Climate Change

CERC
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Environmental Information, Awareness, Capacity Building and Livelihood Programme
EIACP

Consumer Education and Research Centre
EIACP Resource Partner, Programme Centre
Ahmedabad, India

Editorial

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Preface

Climate change is real which can be witnessed in all aspects of our life. The change can be very well felt and observed through the extreme climatic conditions. The monsoons, summers and winters are getting extreme and intense with the coming years. Lately, mankind has faced some devastating environmental calamities with huge magnitude which has seen loss of human life and millions worth properties. Global warming is the main reason that is being attributed to the change in climate. The warming of the earth is happening due to enormous amount of carbon equivalent emissions such as Carbon dioxide, Sulphur oxides, Nitrous oxides, Methane etc. By the year 2100, the planet earth might face a rise in temperature between 2.4 and 2.6 °C above preindustrial levels. This could be accompanied by the more frequent and long lasting heat waves cause droughts, feminine, food shortages, migration, infections etc. To make the earth habitable and to curb the temperature rise, many efforts are being made by countries around the world. These efforts can be seen as commitments by world leaders in the form of policy changes, technology advancements, shifting towards renewables, adoption of cleaner and greener technologies etc.

At the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, India presented five nectar elements (Panchamrit.). The Panchamrit is India's plan towards Climate Action by committing to reach 500GWNon-fossil energy capacity by 2030, by shifting its 50 per cent of its energy requirements from renewable energy by 2030, by reducing total projected carbon emissions by one billion tonnes from now to 2030, by reducing the carbon intensity of the economy by 45 per cent by 2030 and by achieving the target of net zero emissions by 2070. The mantra of LiFE- Lifestyle for Environment to combat climate change was also shared in COP 26. It was stated that Lifestyle for Environment has to be taken forward as a campaign to make it a mass movement of Environment Conscious Lifestyles.

This book on climate change sheds light on its causes and impacts to draw attention of the world towards mindful and deliberate utilization.

CLIMATE CHANGE: AN OVERVIEW

Climate is the average weather condition of a particular region & is expressed in terms of temperature, precipitation, storms and other weather indicators.
Whereas, climate change refers to the changes to the average weather/ weather variability of a particular region.

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term.

According to United Nations Framework Convention on Climate Change (UNFCCC), climate change refers to 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.

Earth's climate has changed throughout its history. The current warming is happening at a pace not seen in the past thousands of years.

This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.)

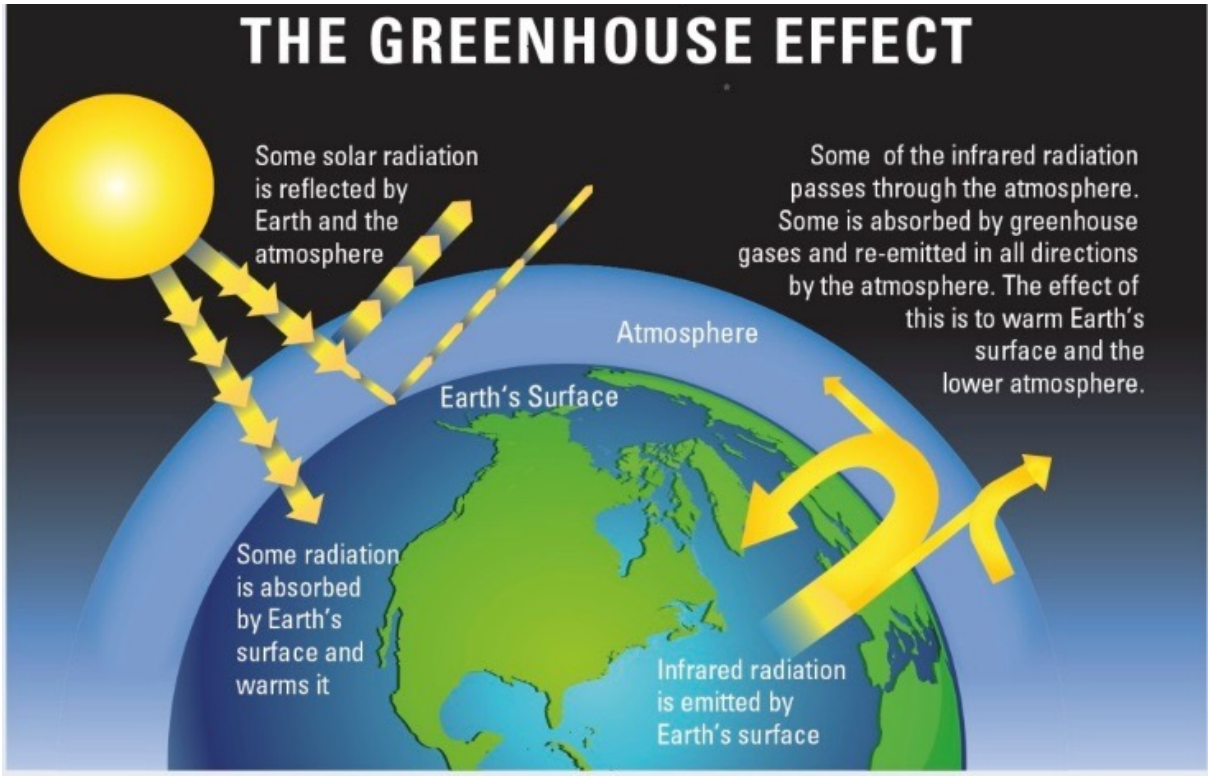
The current warming trend is due to anthropogenic activities and that the atmospheric gases produced by human activities have trapped more of the sun's energy in the Earth system. This trapping of heat has warmed the atmosphere and caused changes in the atmosphere, ocean, cryosphere and biosphere.

> Scientific evidence for warming of the climate system is unequivocal.
> - Intergovernmental Panel on Climate Change

Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.
- World Meteorological Organisation (WMO)

The natural climate system

The sun is the single most important energy source of earth. The energy reaching earth from sun is called solar radiation. Some of this solar energy is absorbed by the earth's surface and some are remitted back to the space. But not all radiation makes to the outer space, some are trapped by the greenhouse gases and clouds. The temperature we feel is the balance of the heat trapped by the earth's atmosphere. Life on earth exist because of the natural greenhouse effect, however, increase in concentration of the greenhouse gas molecules leads increase trapping of heat, thereby changing the climate.



Source: US EPA

Changes in Climate

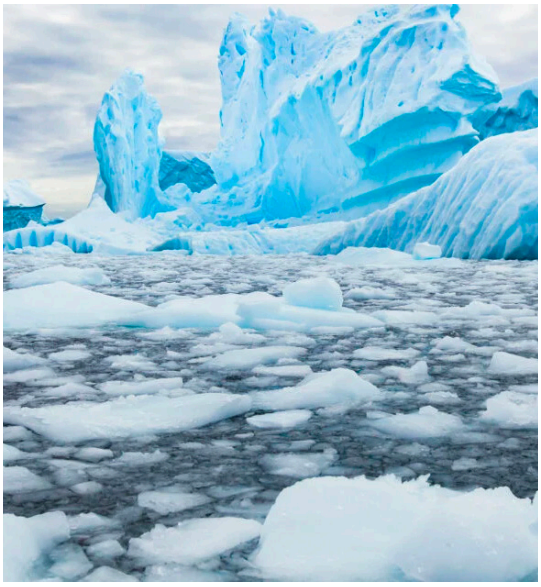
The factors that influence the change in the climate are called Climate Forcings. There are three types of climate forcings (i) Volcanic eruptions (ii) changes in the output of sun's radiation (iii) anthropogenic activities that releases the greenhouse gases.

i. Volcanic eruptions: Unpredictable volcanic eruptions inject large amount of aerosols into the atmosphere which causes the cooling of the earth's atmosphere.
ii. Changes in the output of sun's radiation or solar variation: The change in the amount of radiation emitted by the sun or the small changes in the energy received by the earth due to the change in the earth's rotation in the orbit is called solar variation.
iii. Anthropogenic activities: Anthropogenic activities leading to industrialization and urbanization releases large concentration of CO_2 and GHG, which imbalances the natural carbon and GHG cycle.

