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We 4 Climate

The lecture series promote a dialogue for knowledge exchange and experience sharing about climate change challenges. The participants will comprise stakeholders including policymakers, researchers, practitioners and the general public, as well as students across four Indian states

- **Tamil Nadu**
- **Telangana**
- **Punjab**
- **Himachal Pradesh**

The lecture series is conducted by Centre for Environment Education (CEE) as part of the Indo- German bilateral project "Climate Change Adaptation in Rural Areas of India (CCA RAI)" of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

This booklet is aimed at sharing information and creating awareness about climate change, its impacts, India's response to combat climate change and state-specific impacts.

The book is developed specially for the state of Tamil Nadu with support from Department of Environment, Tamil Nadu and GIZ.

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1 What is Climate Change?

Weather and Climate

Climate change is the biggest challenge Planet Earth faces this century.

The word climate is often confused with weather. Though they are related they are different in some important ways.

Weather is the day to day state of the atmosphere for a specific place, i.e. temperature, precipitation, humidity, air pressure and wind. Climate is the long-term weather pattern of a specific place. Climate is the long term – at least over 30 years – average of the weather conditions of a place.

As for example the statement '39°C! It's hot today in Hyderabad!' describes the weather condition for the day, while the average 28.8°C mean surface temperature in

Chennai partly describes the city's climate. Another example is: An IPCC, 2014 report on the long term changes – Net annual temperatures in India in 2030s, with respect to 1970s, will increase by 1.7 to 2.2°C. – might refer to climate change.

A strong anomaly of average long-term weather conditions is what we call climate change.

Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).

Intergovernmental Panel on Climate Change

A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods is called as climate change.

United Nations Framework Convention on Climate Change

What causes Climate Change?

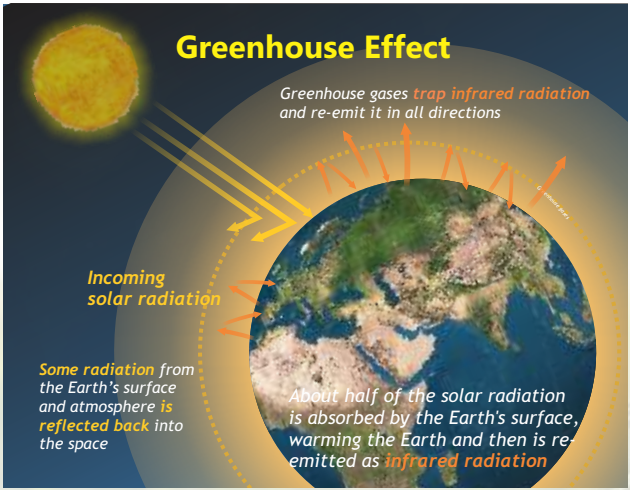
Climatic changes can take place either due to natural phenomena or human activities. The world authority on climate science, the IPCC (Intergovernmental Panel on Climate Change), is convinced that the currently observed changes are attributable to human activities, mainly the burning of fossil fuels.

Before the industrial revolution started in the 1750s the global average surface temperature was 14°C, which has increased by 0.85°C and continues to rise due to increased release of greenhouse gases in the atmosphere.

Why is the Globe warming up?

Some of the gases in the Earth's atmosphere can trap heat and maintain the Earth's temperature, acting as a thermal blanket. These gases, namely, Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) are called **Greenhouse Gases** (GHGs) and their effect is called **Greenhouse Effect.**

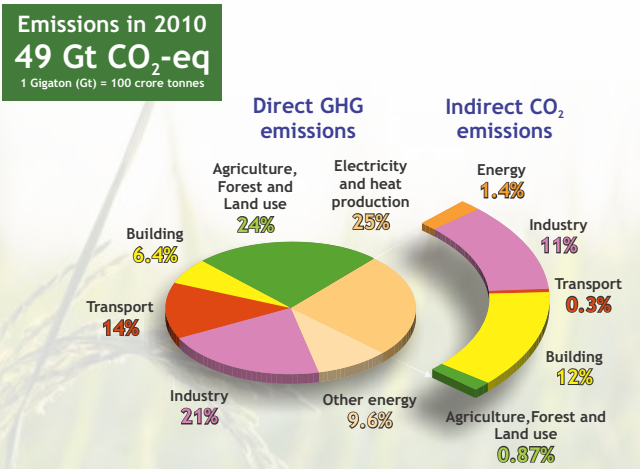
However, the concentration of the naturally present greenhouse gases in the atmosphere is increasing and new gases are being added, which leads to more heat being retained in the atmosphere. The result is the warming of our atmosphere. This is known as **enhanced greenhouse gas effect**, which is causing the global average temperature to rise.



