fossil fuel and releasing, through that process, increasing quantities of CO₂ into the atmosphere. CO₂ has the ability to allow entry of sunlight, which comes in short waves but prevents the passage of long wave radiations from the heated surfaces of land and water. It is apprehended that this accumulation of CO₂ in the atmosphere will interfere with the process of loss of heat from the surface of the earth, leading to accumulation of heat in the atmosphere to trigger global warming. Additive heating would upset ecological balance and human beings would inevitably suffer from such changes of global climate. Eventually, the human races may fail to adapt to the altered climate and be totally destroyed along with many other types of biota from this planet.

All the apprehended consequences of global warming should be seen as disaster. But none of these would be seen as caused by natural hazard. The uncontrolled release of CO₂ is a product of human folly, and hence the cause of apprehended global warming can not be describe as a natural phenomenon.

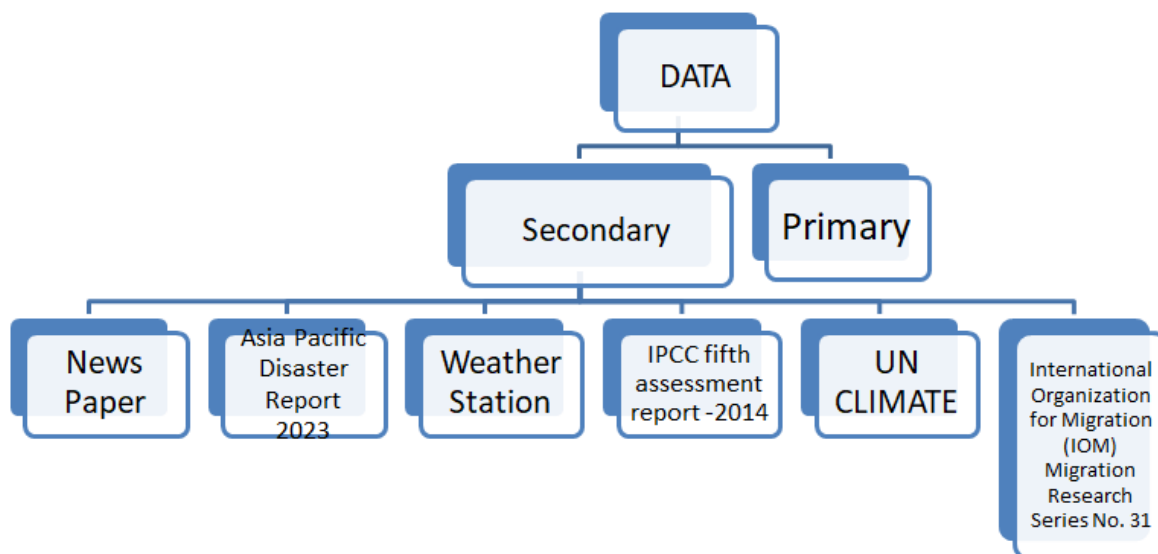
OBJECTIVES:

To present study focused on the following major objectives -

- a) To discuss the increase in various gases due to various human activities like industrialization, urbanization, deforestation etc. Which is one of the causes of climate change? Also discuss about the various causes of global warming.
- b) To discuss the various effect of climate change.

II. METHODOLOGY

The required data for the present study has been divided into two parts a) primary data and b) Secondary data. It has been taken fulfill from secondary source. Secondary data has been acquired from News paper, Asia Pacific Disaster Report 2023, Weather Station, IPCC fifth assessment report -2014, UN CLIMATE, International Organization for Migration (IOM) Migration Research Series No. 31.

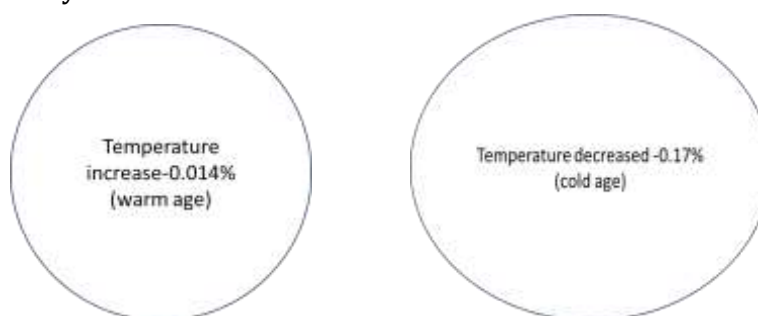


CAUSAL FACTORS IN CLIMATE CHANGE :

1. ASTRONOMICAL CAUSES :

➤ At intervals of 11 –year and 206 year cycles, solar variability (sun spot activity) causes solar flares, when swarms of cosmic rays spread out in all direction. As one of the result of this bombardment the bondage between hydrogen (H) and oxygen (O) in water vapour (H₂O) that reaches the upper layer of the atmosphere breaks. Hydrogen , on account of low mass, escape the gravitational field of the earth and goes into the outer space. Oxygen, being heavier, sinks into the atmosphere. This is a process that has enriched the global atmosphere with free oxygen, which the original atmosphere did not have. Oxygen allows the entry of short wave sunlight and also the escape of long wave radiated heat. Unlike the CO₂ , oxygen allows cooling of the earth.

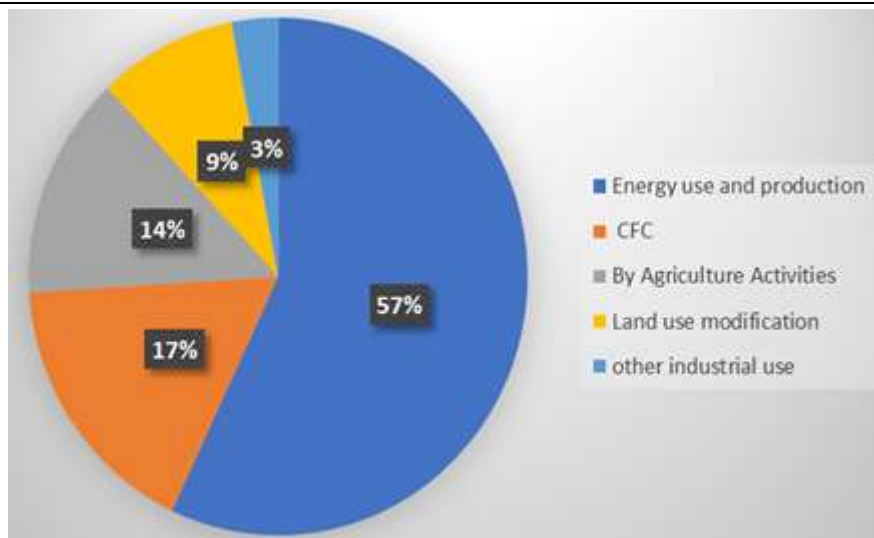
Orbit- 90-100 thousands year



Contribution of different activities in global warming

- 1. Energy use and production = 57%
- 2. CFC = 17%
- 3. By Agriculture Activities = 14%
- 4. Land use modification = 09%
- 5. other industrial use = 03%

- At intervals of 21000 year cycle ,earth combined tilt and elliptical orbit around the sun (precession of the equinoxes) changes. That can bring parts of the earths surface to get newly covered by ice caps.
- At intervals of 41000 year circle,+/-1.5⁰ wobble happens in earth’s orbit (tilt).This also causes reorientation of the earth’s thermal belts.
- At intervals of 100000-year cycle, variations in the shape of earths elliptical orbit (cycle of eccentricity) also changes. This can after the quantity of solar heat reaching the earth.
- Passage of the sun through spiraling arms of galaxies can cause changes in temperature on the earth. Ice ages may be caused by our solar system’s passage through our galaxy’s spiral arms during our orbit around the center of the galaxy. Some evidences have been marshaled, which show a correlation between changes in the flux of cosmic rays reaching the earth and the timing of past ice ages.
- **Anthropogenic Emission-** Fossil and Bio Fuel emissions from Industry, Transport & ships, etc.