The Evidence for climate change

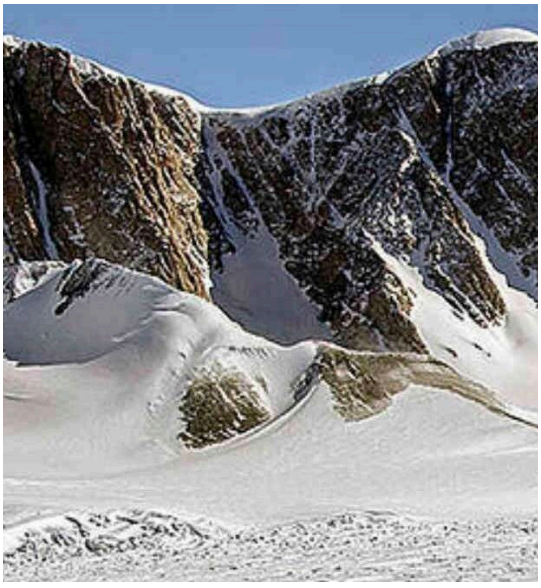
a) Global temperature is rising

The planet's average surface temperature has risen about 2 degrees Fahrenheit (1 degrees Celsius) since the late 19th century, a change driven largely by increased carbon dioxide emissions into the atmosphere and other human activities. Most of the warming occurred in the past 40 years, with the seven most recent years being the warmest. The years 2016 and 2020 are tied for the warmest year on record.



b) The ocean is getting warmer

The ocean has absorbed much of this increased heat, with the top 100 meters (about 328 feet) of ocean showing warming of more than 0.6 degrees Fahrenheit (0.33 degrees Celsius) since 1969. Earth stores 90% of the extra energy in the ocean.



c) The ice sheets are shrinking

The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost an average of 279 billion tons of ice per year between 1993 and 2019, while Antarctica lost about 148 billion tons of ice per year.

d) Glaciers are retreating

Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska, and Africa.

e) Snow cover is decreasing

Satellite observations reveal that the amount of spring snow cover in the Northern Hemisphere has decreased over the past five decades and the snow is melting earlier.

f) Sea level is rising

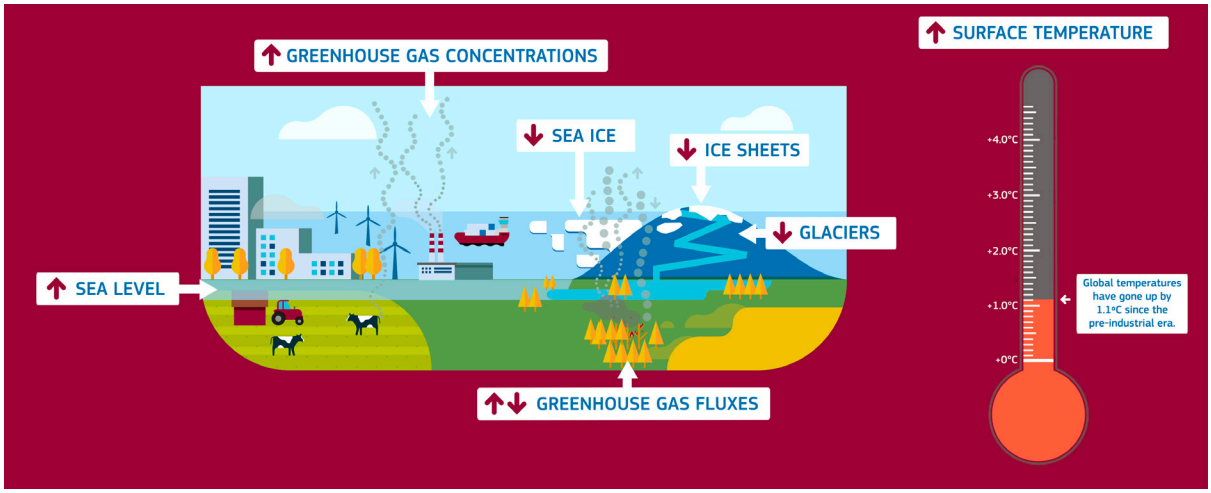
Global sea level rose about 8 inches (20 centimeters) in the last century. The rate in the last two decades, however, is nearly double that of the last century and accelerating slightly every year.

g) Arctic sea ice is declining

Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.

h) Extreme events are increasing in frequency
The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.

i) Ocean acidification is increasing
Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30%. This increase is due to humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the ocean. The ocean has absorbed between 20% and 30% of total anthropogenic carbon dioxide emissions in recent decades (7.2 to 10.8 billion metric tons per year.



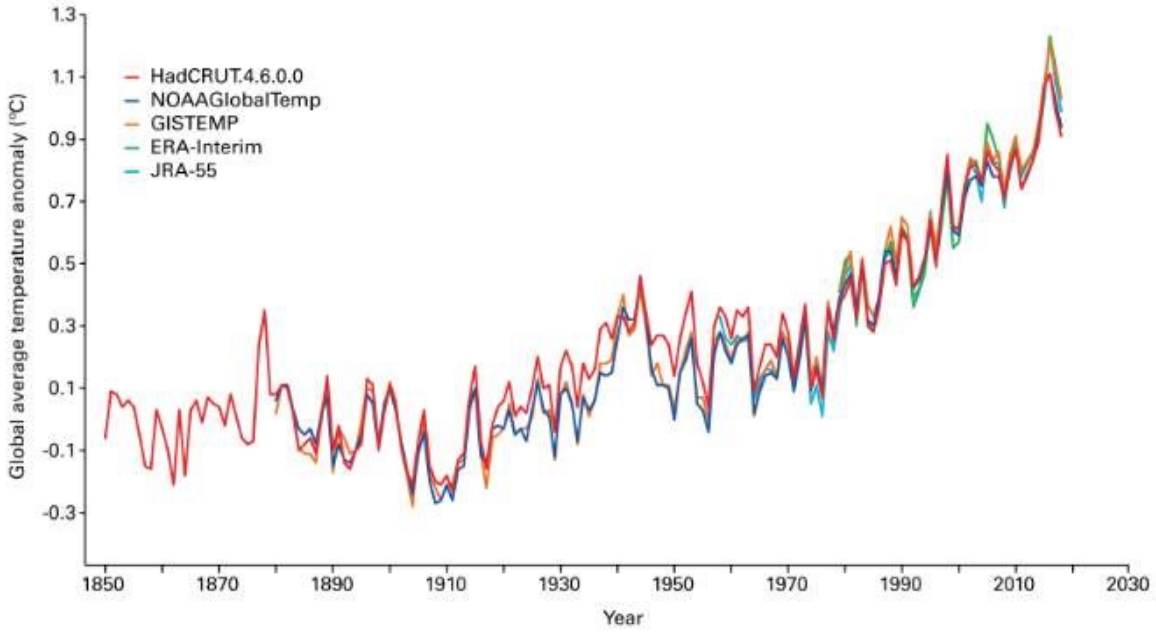
Climate Indicators

Climate indicators helps in understanding the status of the climate. Here are few climate indicators that helps us understand the change in the climate over a period of time. One of the headline indicators is the global temperature which attributes the global warming. Under the United Nations Framework for Climate Change Convention and Paris Agreement, in 2015, it was agreed by the signatory parties to limit the increase of the global temperature between 1.5 degrees to 2 degrees above pre-industrial levels. Temperature can be projected & modelled using general circulation models which involves equations of mass, energy and heat transfers. Year 2017 was recorded as the warmest year and years between 2013-2017 were recorded as the warmest 5 years on record. On the other hand, precipitation is one such headline indicator which is difficult to measure and model. Ocean, one of the most important headline indicator absorbs 94% of the trapped heat which results in melting of the sea ice. The thermal heat expansion of oceans and melting of ice results in sea level rise, thereby inundating the surrounding densely populated areas. The Intergovernmental panel on Climate Change releases status reports after reviewing the status of all the indicators.

Below are the data of few indicators that shows changes in their status:

Surface Temperature

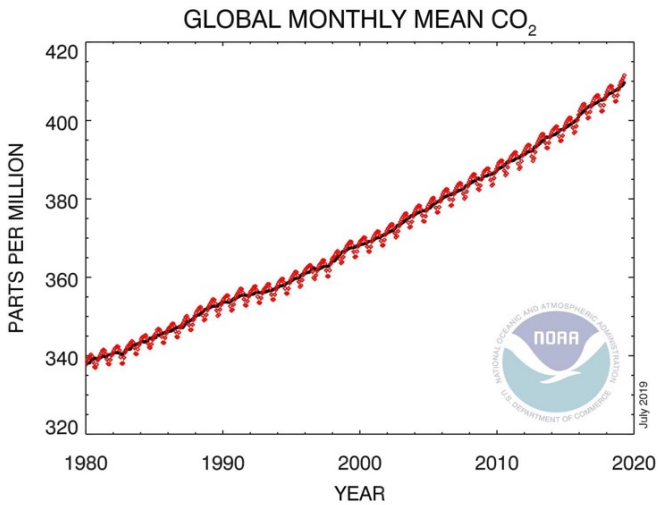
1. Warming since the mid-18th century is estimated to be around 1.1 degree Celsius.
2. The surface temperature has been increasing by 0.1 degree Celsius every 5-6 years since the 1970s.
3. 2015, 2016, 2017 and 2018 are the four warmest years on record.