Why is the Concentration Of GHGs Increasing?

The earth's climate had been changing due to natural causes since ages. However, the current change is **human-made.**

Since the industrial revolution, the concentration of greenhouse gases (mainly CO_2, CH_4 and N_2O) in the atmosphere has increased due to various human activities such as burning of fossil fuel for energy generation, industrial processes and transportation; deforestation and agriculture practices etc. Moreover, new gases like HFCs, PFCs and SF_6, used in refrigeration and air conditioning, have been added. With urbanisation, population growth and fancier lifestyles greenhouse gas emissions have reached unprecedented levels.



Source- Synthesis Report, IPCC Fifth Assessment Report (AR5)

Where do the global greenhouse gas emissions come from?

The 2°C

The scientific evidence and political goals suggest that in order to avoid irreversible damage, the planetary warming should be restricted to below 2°C and efforts should be undertaken to limit it to 1.5°C.

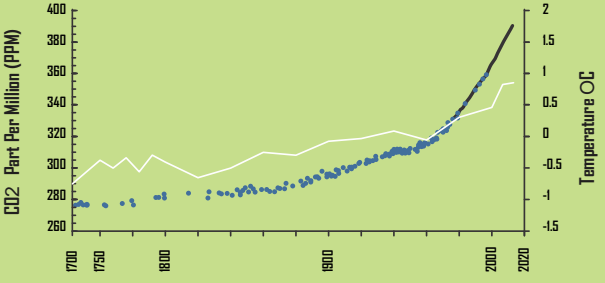
Paris Agreement, 2015

CO_2: The main culprit

Carbon dioxide acts as a thermostat regulating the temperature of Earth. Since industrial revolution, the concentration of CO_2 in the atmosphere has increased from 278 to 400 PPM. It accounted for 78% of the total GHG emissions from 1970 to 2010.

The other greenhouse gases, if emitted in the equal quantity as CO_2 are more potent and have higher warming potential. However, the amount of CO_2 emitted is much higher and it remains in the atmosphere for thousands of years.

CO2 and Temperature Rise: Correlation



Graph is re-drawn using IPCC and NOAA data

Source: IPCC Fifth Assessment Report (AR5), Working Group I and NOAA

2 Impacts of Climate Change

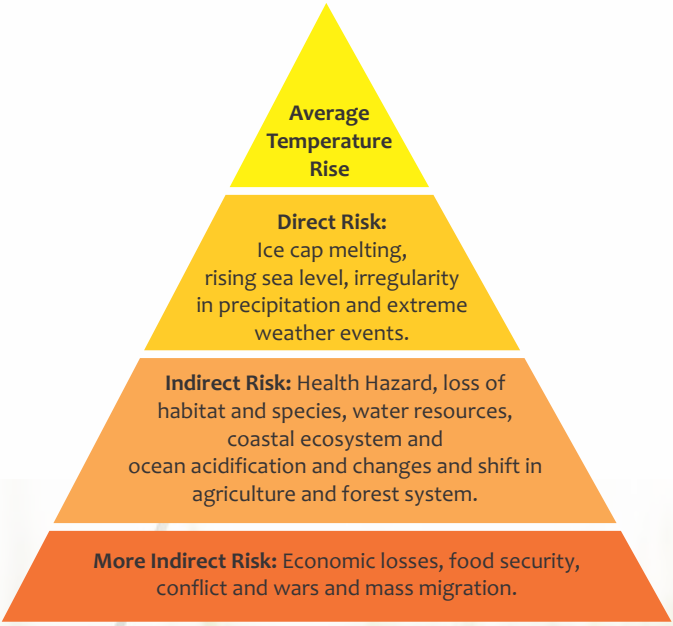
The impacts of climate change are already visible.