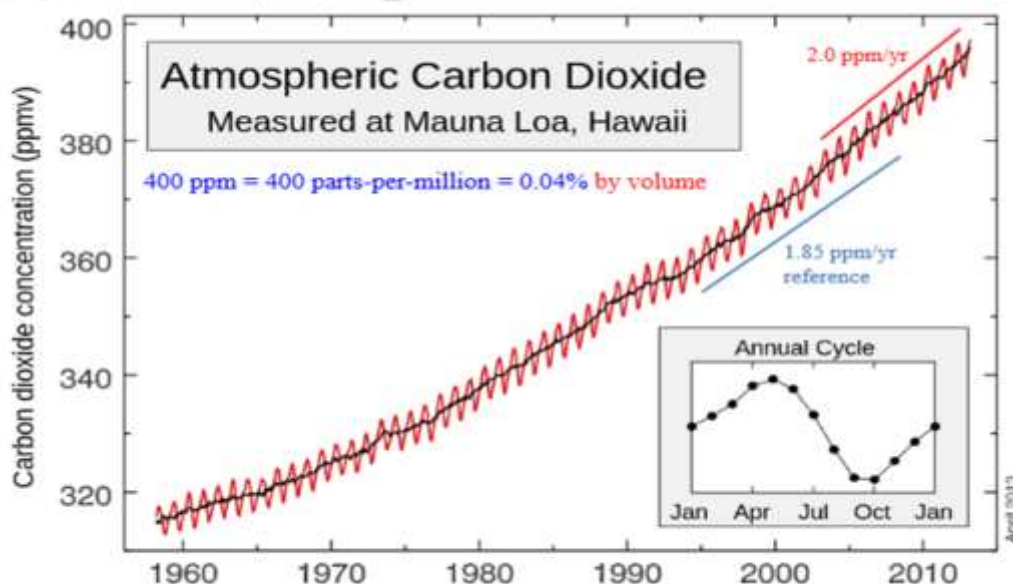
2. ATMOSPHERIC CAUSES:

Heat retention is caused by some atmospheric gases, such as gaseous water vapour (not droplets), carbon dioxide, methane(CH₄), N₂O and a few other miscellaneous gases.

3. TECTONIC CAUSES:

- Shifting continents, through continental drift, cause changes in the pattern of circulation of ocean currents, which alters the pattern of heat distribution on the planet. It seems that whenever there is a large landmass at one of the Earth’s poles, there are ice ages.
- Plate movements, the basic loco motor for continental drift, do expose the asthenosphere at spreading center zones, leading to fresh have flows, and release of volcanic bombs, ashes. The released gases and ash into the atmosphere can cause climate change. With converging plate movements, new volcanoes form through remelting of the subducted plate. These also contribute towards climate change.
- Sea floor spreading, associated with plate tectonics and continental drift, cause variations in ocean displacement.

The Rise of CO₂

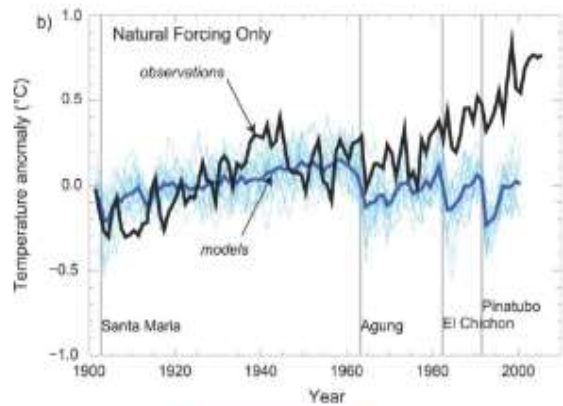
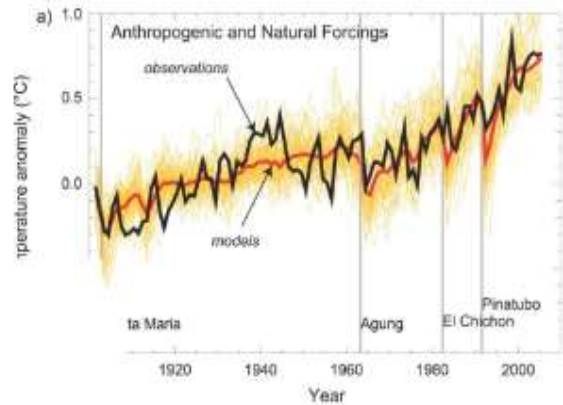
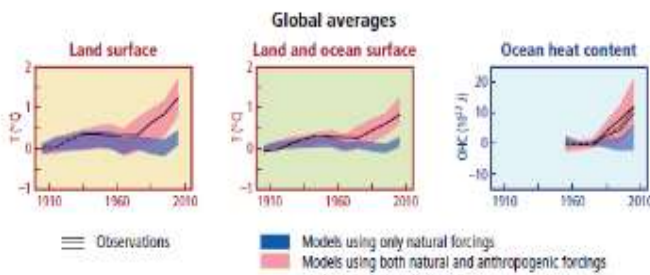


Keeling, a researcher, started measuring atmospheric CO₂ from Mauna Loa in Hawaii in 1958. Besides the annual photosynthetic cycle, a profound trend is seen.