Source: Global mean temperature anomalies with respect to the 1850-1900 baseline, for the five global datasets (Source: UK Met Office Hadley Centre)

Greenhouse Gases

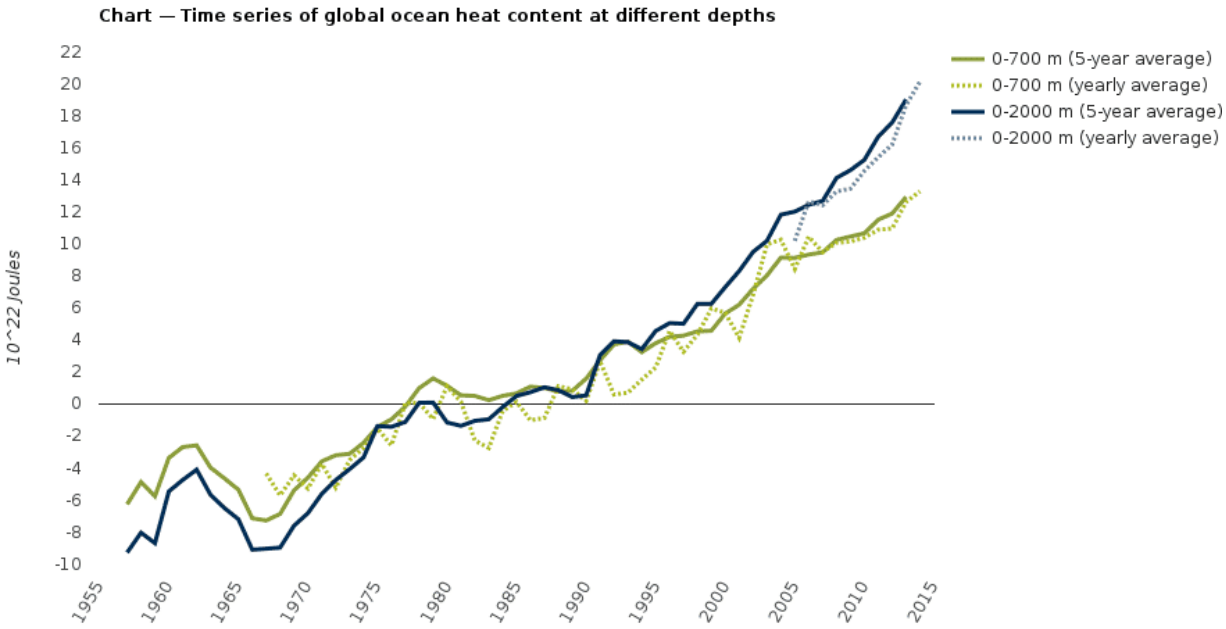
1. In 2017, the global levels of CO_2 concentration in the atmosphere passed 405 parts per million (ppm) and will not decrease for generations to come. This does not include other greenhouse gases or aerosols, which also affect the climate.
2. The concentration of other greenhouse gases such as CH_4 and N_2O were also the highest on record in 2018.
3. Together, land-use change and fossil CO_2 emissions reached an estimated 41.5 ± 3.0 billion tons of CO_2 in 2018. You might find this also expressed in gigatons or $GtCO_2$.



Source: Global monthly mean carbon dioxide globally averaged over marine surface sites since 1980 (Source: The Global Monitoring Division of NOAA/Earth System Research Laboratory).

Ocean Heat

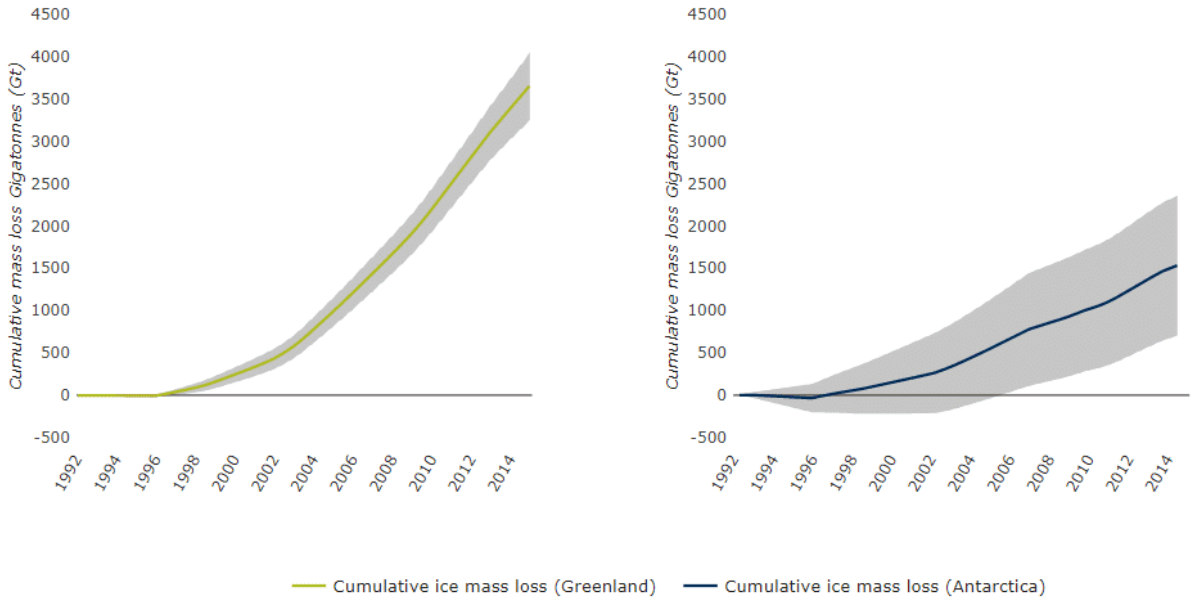
1. More than 90% of the energy trapped by greenhouse gases goes into the oceans. The global surface temperature has been rising slowly because our oceans have been absorbing most of the excess energy in the climate system.
2. Warming of the upper (0–700 metres) ocean accounted for about 64 % of the total heat uptake.
3. Recent observations also show substantial warming of the deeper ocean (between depths of 700 and 2,000m and below 3,000m)



Time series of global ocean heat content at different depths. (Source: European Environment Agency/ Data: National Oceanic and Atmospheric Administration (NOAA))

Sea Ice

1. The extent and volume of Arctic sea ice have declined rapidly since global data became available, especially in summer.
2. In each year between 2007 and 2018, Arctic summer sea ice extent was lower compared to any previous year since the introduction of satellites in 1979.
3. The largest bodies of ice, the Greenland and Antarctic ice sheets, have been losing large amounts of ice at an increasing rate since 1992.



Source: Cumulative ice mass loss from Greenland and Antarctica. (Source: European Environment Agency/ Data: University of Leeds)

Sea Level

1. Global mean sea level in 2016 was the highest yearly average since measurements started in the late 19th century.
2. The rate of sea level rise since 1993, when satellite measurements became available, is around 3 mm/year, compared to 1.2 to 1.7 mm/year prior.
3. In 2018, the total sea level change since 1993 was 78 mm.

Ocean Acidity

1. In the past decade, the oceans absorbed around 25% of anthropogenic carbon dioxide emissions. The absorbed carbon dioxide reacts with seawater and leads to ocean acidification.
2. Ocean surface pH has declined from 8.2 to below 8.1 over the industrial era as a result of the increase in atmospheric CO2 concentrations. This decline corresponds to an increase in oceanic acidity of about 30 %.
3. Ocean acidification in recent decades has been occurring 100 times faster than during past natural events over the last 55 million years.

Source: https://climate.nasa.gov

CAUSES OF CLIMATE CHANGE

Life on Earth depends on energy coming from the Sun. About half the light energy reaching Earth's atmosphere passes through the air and clouds to the surface, where it is absorbed and radiated in the form of infrared heat. About 90% of this heat is then absorbed by greenhouse gases and re-radiated, slowing heat loss to space.