The average surface temperature increase is causing the polar ice cap to melt with subsequent increase in the sea level rise. However, these are the primary and direct impacts and their onset is slow.

The immediate direct impacts are the increase in extreme weather conditions and irregularity in precipitation which has indirect impacts on health, agriculture and water resources. At other levels are the indirect impacts such as migration, economic losses and wars.

In other words impacts of climate change are cascading in nature – change as a trigger in one of the systems will alter and impact all the associated ecosystems and earth's elements.

Cascading Impacts of Climate Change



Observed and Possible Impacts of Climate Change for India

High Health Risk due to increase in heat waves, vector borne diseases and epidemics.

- Increase in number of heat wave days from about 5 to between 30 and 40 every year.
- Change in spatial and temporal pattern with increased frequency of vector borne diseases.
- Loss of life due to increased frequency and intensity of flood, drought, cyclone and others.

In 2017, India witnessed one of the hottest summers with Chennai recording the highest maximum temperature (43.6°C) in the last 15 years.

Ecological degradation

- Loss of ecosystem and biodiversity.
- Increased frequency of forest fires.

Coastal inundation, sea water ingress and loss of life due to sea level rise

- 40 million Indians will be at risk from rising sea levels by 2050.
- 14,000 sq.km of land at risk due to 1 m rise in sea level.
- Mumbai and Kolkata may go under water due to sea level rise.

Losses due to natural disaster

- Loss of life and infrastructure due to intense and frequent extreme weather events.
- Energy production, industrial process and infrastructure damages.

Decreased agriculture productivity due to variability in precipitation and temperature rise.

- Wheat, rice, maize and sorghum production may decline.
- Apple cultivation shifts to higher altitude in the Himalayas.
- Possible 1.5 per cent loss in GDP.
- Shrinkage in annual agricultural income by 20 to 25 per cent in unirrigated farmland and 15 to 18 per cent in irrigated areas.

Source- Executive summary, India, Second National Communication to the United Nation Framework Convention on Climate Change

Climate, Climate Change, and Agriculture, India Economic Survey, 2017-18

Down To Earth. (2017). Climate change impact on agriculture leads to 1.5 per cent loss in India's GDP. [Online]. Avaliable at http://www.downtoearth.org.in/news/climate-change-causes-about-1-5-per-cent-loss-in-india-s-gdp-57883

India water portal. [Online]. Avaliable at http://www.indiawaterportal.org/sites/indiawaterportal.org/files/b3climate.pdf

The Hindu. Business linex. (2018). 14,000 sq.km. land at risk with rising sea level: Report. [Online]. Avaliable at https://www.thehindubusinessline.com/news/14000-sqkm-land-at-risk-with-rising-sea-level-report/article23105650.ece

3 Solutions to Climate Change

What is Mitigation? What is Adaptation?

Mitigation: **Reducing climate change.**

Actions that reduce the GHGs emissions or enhance the natural sinks of greenhouse gases.

Adaptation: **Coping with the impacts of climate change.**

Adjustments in ecological, social and economic systems to the actual or expected impacts of climate change.

India's Response to Climate Change

India has devised several national and state level policies and actions to combat climate change.

India's **Nationally Determined Contribution** sets a target to lower the GDP emissions intensity by 33 per cent to 35 per cent by 2030 compared to 2005 levels. It sets out climate action within the perspective of propagation of a healthy and sustainable lifestyle.

In 2008, Government of India introduced its first comprehensive climate policy called **National Action Plan on Climate Change (NAPCC)**. The action plan has defined strategies and programmes to address climate mitigation and adaptation through eight national missions, namely, Jawaharlal Nehru National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a "Green India", National Mission for Sustainable Agriculture, and National Mission on Strategic Knowledge for Climate Change.