Models are tested by entering real data from the past and seeing how well the model *would have* predicted past trends

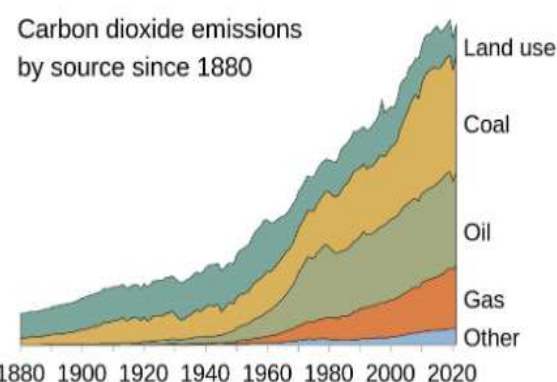
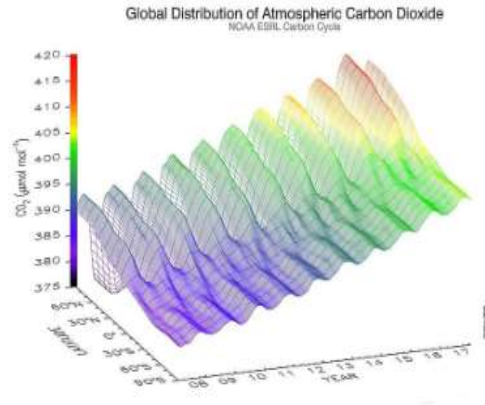
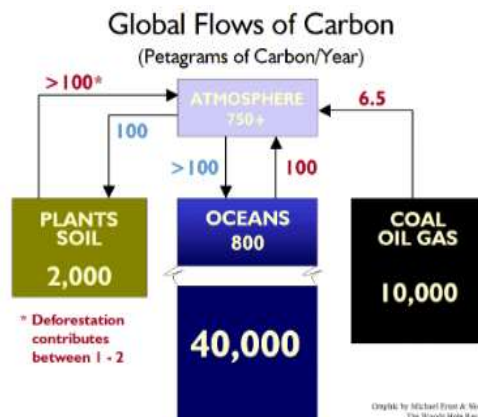
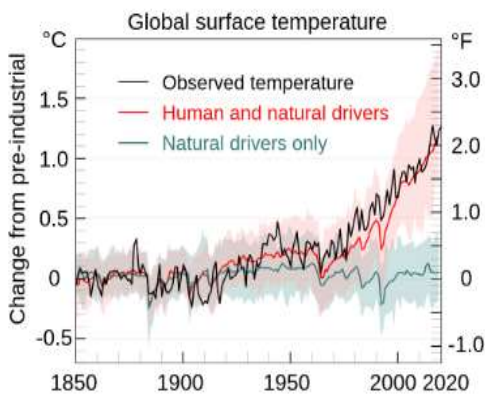
Models that incorporate *only* natural factors or *only* anthropogenic factors predict poorly

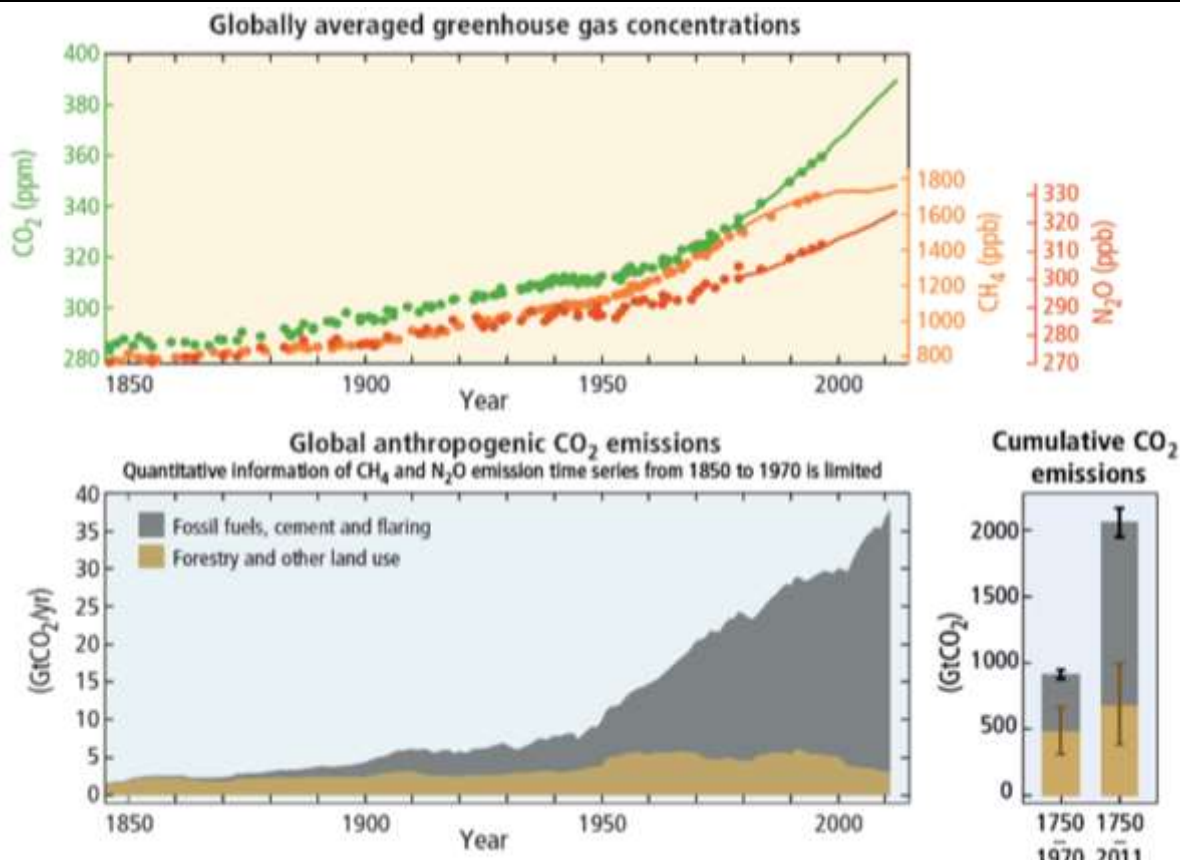
But models including **both** natural and anthropogenic factors predict very well



IPCC, 2018

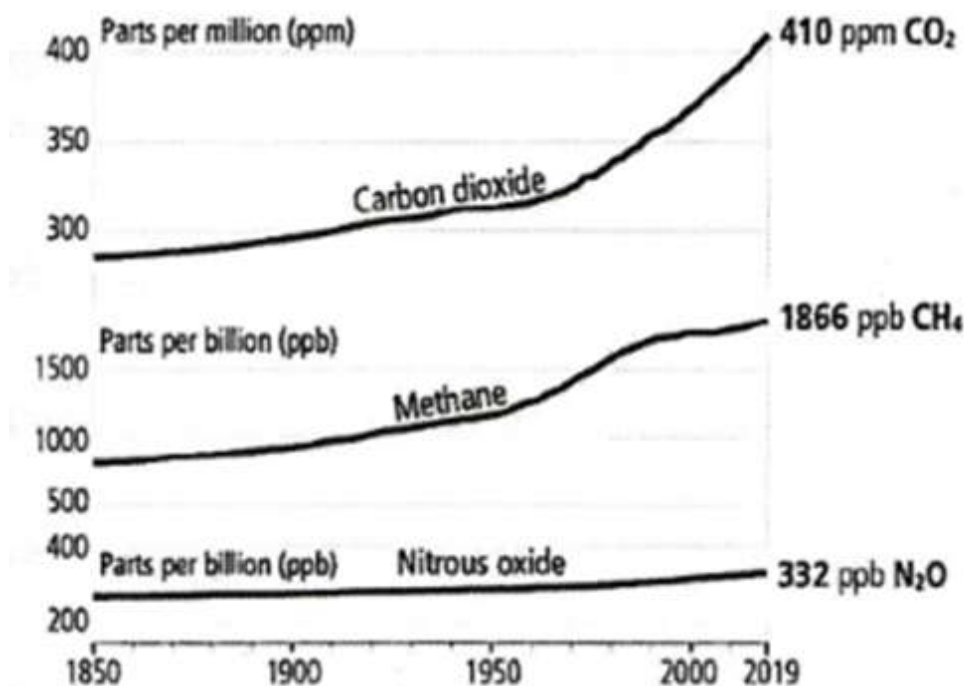
CARBON EMISSION AS THE DRIVER OF GLOBAL WARMING