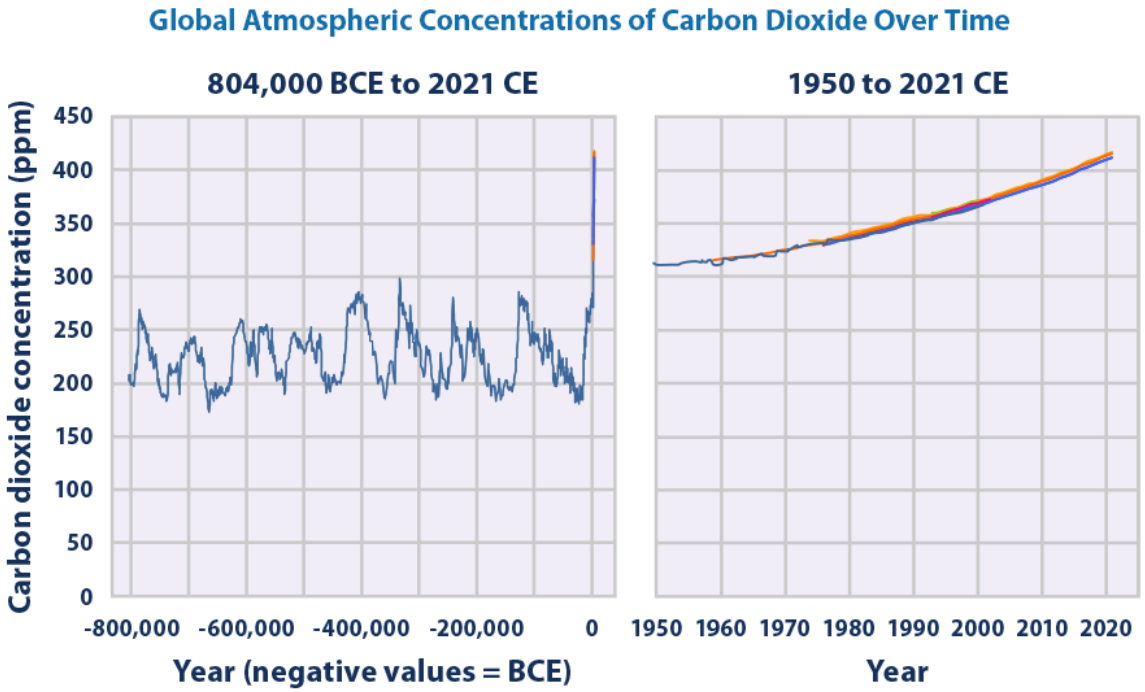
The earth has gone through warming and cooling phases in the past, long before humans were around. Forces that can contribute to climate change include the sun's intensity, volcanic eruptions, and changes in naturally occurring greenhouse gas concentrations. However, a portion of such outgoing energy is absorbed by atmospheric gases this also helps to keep the temperature warmer, the gases which trap the heat energy is known as greenhouse gases.

Recent decades, after the industrial revolution the amount of greenhouse gases (GHG) in the atmosphere has greatly increased due to human emission of GHG and removal of natural sinks such as deforestation and oceanic pollution. This process of increase in greenhouse effect causes warming of the earth surface and alters the energy transfer between atmosphere, space, land and the oceans. This phenomenon is referred as global warming.

Four Major Gases that contribute to the Greenhouse Effect:

a) Carbon Dioxide

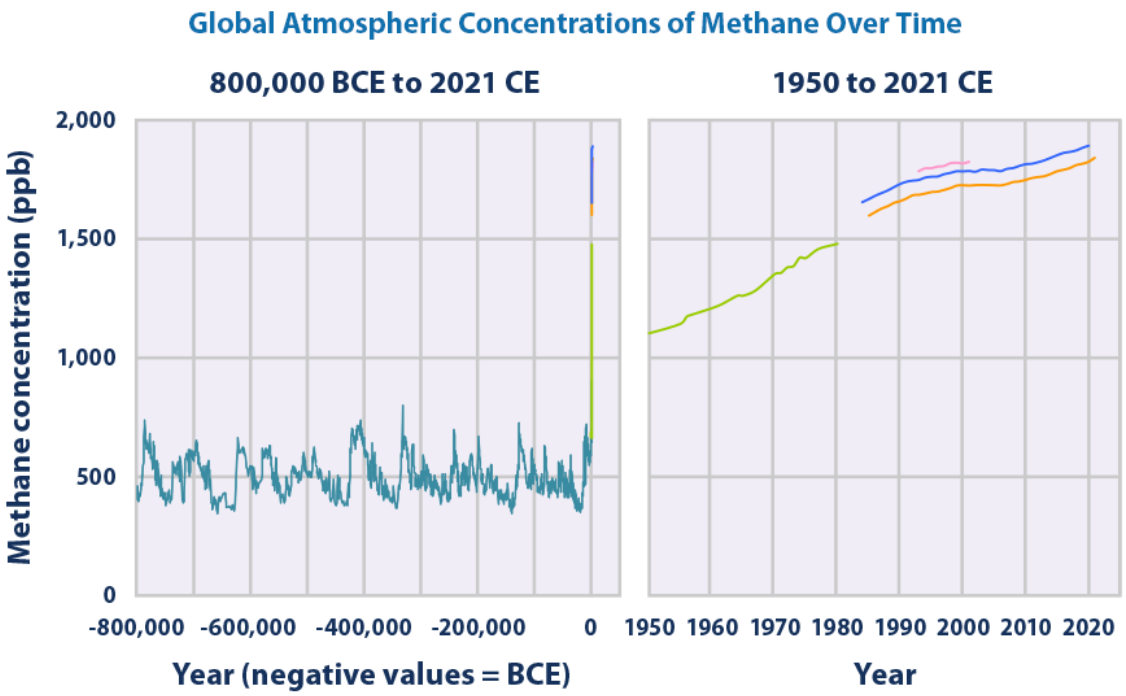
A very important component of the atmosphere, carbon dioxide (CO_2) is released through natural processes (like volcanic eruptions) and through human activities, like burning fossil fuels and deforestation. Human activities have increased the amount of CO_2 in the atmosphere by 50% since the Industrial Revolution began (1750). This sharp rise in CO_2 is the most important climate change driver over the last century.



Data source: Compilation of eight underlying datasets. See www.epa.gov/climate-indicators for specific information.

b) Methane

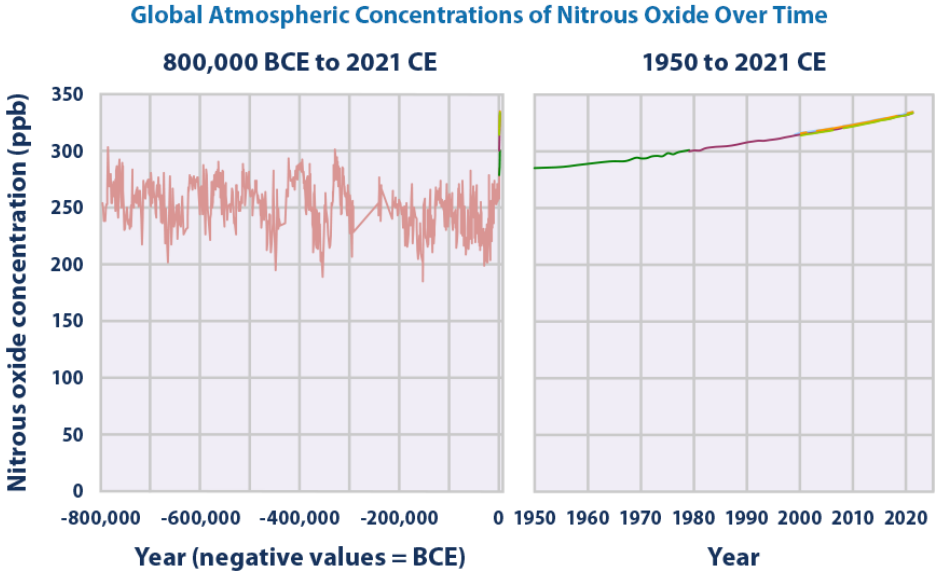
Like many atmospheric gases, methane comes from both natural and human-caused sources. Methane comes from plant-matter breakdown in wetlands and is also released from landfills and rice farming. Livestock animals emit methane from their digestion and manure. Leaks from fossil fuel production and transportation are another major source of methane, and natural gas is 70% to 90% methane. As a single molecule, methane is a far more effective greenhouse gas than carbon dioxide but is much less common in the atmosphere. The amount of methane in our atmosphere has more than doubled since pre-industrial times.



Data source: Compilation of five underlying datasets. See www.epa.gov/climate-indicators for specific information.

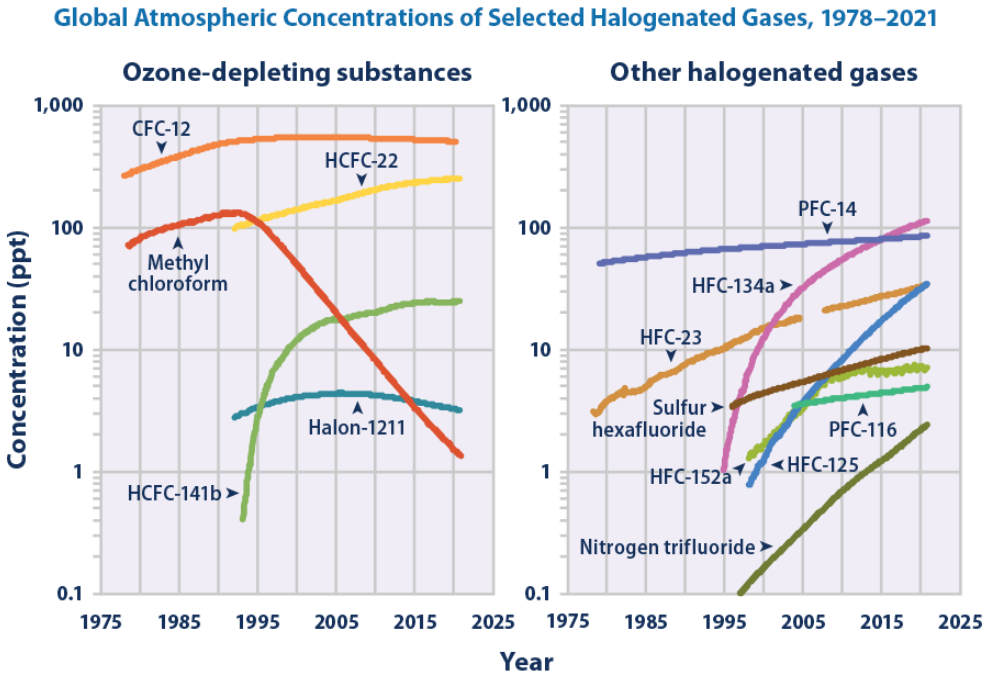
c) Nitrous Oxide

A potent greenhouse gas produced by farming practices, nitrous oxide is released during commercial and organic fertilizer production and use. Nitrous oxide also comes from burning fossil fuels and burning vegetation and has increased by 18% in the last 100 years.