Following the implementation of NAPCCs, the Government of India tasked all the state governments in 2009 to prepare their respective **State Action Plans on Climate Change (SAPCCs)**. The state level plan includes regional mapping of vulnerability, observed and projected impacts and action plan and strategies for mitigation and adaptation. SAPCCs enrich the national climate change policies by feeding local and regional experiences, needs and solutions.

Power of the sun: India has an ambitious target of achieving 100 GW of solar power until 2022 under the National Solar Mission. To meet the target, 60 GW is targeted through large and medium scale grid-connected solar power plants while 40 GW is through rooftops. Until now, India has achieved around 22 GW of cumulative solar capacity. Addtionally, India has shown global commitment by launching **International Solar Alliance (ISA)** to assist and help achieve the common goals of increasing the use of solar energy in a safe, convenient, affordable, equitable and sustainable manner. The ISA is a mutual cooperation among solar rich countries lying fully or partially between the tropics of Cancer and Capricorn. As of now, 65 countries have signed the ISA Framework Agreement.

4 State Status: Impacts and Responses to Climate Change by Tamil Nadu

Possible impacts of climate change on Tamil Nadu

Average annual maximum temperature could increase by 3.1°C by 2100 from the baseline of 1970-2000.

Average annual minimum temperature could increase by 3.5°C

Average annual rainfall could reduce by up to 9 per cent.

Increased intensity of cyclones and floods.

Loss of 144 sq.km of land if the sea level rises by a meter by 2050.

Source- State Action Plan on Climate Change of Tamil Nadu State, , Government of Tamil Nadu, July 2014

Scroll.in. (2018). If sea levels rise by 1 metre, Tamil Nadu losses could be worth half its current economy, says study. [Online]. Avaliable at https://scroll.in/article/866394/in-tamil-nadu-loss-from-rising-sea-levels-could-be-worth-half-its-economy-warns-new-climate-study

Tamil Nadu State Action Plan on Climate Change (TNSAPCC)

Tamil Nadu State Action Plan on Climate Change (TNSAPCC) aims for Balanced Growth and Resilience with “adaptation” forming the predominant component of the state's response strategy. The plan envisages an integrated approach to inclusive, sustainable and climate resilient development, ensuring overall economic growth as per the Tamil Nadu's vision 2023 agenda. Tamil Nadu State Climate Change Cell, housed at the Department of Environment, has been designated as the nodal body for all the operational aspects of the TNSAPCC implementation and coordination within the state.

The plan entails a combination of hard and soft approaches towards addressing climate concerns of the state across the following thrust areas:

Sustainable agriculture & allied sectors

- Research on crop season, effects of change etc
- Promoting integrated disease & pest management

Water resources

- Rain water harvesting measures
- Desilting & widening of channels

Forest & Bio-diversity

- Increase forest cover
- Enhancing conservation efforts

Coastal Area Management

- Avert pollution of water
- Coastal zone protection

Energy Efficiency, Renewable Energy and Solar Mission

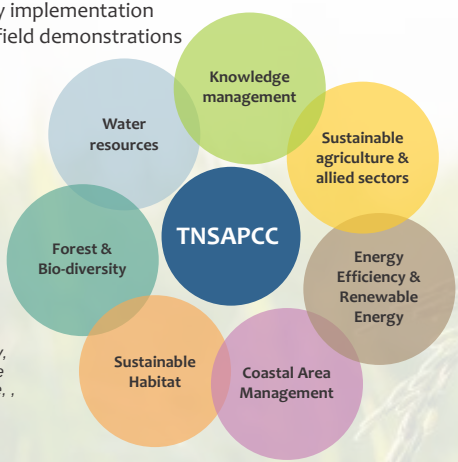
- Encouraging off and on grid renewable energy
- Demand side management

Sustainable Habitat

- Revamping water supply schemes
- Air quality monitoring

Knowledge management

- Research & policy implementation
- Innovations and field demonstrations



Source- Executive Summary, State Action Plan on Climate Change of Tamil Nadu State, , Government of Tamil Nadu, July 2014.