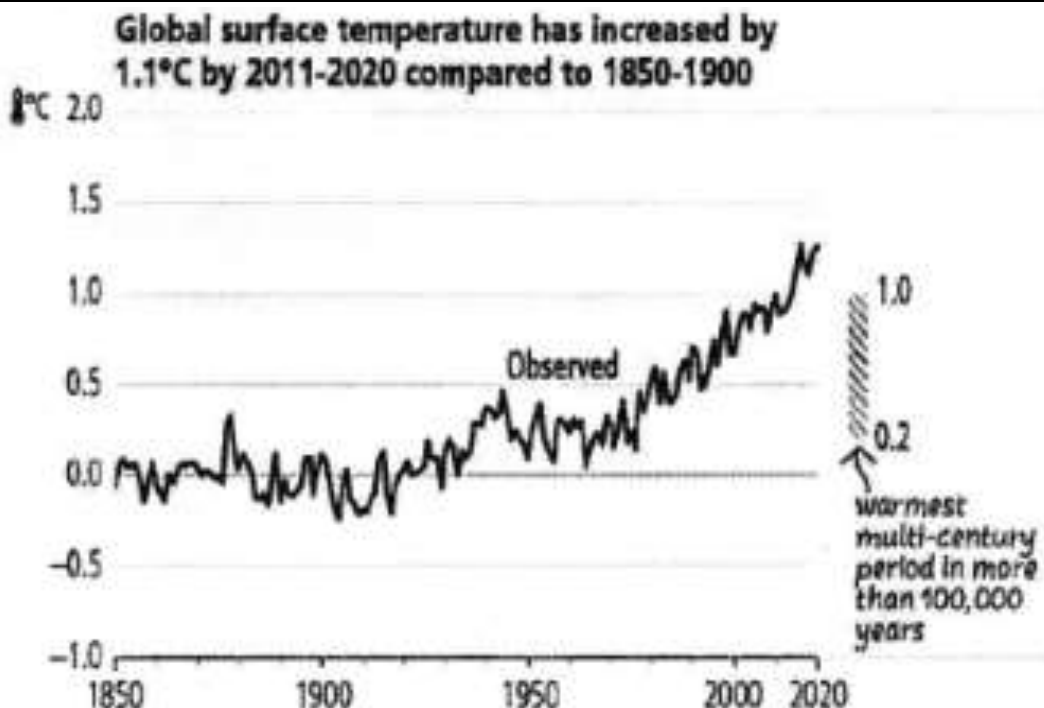


IPCC Fifth Assessment Report (2014)

ANTHROPOGENIC CAUSES -RAPIDLY INCREASE OF GREEN HOUSE GASES



Source : Climate change: Vulnerability, Mitigation, and Adaptation (Sudipta Kayal, Moumita Mandal).



Source : Climate change: Vulnerability, Mitigation, and Adaptation (Sudipta Kayal, Moumita Mandal)

INCREASING TRENDS IN CO₂ CONCENTRATION :

“Keeling” Curve for India

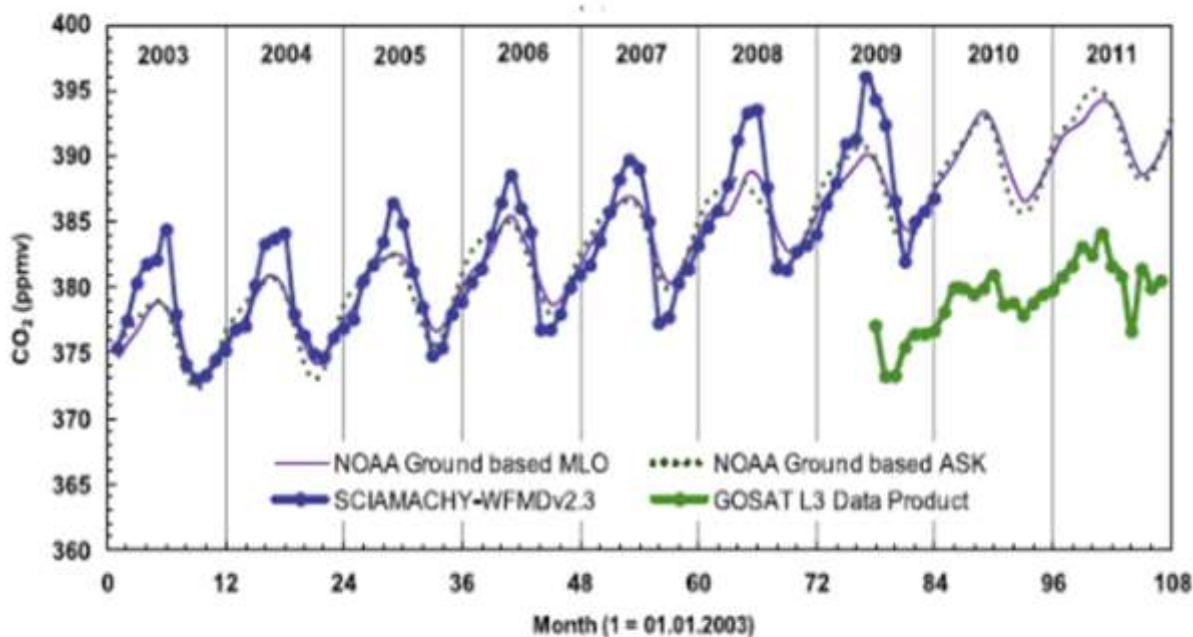
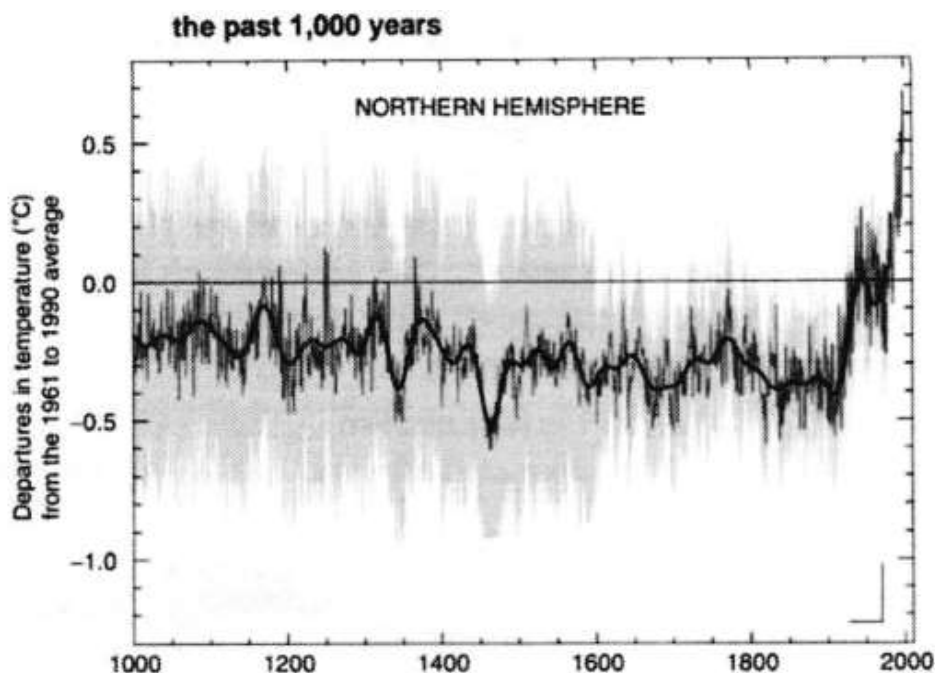