d) Chlorofluorocarbons (CFCs)

These chemical compounds do not exist in nature – they are entirely of industrial origin. They were used as refrigerants, solvents (a substance that dissolves others), and spray-can propellants. An international agreement, known as the Montreal Protocol, now regulates CFCs because they damage the ozone layer. Despite this, emissions of some types of CFCs spiked for about five years due to violations of the international agreement. Once members of the agreement called for immediate action and better enforcement, emissions dropped sharply starting in 2018.



e) Water Vapor

Water vapor is the most abundant greenhouse gas, but because the warming ocean increases the amount of it in our atmosphere, it is not a direct cause of climate change. Rather, as other forcings (like carbon dioxide) change global temperatures, water vapor in the atmosphere responds, amplifying climate change already in motion. Water vapor increases as Earth's climate warms. Clouds and precipitation (rain or snow) also respond to temperature changes and can be important feedback mechanisms as well.

Humans cause climate change by releasing carbon dioxide and other greenhouse gases into the air. Today, there is more carbon dioxide in the atmosphere than there ever has been in at least the past 2 million years. During the 20th and 21st century, the level of carbon dioxide rose by 40%.

We produce greenhouse gases in lots of different ways:

- Burning fossil fuels – Fossil fuels such as oil, gas, and coal contain carbon dioxide that has been 'locked away' in the ground for thousands of years. When we take these out of the land and burn them, we release the stored carbon dioxide into the air.
- Deforestation – Forests remove and store carbon dioxide from the atmosphere. Cutting them down means that carbon dioxide builds up quicker since there are no trees to absorb it. Not only that, trees release the carbon they stored when we burn them.
- Agriculture – Planting crops and rearing animals releases many different types of greenhouse gases into the air. For example, animals produce methane, which is 30 times more powerful than carbon dioxide as a greenhouse gas. The nitrous oxide used for fertilisers is ten times worse and is nearly 300 times more potent than carbon dioxide!
- Cement – Producing cement is another contributor to climate change, causing 2% of our entire carbon dioxide emissions.

Over the last century, burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO_2). This increase happens because the coal or oil burning process combines carbon with oxygen in the air to make CO_2. To a lesser extent, clearing of land for agriculture, industry, and other human activities has increased concentrations of greenhouse gases.

The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide levels by nearly 50% since 1750. This increase is due to human activities, because scientists can see a distinctive isotopic fingerprint in the atmosphere.
In its Sixth Assessment Report, the Intergovernmental Panel on Climate Change, composed of scientific experts from countries all over the world, concluded that it is unequivocal that the increase of CO_2, methane, and nitrous oxide in the atmosphere over the industrial era is the result of human activities and that human influence is the principal driver of many changes observed across the atmosphere, ocean, cryosphere and biosphere.

> *"Since systematic scientific assessments began in the 1970s, the influence of human activity on the warming of the climate system has evolved from theory to established fact."*
>
> - Intergovernmental Panel on Climate Change

Source:

1. https://climate.nasa.gov
2. https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases
3. https://www.metoffice.gov.uk/weather/climate-change/causes-of-climate-change

IMPACTS OF CLIMATE CHANGE

The IPCC's Sixth Assessment report, published in 2021, found that human emissions of heat-trapping gases have already warmed the climate by nearly 2 degrees Fahrenheit (1.1 degrees Celsius) since pre-Industrial times (starting in 1750).1 The global average temperature is expected to reach or exceed 1.5 degrees C (about 3 degrees F) within the next few decades. These changes will affect all regions of Earth. The severity of effects caused by climate change will depend on the path of future human activities. More greenhouse gas emissions will lead to more climate extremes and widespread damaging effects across our planet. However, those future effects depend on the total amount of carbon dioxide we emit. So, if we can reduce emissions, we may avoid some of the worst effects.

"Increasing magnitudes of warming increase the likelihood of severe, pervasive, and irreversible impacts."

- Intergovernmental Panel on Climate Change

Some of the impacts by the climate change are as following:

a) Sea level will rise 1-8 feet by 2100

Global sea level has risen about 8 inches (0.2 meters) since reliable record-keeping began in 1880. By 2100, scientists project that it will rise at least another foot (0.3 meters), but possibly as high as 8 feet (2.4 meters), if we continue carbon emissions at our current rate. Sea level is rising because of added water from melting land ice and the expansion of seawater as it warms.

Even small sea level changes can cause increased flooding, because storm surge and high tides combine with sea level rise and sinking of land along coastlines to amplify flooding in some regions. Sea level rise will continue past 2100 because the ocean takes a very long time to fully respond to warmer conditions at Earth's surface. As ocean waters continue to warm, sea level will continue to rise.

b) More droughts and heat waves

Droughts in the Southwest and heat waves (periods of abnormally hot weather lasting days to weeks) are projected to become more intense, and cold waves less intense and less frequent.

All seasons are projected to continue to get hotter. By the end of this century, if we continue emitting greenhouse gases at our current rate, extreme heat events that used to occur only once in 20 years are expected to occur every year.

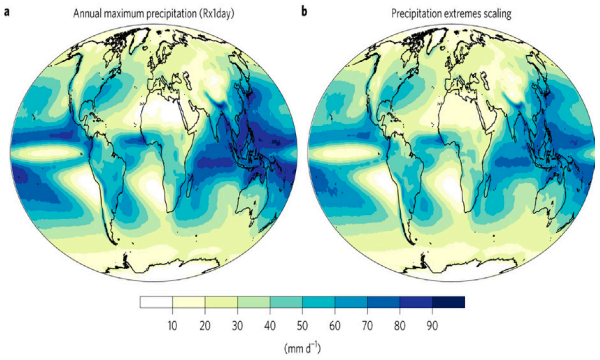
c) Longer wildfire season

Warming temperatures have made the wildfire season longer and more severe in the West, and deepening drought in the region has added to the risk of fires. Scientists estimate that human-caused climate change has already doubled the area of forest burned in recent decades. By around 2050, the amount of land consumed by wildfires in Western states is projected to further increase by two to six times. Even in rainy regions like the Southeast, wildfires are projected to increase by about 30%.

Globally, fire weather seasons have lengthened. Drought remains the dominant driver of fire emissions, but recently there has been increased fire activity in some tropical and temperate regions due to warmer temperatures that increase vegetation flammability. The northern boreal zone (Earth's northernmost forests) near the Arctic is also experiencing larger and more frequent fires, and this may increase under a warmer climate.

More fires and a longer fire season are causing an additional health hazard of wildfire smoke, which affects tens of millions of people in the United States. Meanwhile, the costs of fighting wildfires have risen 11-fold over the past 30 years, adding a financial burden on top of the public health risk.

d) Changes in precipitation patterns



Climate change is having an uneven effect on precipitation (rain and snow) in the United States, with some locations experiencing increased precipitation and flooding, while others experience drought. Scientists project more winter and spring precipitation for the northern United States, and less for the Southwest, over this century.

Projections of future climate over the U.S. suggest that the recent trend toward increased heavy precipitation events will continue. This means that while it may rain less frequently in some regions (such as the Southwest), when it does rain, heavy downpours will be more common.

e) Frost-free season (and growing season) will lengthen

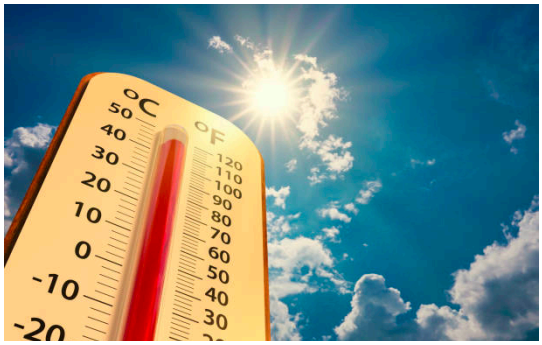
The length of the frost-free season, and the corresponding growing season, has been increasing since the 1980s, with the largest increases occurring in the western United States. Across the United States, the growing season is projected to continue to lengthen, which will affect ecosystems and agriculture.

If heat-trapping gas emissions continue to grow at current rates, increases of a month or more in the length of the growing season are projected across most of the United States by the end of the century, with slightly smaller increases in the northern Great Plains. The frost-free season could become more than eight weeks longer in parts of the western United States,

particularly in high elevation and coastal areas. The increases will be considerably smaller if we reduce our emissions of heat-trapping gases.

f) Rise in global temperatures

The climate of the United States is directly linked to the changing global climate. The last eight years have been the hottest years on record for the globe. Recent research shows that current global temperatures and the rate of the current warming are both unprecedented over the past 24,000 years. These trends are expected to continue, but reducing greenhouse gas emissions would lessen the amount of warming in the future.



g) Arctic is very likely to become ice-free

Sea ice cover in the Arctic Ocean is expected to continue decreasing, and the Arctic Ocean will very likely become essentially ice-free in late summer if current projections hold; this change is expected to occur before mid-century.

Source:

https://climate.nasa.gov/effects/#:~:text=The%20IPCC's%20Sixth%20Assessment%20report,exceed%201.5%20degrees%20C%20(about

13 CLIMATE ACTION

TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

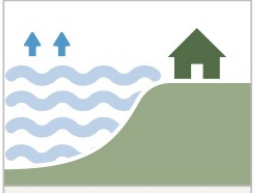
CLIMATE CHANGE IS HUMANITY'S "CODE RED" WARNING

OUR WINDOW TO AVOID CLIMATE CATASTROPHE IS CLOSING RAPIDLY

DIFFERENT TEMPERATURE SCENARIOS FOR CORAL REEFS

CORAL REEFS

SEA LEVEL WILL RISE 30-60 CM BY 2100



SEA LEVEL RISE

DROUGHT ESTIMATED TO DISPLACE 700 MILLION PEOPLE BY 2030

DROUGHTS

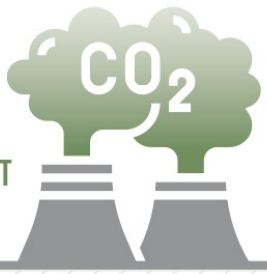
MEDIUM- TO LARGE-SCALE DISASTERS WILL INCREASE 40% FROM 2015 TO 2030

DISASTERS

ENERGY-RELATED CO_2 EMISSIONS INCREASED

6% IN 2021

REACHING HIGHEST LEVEL EVER

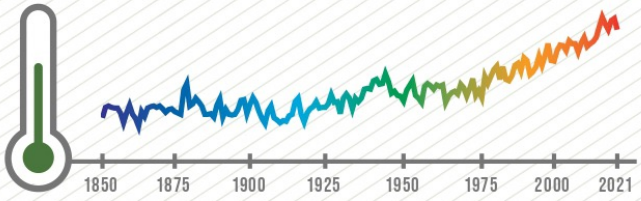


CLIMATE FINANCE

FALLS SHORT OF $100 BILLION YEARLY COMMITMENT

DEVELOPED COUNTRIES PROVIDED $79.6 BILLION IN CLIMATE FINANCE IN 2019

RISING GLOBAL TEMPERATURES CONTINUE UNABATED, LEADING TO MORE EXTREME WEATHER



THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2022: UNSTATS.UN.ORG/SDGS/REPORT/2022/

CLIMATE RESILIENT FACTORS

Adaptation

Climate change repercussions have been faced by the human race for a very long time. Adaptive efforts have been made globally to overcome the detrimental impacts on humans and environment. Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Adaptation solutions can range from building flood defenses, setting up early warning systems for cyclones and switching to drought-resistant crops, to redesigning communication systems, business operations and government policies.

Types of adaptation are based on natural systems and human systems which may be reactive and anticipatory. Changes in duration of seasons and changes in ecosystem are reactive forms of climate change. The human systems involve both private and public. Moving homes, buying of air conditioners/heaters, changes in insurance premiums, offering compensations/subsidiaries etc are reactive measures taken due to natural calamities. Installing early warning systems, establishing new building codes, changing architecture of buildings, buying hazard insurance etc are anticipatory measures taken by public & private entities. Behavioral changes such as individuals reducing their food waste, shunning plastics in daily lives, using of public transports etc can also be considered as an appropriate action to prevent climate change. Thus, one can understand adaptation as a process to adjust to the current and future effects of climate change.

Mitigation

Mitigation means avoiding or reducing the emissions of heat trapping greenhouse gases into the atmosphere. Mitigation measures include transition to cleaner fuels or renewable energies from fossil fuels, stopping deforestation, restoring natural habitats etc. Mitigation part is difficult to accomplish as the damage is already done but the efforts to reach the net zero emissions can gain momentum by enhancing sinks. These sinks are oceans, forests, and soils etc that can accumulate and store these harmful greenhouse gases.

Another effective efforts taken by the government bodies around the globe is by pricing the carbon. One way is to put direct tax to the carbon content of fossil fuels such as coal, oil products, natural gas etc. Another way is “Emission Trading System” or “Cap and Trade System” through which allowances are given to the amount of carbon released every year by creating a trading system between less intensive and more intensive carbon emitting sectors. Carbon pricing has been seen very effective to change the behavioral shift. Pricing carbon to all the products or services from energy providers, manufactures, consumers etc will see more adoption of cleaner and efficient technologies and reduced energy demands.

Vulnerability

It is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is EXPOSED, its SENSITIVITY, and its ADAPTIVE CAPACITY.

EXPOSURE (IPCC): the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.

SENSITIVITY (IPCC): the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. A change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. Damages caused by an increase in the frequency of coastal flooding due to sea level rise).

POTENTIAL IMPACT (IPCC): impacts of climate change are the effects of climate change o n natural (e.g. Water resources, biodiversity, soil, etc) and human systems (e.g. Agriculture, health, tourism, etc). Potential impacts are all impacts that may occur given a projected change in climate, without considering adaptation.

ADAPTIVE CAPACITY (IPCC): the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities, or to cope with the consequences.

RISK: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability and hazard. There are two types of assessments,

(i) Qualitative assessment (ii) Quantitative assessment

(i) Qualitative assessment: Qualitative assessment rely on descriptive information and expert knowledge and evaluation ranking into qualitative classes such as “high”, “medium” and “low”.

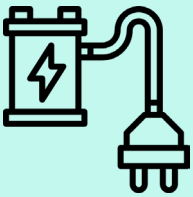
(ii) Quantitative assessment: Where technical expertise and appropriate models are available, quantitative assessment of risk may be performed.

Climate-Related Opportunities

It relates to efforts to mitigate and adapt to climate change, such as resource efficiencies and cost savings, the adoption of low-emission energy sources, the development of new products and services, access to new markets, and building resilience along the supply chain.

Efforts to mitigate and adapt to climate change also produce opportunities for organizations through, for example, resource efficiency and cost savings, the adoption of low-emission energy sources, the development of new products and services, access to new markets, maximizing new policies that subsidize efficiencies and clean energy, and building resilience along the supply chain. Climate-related opportunities will vary depending on the region, market, and industry in which an organization operates.

Climate-Related Opportunity Categories

Opportunity Categories	
Resource Efficiency 	There is growing evidence and examples of organizations that have successfully reduced operating costs by improving efficiency across their production and distribution processes, buildings, machinery/appliances, and transport/mobility—in particular in relation to energy efficiency but also including broader materials, water, and waste management. Such actions can result in direct cost savings to organizations' operations over the medium to long term and contribute to the global efforts to curb emissions. Innovation in technology is assisting this transition; such innovation includes developing efficient heating solutions and circular economy solutions, making advances in LED lighting technology and industrial motor technology, retrofitting buildings, employing geothermal power, offering water usage and treatment solutions, and developing electric vehicles.
Energy Source 	According to the International Energy Agency (IEA), countries will need to transition a major percentage of their energy generation to low emission alternatives such as wind, solar, wave, tidal, hydro, geothermal, nuclear, biofuels, and carbon capture and storage to meet global emission-reduction goals. Investments in renewable energy capacity are exceeding investments in fossil fuel generation. The trend toward decentralized clean energy sources, rapidly declining costs, improved storage capabilities, and subsequent global adoption of these technologies are significant. Organizations that shift their energy usage toward low emission energy sources could potentially save on annual energy costs.
Products and Services 	Organizations that innovate and develop new low-emission products and services may improve their competitive position and capitalize on shifting consumer and producer preferences. Some examples include consumer goods and services that place greater emphasis on a product's carbon footprint in its marketing and labeling (e.g., travel, food, beverage and consumer staples, mobility, printing, fashion, and recycling services) and producer goods that place emphasis on reducing emissions (e.g., adoption of energy-efficiency measures along the supply chain).