Fig: The SCIAMACHY and GOSAT data of CO₂ over India compared with ground NOAA flask data at Mauna Loa (MLO) and Assekrem (ASK).

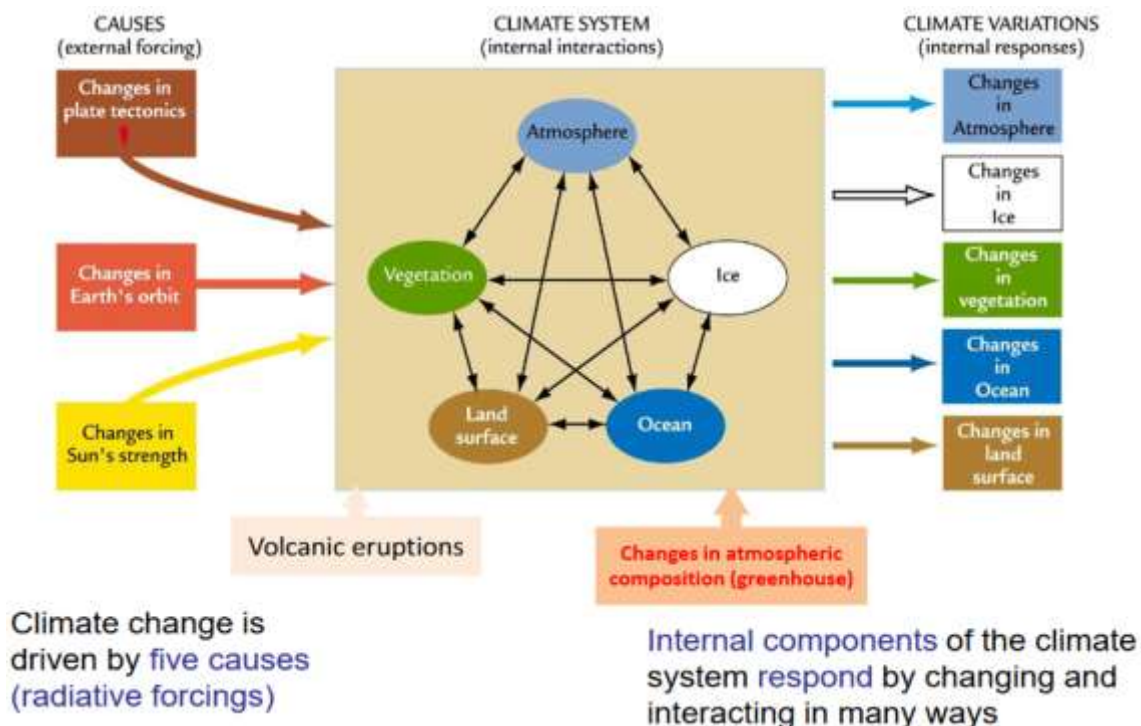
HOCKY STICK GRAPH



Source : Climate change: Vulnerability, Mitigation, and Adaptation (Sudipta Kayal, Moumita Mandal)

IMPACT:

The causes of climate change are complex. There are several major factors that can effect the climate system, including NATURAL natural and anthropogenic.



The IPCC reported that the earth's average surface temperature during the 20th century increased approximately 0.6°C. While this may seem like a small change, global temperature are generally quite stable. The difference between today's global temperature and the average global temperature of the last ice age is only about 5°C. However, over the last century we have witnessed a decrease of nearly 10 percentage snow cover and a 10-15% decrease in spring and summer sea-ice in the northern hemisphere. Other observed change that have

been linked to climate include longer growing seasons, increases in rainfall and rainfall intensity in the northern hemisphere, and shifts in when ice freezes and break up on rivers and lakes.

The IPCC has projected that global average surface temperatures could increase 1.4 to 5.8°C by 2100. Daily maximum and minimum temperatures will increase as well as the number of hot days, with less cold and frosty days. The global average precipitation and evaporation is also expected to increase by about one to nine percent. The intensity of extreme weather events is also likely to increase, with greater extremes of both flooding and drought.

INCREASE OF NATURAL HAZARDS



AMAZON - A 2021- DESTRUCTIVE WILDFIRE HAZARD, 2019 A GLACIER BRUSH IN RAINI AREA OF CHAMOLI IN GARWAL HIMALAYA OF UTTARAKHAND ON SUNDAY DAMAGED THE TAPOVAN-VISHNUGAD HYDROPOWER PLANT