Markets 	Organizations that pro-actively seek opportunities in new markets or types of assets may be able to diversify their activities and better position themselves for the transition to a lower-carbon economy. In particular, opportunities exist for organizations to access new markets through collaboration with governments, development banks, small-scale local entrepreneurs, and community groups in developed and developing countries as they work to shift to a lower-carbon economy. New opportunities can also be captured through underwriting or financing green bonds and infrastructure (e.g., low-emission energy production, energy efficiency, grid connectivity, or transport networks).
Resilience 	The concept of climate resilience involves organizations developing adaptive capacity to respond to climate change to better manage the associated risks and seize opportunities, including the ability to respond to transition risks and physical risks. Opportunities include improving efficiency, designing new production processes, and developing new products. Opportunities related to resilience may be especially relevant for organizations with long-lived fixed assets or extensive supply or distribution networks; those that depend critically on utility and infrastructure networks or natural resources in their value chain; and those that may require longer-term financing and investment.

Source:

1. This table's content is reproduced from Recommendations of the Task Force on Climate-related Financial Disclosures
2. http://www.lifesecadapt.eu/fileadmin/user_upload/ALLEGATI_LIFESECADAPT/documenti/Vulnerability_Risk_FGiordano.pdf.
3. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter18.pdf
4. http://www.lifesecadapt.eu/fileadmin/user_upload/ALLEGATI_LIFESECADAPT/documenti/Vulnerability_Risk_FGiordano.pdf
5. https://www.epa.gov/climateleadership/climate-risks-and-opportunities-defined#:~:text=Climate%2Drelated%20opportunities%20relate%20to,resilience%20along%20the%20supply%20chain.

CONVENTIONS ON CLIMATE CHANGE

United Nations Framework Convention on Climate Change

The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 198 countries that have ratified the Convention are called Parties to the Convention. Preventing "dangerous" human interference with the climate system is the ultimate aim of the UNFCCC.

United Nations Climate Change
Global Climate Action

The ultimate objective of the Convention is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."

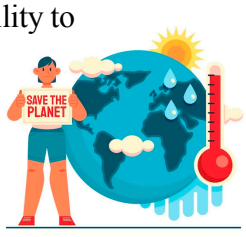
The idea is that, as they are the source of most past and current greenhouse gas emissions, industrialized countries are expected to do the most to cut emissions on home ground. They are called Annex I countries and belong to the Organization for Economic Cooperation and Development (OECD). They include 12 countries with "economies in transition" from Central and Eastern Europe. Annex I countries were expected by the year 2000 to reduce emissions to 1990 levels. Many of them have taken strong action to do so, and some have already succeeded. Industrialized nations agree under the Convention to support climate change activities in developing countries by providing financial support for action on climate change-- above and beyond any financial assistance they already provide to these countries. A system of grants and loans has been set up through the convention and is managed by the Global Environment Facility. Industrialized countries also agree to share technology with less-advanced nations.

Industrialized countries have to report regularly on their climate change policies and measures, including issues governed by the Kyoto Protocol (for countries which have ratified it). They must also submit an annual inventory of their greenhouse gas emissions, including data for their base year (1990) and all the years since.

Developing countries report in more general terms on their actions both to address climate change and to adapt to its impacts - but less regularly than Annex I Parties do, and their reporting is contingent on their getting funding for the preparation of the reports, particularly in the case of the least developed countries.

Economic development is particularly vital to the world's poorer countries. Such progress is difficult to achieve even without the complications added by climate change. The Convention takes this into consideration by accepting that the share of greenhouse gas emissions produced by developing nations will grow in the coming years. Nonetheless, in the interests of fulfilling its ultimate goal, it seeks to help such countries limit emissions in ways that will not hinder their economic progress. One such win-win solution was to emerge later, when the Kyoto Protocol to the Convention was conceived.

The Convention acknowledges the vulnerability of all countries to the effects of climate change and calls for special efforts to ease the consequences, especially in developing countries which lack the resources to do so on their own. In the early years of the Convention, adaptation received less attention than mitigation, as parties wanted more certainty on impacts of and vulnerability to



climate change. When IPCC's Third Assessment Report was released, adaptation gained traction, and parties agreed on a process to address adverse effects and to establish funding arrangements for adaptation. Currently, work on adaptation takes place under different Convention bodies. The Adaptation Committee, which Parties agreed to set up under the Cancun Adaptation Framework as part of the Cancun Agreements, is a major step towards a cohesive, Convention-based approach to adaptation.

The UNFCCC is a "Rio Convention", one of two opened for signature at the "Rio Earth Summit" in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification. The three are intrinsically linked. It is in this context that the Joint Liaison Group was set up to boost cooperation among the three Conventions, with the ultimate aim of developing synergies in their activities on issues of mutual concern.

The Kyoto Protocol

The Kyoto Protocol was adopted on 11 December 1997. Owing to a complex ratification process, it entered into force on 16 February 2005. Currently, there are 192 Parties to the Kyoto Protocol. The Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on mitigation and to report periodically.

The Kyoto Protocol is based on the principles and provisions of the Convention and follows its annex-based structure. It only binds developed countries, and places a heavier burden on them under the principle of "common but differentiated responsibility and respective capabilities", because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere. The Kyoto Protocol sets binding emission reduction targets for 37 industrialized countries and economies in transition and the European Union. Overall, these targets add up to an average 5 per cent emission reduction compared to 1990 levels over the five year period 2008–2012 (the first commitment period).

Doha Amendment

In Doha, Qatar, on 8 December 2012, the Doha Amendment to the Kyoto Protocol was adopted for a second commitment period, starting in 2013 and lasting until 2020. As of 28 October 2020, 147 Parties deposited their instrument of acceptance, therefore the threshold of 144 instruments of acceptance for entry into force of the Doha Amendment was achieved. The amendment entered into force on 31 December 2020.

The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of GHG to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

On 21 December 2012, the amendment was circulated by the Secretary-General of the United Nations, acting in his capacity as Depositary, to all parties to the Kyoto Protocol in accordance with Articles 20 and 21 of the Protocol.

During the first commitment period, 37 industrialized countries and economies in transition and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of parties in the second commitment period is different from the first.

The Kyoto mechanisms

One important element of the Kyoto Protocol was the establishment of flexible market mechanisms, which are based on the trade of emissions permits. Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms.

A. International Emissions Trading

Greenhouse gas emissions a new commodity

Parties with commitments under the Kyoto Protocol have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or assigned amounts, at over the 2008-2012 commitment period. The allowed emissions are divided into assigned amount units (AAUs).

Emissions trading, as set out in Article 17 of the Kyoto Protocol, allows countries that have emission units to spare emissions permitted them but not "used" to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity. This is known as the "carbon market."

Other trading units in the carbon market

More than actual emissions units can be traded and sold under the Kyoto Protocols emissions trading scheme. The other units which may be transferred under the scheme, each equal to one tonne of CO_2, may be in the form of: A removal unit (RMU) on the basis of land use, land-use change and forestry (LULUCF) activities such as reforestation. An emission reduction unit (ERU) generated by a joint implementation project. A certified emission reduction (CER) generated from a clean development mechanism project activity. Transfers and acquisitions of these units are tracked and recorded through the registry systems under the Kyoto Protocol. An international transaction log ensures secure transfer of emission reduction units between countries.

The commitment period reserve

In order to address the concern that parties could "oversell" units, and subsequently be unable to meet their own emissions targets, each party is required to maintain a reserve of ERUs, CERs, AAUs and/or RMUs in its national registry. This reserve, known as the "commitment period reserve", should not drop below 90 per cent of the party's assigned amount or 100 per cent of five times its most recently reviewed inventory, whichever is lowest.

Relationship to domestic and regional emissions trading schemes

Emissions trading schemes may be established as climate policy instruments at the national level and the regional level. Under such schemes, governments set emissions obligations to be reached by the participating entities. The European Union emissions trading scheme is the largest in operation.

B. Clean Development Mechanism (CDM)

The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets.

The mechanism is seen by many as a trailblazer. It is the first global, environmental investment and credit scheme of its kind, providing a standardized emissions offset instrument, CERs. A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers.

The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

Operating details of the CDM

A CDM project must provide emission reductions that are additional to what would otherwise have occurred. The projects must qualify through a rigorous and public registration and issuance process. Approval is given by the Designated National Authorities. Public funding for CDM project activities must not result in the diversion of official development assistance.

The mechanism is overseen by the CDM Executive Board, answerable ultimately to the countries that have ratified the Kyoto Protocol.

Operational since the beginning of 2006, the mechanism has already registered more than 1,650 projects and is anticipated to produce CERs amounting to more than 2.9 billion tonnes of CO_2 equivalent in the first commitment period of the Kyoto Protocol, 2008–2012.

C. Joint implementation (JI)

The mechanism known as "joint implementation", defined in Article 6 of the Kyoto Protocol, allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO_2, which can be counted towards meeting its Kyoto target.

Joint implementation offers parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host party benefits from foreign investment and technology transfer.

Eligibility and approval

A Joint Implementation project must provide a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to what would otherwise have occurred. Projects must have approval of the host party and participants have to be authorized to participate by a party involved in the project. Projects starting as from the year 2000 may be

eligible as JI projects if they meet the relevant requirements, but ERUs may only be issued for a crediting period starting after the beginning of 2008.

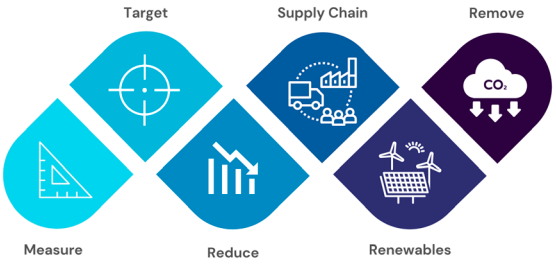
Track 1 and Track 2 procedures

If a host party meets all of the eligibility requirements to transfer and/or acquire ERUs, it may verify emission reductions or enhancements of removals from a JI project as being additional to any that would otherwise occur. Upon such verification, the host party may issue the appropriate quantity of ERUs. This procedure is commonly referred to as the Track 1 procedure.

If a host party does not meet all, but only a limited set of eligibility requirements, verification of emission reductions or enhancements of removals as being additional has to be done through the verification procedure under the Joint Implementation Supervisory Committee (JISC). Under this so-called Track 2 procedure, an independent entity accredited by the JISC has to determine whether the relevant requirements have been met before the host party can issue and transfer ERUs. A host party which meets all the eligibility requirements may at any time choose to use the verification procedure under the JISC (Track 2 procedure).

These mechanisms ideally encourage GHG abatement to start where it is most cost-effective, for example, in the developing world. It does not matter where emissions are reduced, as long as they are removed from the atmosphere. This has the parallel benefits of stimulating green investment in developing countries and including the private sector in this endeavour to cut and hold steady GHG emissions at a safe level. It also makes leap-frogging that is, the possibility of skipping the use of older, dirtier technology for newer, cleaner infrastructure and systems, with obvious longer-term benefits more economical.

Monitoring Emission Targets



The Kyoto Protocol also established a rigorous monitoring, review and verification system, as well as a compliance system to ensure transparency and hold parties to account. Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out. Registry systems track and record transactions by parties under the mechanisms. The UN Climate Change Secretariat, based in Bonn, Germany, keeps an international transaction log to verify that transactions are consistent with the rules of the Protocol. Reporting is done by parties by submitting annual emission inventories and national reports under the Protocol at regular intervals. A compliance system ensures that parties are meeting their commitments and helps them to meet their commitments if they have problems doing so.

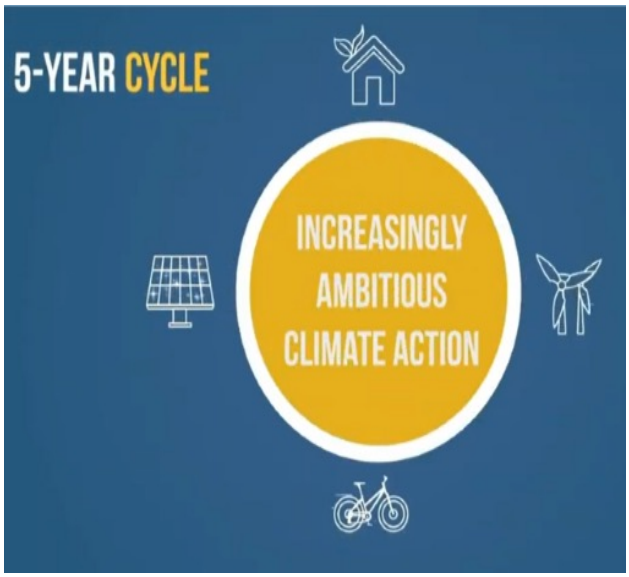
Adaptation

The Kyoto Protocol, like the Convention, is also designed to assist countries in adapting to the adverse effects of climate change. It facilitates the development and deployment of technologies that can help increase resilience to the impacts of climate change.

The Adaptation Fund was established to finance adaptation projects and programmes in developing countries that are parties to the Kyoto Protocol. In the first commitment period, the fund was financed mainly with a share of proceeds from CDM project activities. In Doha, in 2012, it was decided that for the second commitment period, international

emissions trading and joint implementation would also provide the Adaptation Fund with a 2 percent share of proceeds.

The Paris Agreement



The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century.

The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

Implementation of the Paris Agreement requires economic and social transformation, based on the best available science. The Paris Agreement works on a 5- year cycle of increasingly ambitious climate action carried out by countries. By 2020, countries submit their plans for climate action known as nationally determined contributions (NDCs).

In their NDCs, countries communicate actions they will take to reduce their Greenhouse Gas emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impacts of rising temperatures. To better frame the efforts towards the long-term goal, the Paris Agreement invites countries to formulate and submit by 2020 long-term low greenhouse gas emission development strategies (LT-LEDS). LT-LEDS provide the long-term horizon to the NDCs. Unlike NDCs, they are not mandatory. Nevertheless, they place the NDCs into the context of countries' long-term planning and development priorities, providing a vision and direction for future development.

The Paris Agreement provides a framework for financial, technical and capacity building support to those countries who need it. The Paris Agreement reaffirms that developed countries should take the lead in providing financial assistance to countries that are less endowed and more vulnerable, while for the first time also encouraging voluntary contributions by other parties. Climate finance is needed for

mitigation, because large-scale investments are required to significantly reduce emissions. Climate finance is equally important for adaptation, as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate.

The Paris Agreement speaks of the vision of fully realizing technology development and transfer for both improving resilience to climate change and reducing GHG emissions. It establishes a technology framework to provide overarching guidance to the well-functioning Technology Mechanism. The mechanism is accelerating technology development and transfer through its policy and implementation arms.

Not all developing countries have sufficient capacities to deal with many of the challenges brought by climate change. As a result, the Paris Agreement places great emphasis on climate-related capacity-building for developing countries and requests all developed countries to enhance support for capacity-building actions in developing countries.

With the Paris Agreement, countries established an enhanced transparency framework (ETF). Under ETF, starting in 2024, countries will report transparently on actions taken and progress in climate change mitigation, adaptation measures and support provided or received. It also provides for international procedures for the review of the submitted reports. The information gathered through the ETF will feed into the Global stocktake which will assess the collective progress towards the long-term climate goals. This will lead to recommendations for countries to set more ambitious plans in the next round.

Although climate change action needs to be massively increased to achieve the goals of the Paris Agreement, the years since its entry into force have already sparked low-carbon solutions and new markets. More and more countries, regions, cities and companies are establishing carbon neutrality targets. Zero-carbon solutions are becoming competitive across economic sectors representing 25% of emissions. This trend is most noticeable in the power and transport sectors and has created many new business opportunities for early movers. By 2030, zero-carbon solutions could be competitive in sectors representing over 70% of global emissions.

Source: https://unfccc.int/process-and-meetings

13 CLIMATE ACTION

CLIMATE ACTION: WHY IT MATTERS

What's the goal here?

Taking urgent action to tackle climate change and its impacts.

Why?

The climate crisis continues unabated as the global community shies away from the full commitment required for its reversal. 2010-2019 was warmest decade ever recorded, bringing with it massive wildfires, hurricanes, droughts, floods and other climate disasters across continents.

How are people being affected by climate change?

Climate change is affecting every country in the world. It is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable.

Weather patterns are changing, sea levels are rising, and weather events are becoming more extreme,

To limit global warming to 1.5C, as called for in the Paris Agreement, greenhouse gas emissions must begin falling by 7.6 % each year starting in 2020

Consumer Education and Research Centre

Consumer Education and Research Centre (CERC), set up in 1978, is a non-political, non-profit and nongovernment organisation dedicated to the education and empowerment of consumers as well as promotion and protection of consumer interests through effective uses of education, research, the media and law. CERC has three major roles-to make consumers aware of their rights, to help them protect themselves and to make providers of goods and services accountable. Its activities include complaints handling, legal advice and litigation, consumer education and awareness programmes, library and information service, publication, comparative testing of products, advocacy, investor and environment protection.

CERC-EIACP Programme centre - Resource Partner

Environmental Information, Awareness, Capacity Building and Livelihood Programme acronymed as EIACP erstwhile Environmental Information System (ENVIS), is a Resource Partner to Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India. MoEF&CC has recognized Consumer Education and Research Centre (CERC) as ENVIS Centre in 2005. The focus of EIACP is to provide environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. across the country. EIACP was conceived as a distributed information network with the subject specific centres to carry out the mandates and to provide the relevant and timely information to all concerned.

Subject assigned to the CERC- EIACP Centre is “Environmental Literacy - Eco-labelling and Eco-friendly Products.” The Centre launched the website http://cercenvis.nic.in/ on NIC (National Informatics Centre) platform with the theme ‘Eco-labelling and Eco-Friendly Products’. The website furnishes the information on national and international scenario on this subject. It publishes theme based quarterly newsletter named “Green Insights”. It also circulates bi-monthly e-bulletin “Green Alert”. To sensitize mass towards sustainable consumption and sustainable lifestyle, we are active on social media platforms such as on Facebook, Instagram, Twitter and Youtube Channel.

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