MAHARASTRA FLOOD -2021



MAL BAZAR FLASH FLOOD -2022



DHILHI -AIR POLLUTION

CURRENT AND FUTURE CLIMATE CRISIS

Climate change morphed into Climate Disruptions



Extreme heat

More frequent
More intense



Heavy rainfall

More frequent
More intense



Drought

Increase in some
regions



Fire weather

More frequent



Ocean

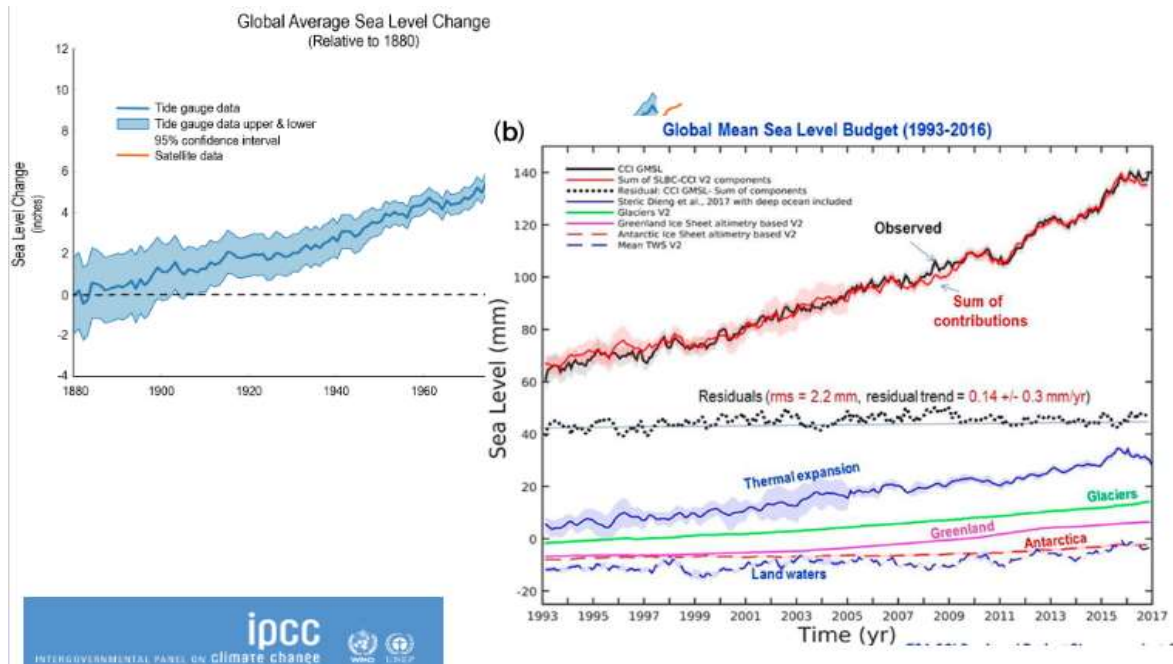
Warming
Acidifying
Losing oxygen

IPCC 2021 & WMO 2021

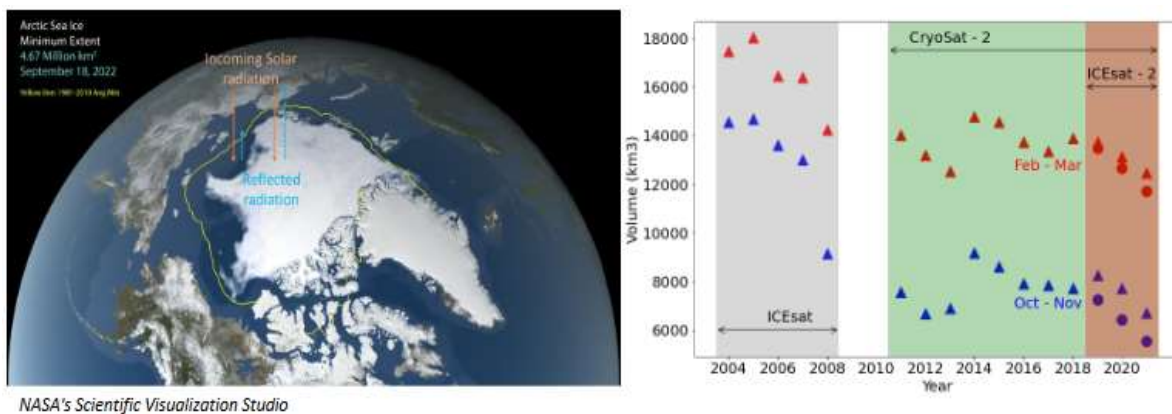
- Hot temperature extremes frequency increased **180%**
- Heavy Precipitation frequency increased **30%**
- Agriculture & ecological droughts in drying regions increased **70%**
- Disaster number increased by **400%** from 1970s to the current decade

A collection of peer-reviewed papers in BAMS in 2020

CUMULATIVE CHANGES IN SEA LEVEL FOR THE WORLD'S OCEANS SINCE 1880

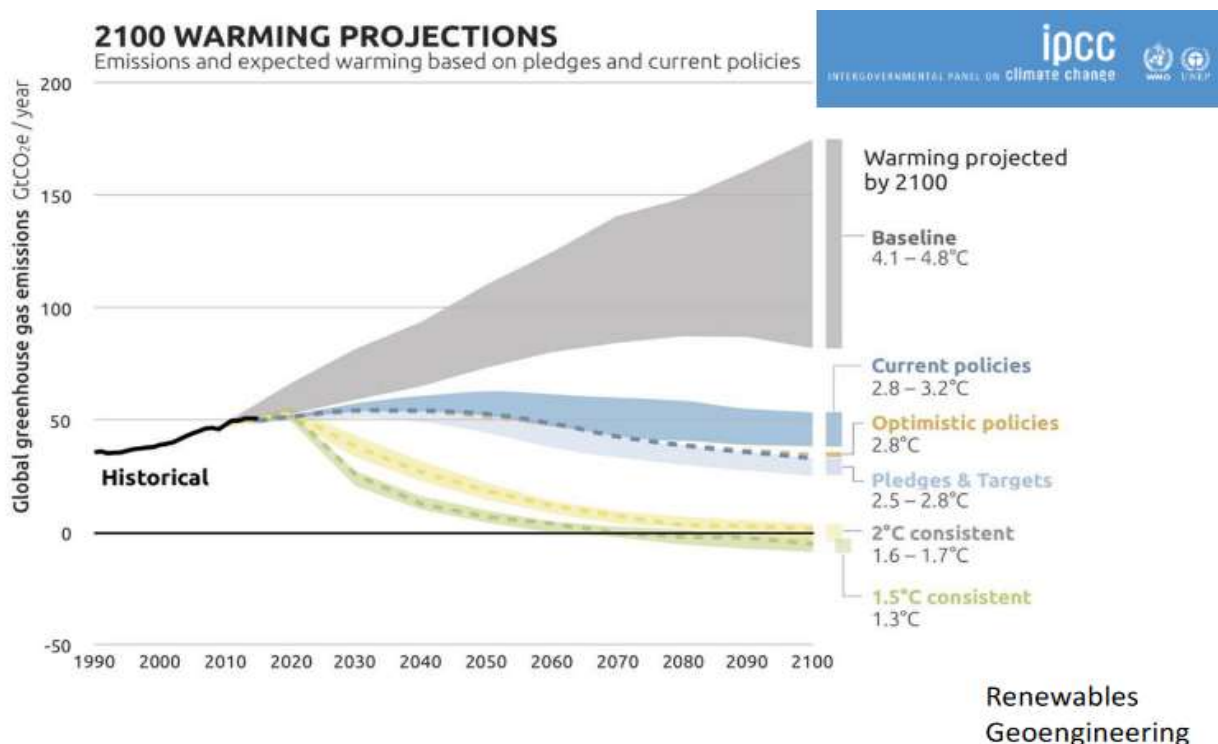


CHANGES IN ARCTIC SEA ICE EXTENT:



Arctic planetary albedo declined by **0.04** (from 0.52 to 0.48) between 1979 and 2011. This decline is reported to increase in solar energy input into the Arctic Ocean region of **$6.4 \pm 0.9 \text{ Wm}^{-2}$** , equivalent to an increase of $0.21 \pm 0.03 \text{ Wm}^{-2}$ averaged over the globe during this period (Pristone et al., 2014)

LIMITING CLIMATE CHANGE



MAJOR OCCURRENCE OF MAJOR FLOOD AND DROUGHT IN INDIA:

YEAR	STATE	CAUSES OF DISASTER	NO. OF PEOPLE DIED
26 TH JULY, 2005	MUMBAI	HEAVY RAINFALL	1094
MONTH OF JUNE, 2013	UATTARAKHAND (KEDARNATHO)	FLASH FLOOD	>5000
2015	GUJRAT	HEAVY RAINFALL	
2016	ASSAM FLOOD		>200 WILD ANIMALS
2017	GUJRAT	HEAVY RAINFFAL (FLOOD)	>200
2018	KERALA	FLOOD	>500
2019	KERAL MADHYAPRADESH, KARNATAK, MAHARASTRA	FLOOD	DAMGE INFRASTRUCTURE

OCTOBER, 2020	HYDRABAD, A.P	FLASH FLOOD	98
2021	UTTARAKHAND(DHOULIGANGA AND RISHIGANGA)	FLASH FLOOD (ROCK AVALANCE)	>200
2022	ASSAM	FLOOD	DAMAGE INFRASTRUCTURE
2013	MAHARAISTRA (AFFECTED DISTRICT- SOLAPUR, PUNE, SATRA, NASIK, LATUR, OSAMABAD)	DROUGHT (<40CM RAINFALL)	5 LAKH FARMER EFFECTED
2015	MAHARAISTRA (14708 VILLAGE EFFECTED)	<50%	EFFECTED 90 LAKHS FARMER

Source : Climate change: Vulnerability, Mitigation, and Adaptation (Sudipta Kayal, Moumita Mandal)

DISASTER IMPACTS IN ASIA AND THE PACIFIC, 2022 :

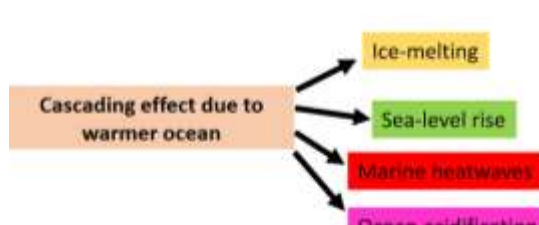
Disaster type	Total number of fatalities	Total number of people affected	Total economic losses, adjusted (US\$)
Flood	4,877	45,846,142	\$34 billion
Earthquake	1,611	3,538,291	\$12.1 billion
Tropical cyclone	605	7,297,397	\$3.4 billion
Other	318	1,235,551	\$0.2 billion
Heatwave	107	28,505	N/A
Drought	n/a	6,104,480	\$7.6 billion
Total	7,518	64,050,366	\$57.3 billion

Source: Asia Pacific Disaster Report 2023

- Climate change could force as many as 216 million people to move within their countries by 2050.
- The IPCC projects a 200 per cent increase in human displacement across Africa for 1.6°C of global warming and an increase of 600 per cent for 2.6°C of global warming
- 2007 Report- IPCC Future Prediction, 2100-59cm sea rise of Maldeep.
- Nasa and USGS report- 80% area effected of Maldeep, 2050.


Source: International Organization for Migration (IOM) Migration Research Series No. 31

IMPACT ON THE OCEAN :



Who are directly impacted by this cascading effect?

- Marine biodiversity
- Lives and livelihoods of coastal communities and beyond - including around 680 million people living in low-lying coastal areas, almost 2 billion who live in half of world's coastal megacities.
- 3.3 billion people depending on fish for protein.
- 60 million people who work in fisheries and the aquaculture sector worldwide.
- And several hundreds from Navy of various countries.



Ice melting

Observations show that the global ocean and land temperature has risen by ~ 10C during 1880 – 2012.

Glacier/Land Ice melting rates have drastically increased in recent past.

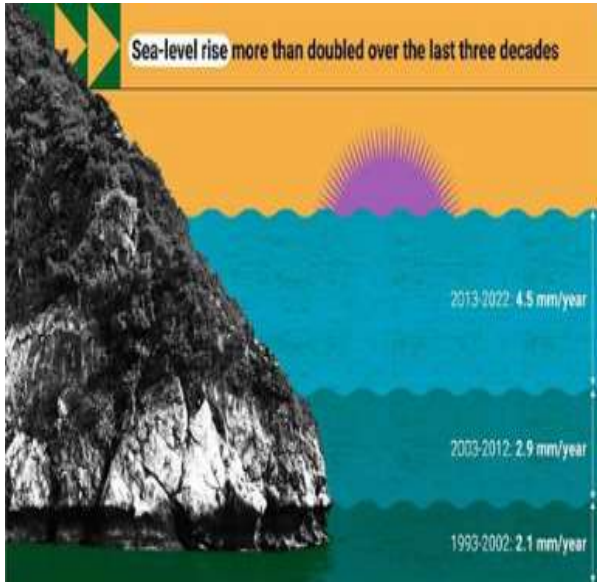
Sea level rise by ~ 20 cm between 1901 – 2012.

Sea-level rise
Sea-level rise has accelerated in recent decades due to increasing ice loss in the world's polar regions.

Global mean sea-level reached a new record high in 2021, rising an average of 4.5 millimeter per year over the period 2013 to 2021 (WMO).

Impact:
Intensifying tropical cyclones,
Deadly storm surges
Coastal hazards - flooding, erosion and landslides

Hot Spots: Western Tropical Pacific,
South-west Pacific, North Pacific
South-west Indian Ocean
South Atlantic face substantially faster sea-level rise.



Marine heatwaves
Doubled in frequency and have become longer-lasting, more intense and extensive.

Major events took place between 2006 and 2015, causing widespread coral bleaching and reef degradation.

Coral bleaching occurs as reefs lose their life-sustaining microscopic algae when under stress. The last global bleaching event started in 2014 and extended well into 2017 - spreading across the Pacific, Indian and Atlantic oceans.

All coral reef could bleach by the end of the century if the water continues to warm. (UN Environment Programme)



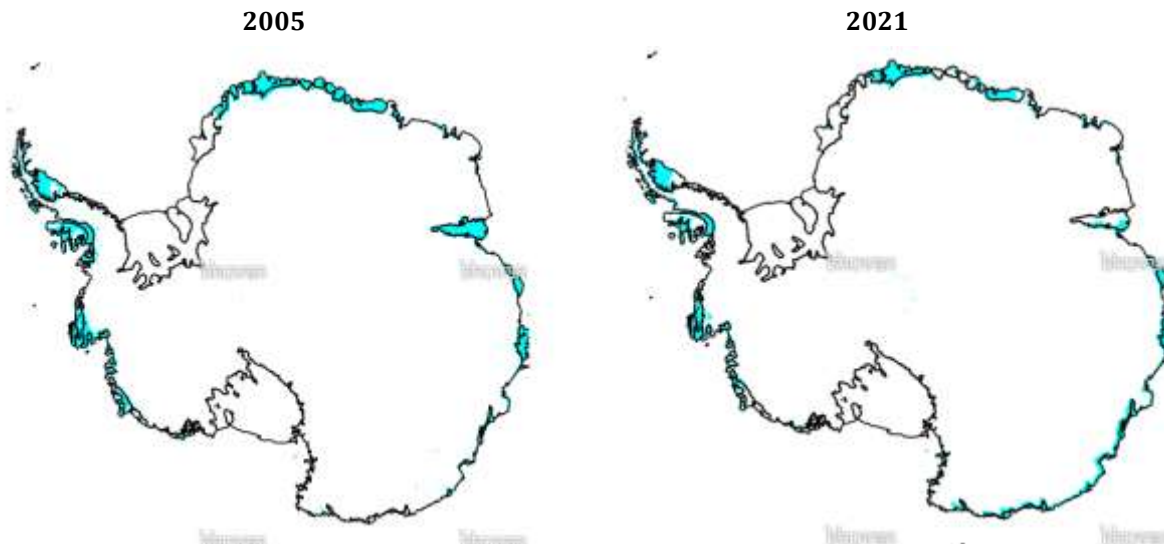
Ocean Acidification
Carbon dioxide in atmosphere, dissolves into seawater to form carbonic acid (H_2CO_3), a weak acid that dissociates into hydrogen ions (H^+) and bicarbonate ions (HCO_3^-).

Increased levels of carbon dioxide in the atmosphere, increases CO_2 dissolving into the ocean. Ocean's average pH = 8.1(basic) but as the ocean continues to absorb more CO_2 , the pH decreases and the ocean becomes more acidic.

Impact:
As carbonate ions bond with excess hydrogen, fewer carbonate ions available for calcifying organisms to build shells. If the pH gets too low, shells and skeletons can even begin to dissolve killing shells, oysters etc

SOURCE: UN CLIMATE

Spatio- temporal dynamics of surface melting over Antarctica is of importance in understanding the response of ice shelves to climate change. Normalised radar backscatter is sensitive to the water content of snow. With the increase in the liquid water content in the snow, there is a sudden decrease in the backscatter from radar. This is the basis of melt detection. Spatiotemporal dynamics of snow melt in Antarctica from 2005 to 2021 using microwave scatterometer data from OSCAT and QuikSCAT is generated at 2.25 km resolution at daily interval.



ANTHROPOGENIC IMPACT ON CLIMATE:

Man and climate mutually affect each other. Sometimes man attempts to control climate deliberately for his personal well being. But, man is also influencing climate inadvertently through his various social and economic activities, such as rapid urbanization, industrialisation, deforestation, farming activities, damming rivers to create artificial lakes for various uses, etc. Thus, man is in fact capable of influencing climate to a considerable extent and is inadvertently changing the earth,s albedo and atmospheric composition through his activities.

Man is instrumental in environmental construction or destruction both. But such disruptions in natural balance by anthropogenic factors are attaining such as alarming dimensions, that might have unpredictable consequences capable of undermining the material basis of mankind’s social and economic development and jeopardizing its very existence. Three most important mechanisms of climate change are : i) changes in supply of solar energy, ii) changes in the transmissivity of the atmosphere for both coming and outgoing radiations; and iii) changes in land use that alters the radiation balance.

CLIMATE CHANGE ADAPTATION AND MITIGATION: FUTURE DIRECTION

- Climate change calls for new approaches to sustainable development that take into account
- complex interactions between climate, social, and ecological systems.
- Climate-resilient pathways that combine adaptation and mitigation to realize the goal of sustainable development is the need of the hour.
- We need to consider sustainable development as the ultimate goal, and mitigation as a way to keep climate change moderate rather than extreme.
- Sustainable development should be inclusive of creating capacities for implementing and sustaining appropriate risk management.
- Responses to be at a multi-scale perspective that takes the socioeconomic, cultural, biophysical, and institutional context into account.
- The effects of climate change will make sustainable development objectives such as food and livelihood security, poverty reduction, health, and access to clean water more difficult to achieve.
- Need to focus more on scientific adaptation to changes as a response strategy to anticipate and cope with impacts that cannot be avoided under different scenarios of climate change.

- India National Hydrogen Mission with aim to becoming a new global hub of green hydrogen and its largest exporter.

III. SUGGESTION

1. Massive afforestation programme.
2. Reduce to burning of fossile fuels for every generation. This will put the developing countries to great disadvantage as they depend on their large coal resources for developmental activities.
3. Develop alternate energy resources. At present nuclear energy is also viable energy source. But Nuclear energy is also associated with hazards.
4. Reduction in the use of automobiles and research in development of more efficient automobile engines.
5. Ban on CFCs and nuclear explosions.
6. Development of environmentally compatible technologies with the help of intensive interdisciplinary research.
7. Effective check on the growth of population and imparting of non formal and formal and environmental education.

IV. CONCLUSION

- The climate change has a multidimensional impact in all aspects of life and environment.
- The cascading effect of climate change impacts severity of ocean state. Major challenges include
 - a) Vulnerable coasts due to rising sea levels (Challenging Harbor Operations)
 - b) Increasing trend of precipitation over ocean (Impacting Fisheries and Fleet Operations)
 - c) Phenomenal increase in Ocean Heat Content (Generating Marine Heat waves)
 - d) Marine heat wave induced increase in cyclonic activity (impacts deviations from regular ship routes, increasing cost of operations)

Climate change is a complex crisis with effects felt globally at all levels, and is primarily driven by anthropogenic activities. The good thing about the climate change is that it brought many countries around the same table many times. Efforts to educate the public about climate change started long back. Effort to reduce the release of greenhouse gases (especially CO₂) has already begun. In 1992 the famous Rio de Jenerio Earth summit took place. Strategies were framed to reduce greenhouse gas emissions (from burning fossil fuel) at 1990 level by the year 2000 A.D. Also they had to agree to provide funds to the developing/ underdeveloped countries to reduce their emission levels.

CONFLICTS OF INTEREST:

The authors declare no conflict of interest.

V. REFERENCES

- [1] Environmental studies -Savindar Shing.
- [2] A text book environmental studies -Dr. Vijay Kumar Tiwari
- [3] Natural hazard and disaster management -Satyesh C Chakraborty
- [4] Model question and answer on Environmental studies -Dr. Ashis Mukhopadhaya
- [5] SOURCE: UN CLIMATE
- [6] Fig: The SCIAMACHY and GOSAT data of CO₂over India compared with ground NOAA flask data at Mauna Loa (MLO) and Assekrem (ASK).
- [7] Source: International Organization for Migration (IOM) Migration Research Series No. 31
- [8] Source: Asia Pacific Disaster Report 2023
- [9] IPCC fifth assessment report -2014
- [10] Source : Climate change: Vulnerability, Mitigation, and Adaptation (Sudipta Kayal, Moumita Mandal)
- [11] <https://bhuvan-app3.nrsc.gov.in/data/download/index.php?c=p&s=NI&g=all>