Case Studies

1. Integrated Mangrove Fishing Farming Systems

The Integrated Mangrove Fishing Farming System (IMFFS) converts saline wasteland into productive land by planting mangroves and farming commercially significant brackish-water fish. The project involves reclamation of abandoned coastal land, and building of infrastructure like ponds with farm bund and embankment for plantation of mangroves. Mangrove not only acts as bio-shield from storms and cyclones but also acts as nutrient for fishes. The IMFFS provides protection against cyclones and storm surges, increases land productivity and creates alternative livelihood for coastal community through fish farming.

The project was implemented by M S Swaminathan Research Foundation (MSSRF), which has regenerated 250 ha of mangroves and provides opportunity to a family to earn between Rs. 15,000 to 30,000 from their ponds within four months of construction.

Source- A compendium of climate action stories: A decade of Earth Care Awards 2008-2018

2. Women Farmers Leading in Climate Action

Dharmapuri village in Tamil Nadu is highly vulnerable to climate change. Studies conclude that rain in the district has gone down by 4 per cent in the 30-year-period between 1990 and 2020. However, the farmers in this village, especially women farmers, are making themselves climate proof by growing millets during the dry spell. Such a women-centric initiative has been possible due to an NGO - the Tamil Nadu Women's Collective (TNWC). The TNWC is a network of grassroot level women farmers who promote collective model farms. The objective of collective farming is to ensure food security, create alternative livelihood options, climate proofing and making agriculture drought resilient and making farm practices chemical free.

Source- Scroll.in. (2018). Why Dharmapuri in Tamil Nadu is drought-prone despite having at least two monsoons a year.[Online]. Avaliable at https://scroll.in/article/877386/why-dharmapuri-in-tamil-nadu-is-drought-prone-despite-having-at-least-two-monsoons-a-year

3. Integrated Rice–Fish–Poultry Farming System

To reduce vulnerability and to climate proof themselves, farmers in the district of Cuddalore, Villupuram, Nagapattinam and Thiruvannamalai are diversifying their agriculture practices through an integrated rice–fish–poultry farming system. The Annamalai University has succesfully studied the feasibilty and impacts of such a model. The model includes a rice field in 200 sq.m area with 20 poultry birds kept in cages of size 1.8 m × 1.2 m × 1 m and 100 fingerlings (Rohu, Mrigal, Catla, Common Carp) in a trench of 20 sq. m area. The bottom of the cage is made of wire mesh, allowing poultry waste to dissolve in the paddy field and serve as manure for rice production and food for the fish. The intervention demonstrates an increase in net return per household by Rs. 33,000 to 50,500/ha/year for two to three crops, weed control by 40 per cent and pest control by 30 per cent.

Source- A. P. Srivastava. Indian Farming. (2018). Selected integrated farming system models for enhanced income. [Online]. Available at https://icar.org.in/sites/default/files/Selected%20Integrated%20Farming%20System%20models.pdf

4. ClimaAdapt

ClimaAdapt is an integrated science-stakeholder approach to develop adaptation framework for water and agriculture sectors in Tamil Nadu and other two states of India. The project's primary objective is to improve the adaptive capacity of the farming communities. The project, until 2017, resulted in farmer-driven testing, refining, upscaling and finally, the implementation of several new rice growing and irrigation technologies as well as seed varieties. Eight Village Knowledge Centres have been established in the project which provide relevant information and training on farming and climate adaptation. The project was a joint initiative of the Norwegian Institute of Bioeconomy Research (NIBIO), the International Water Management Institute (IWMI), the M.S. Swaminathan Research Foundation, the Water and Land Management and Training Institute (WALAMTARI), Tamil Nadu Agricultural University (TNAU) and the Irrigation Management and Training Institute (IMTI).

Source- NIBIO. ClimaAdapt. [Online]. Available at https://www.nibio.no/en/projects/climaadapt

5. First Carbon Capture and Utilisation facility in Tamil Nadu

The Tuticorin thermal power station in Tamil Nadu is the first industrial-scale plant to capture its own carbon dioxide (CO_2) emissions and use it for making baking soda. Moreover, what makes the carbon capture industrial plant significant is that it is running without any subsidy. An Indian company named Carbon Clean Solutions has developed this Carbon Capture and Utilisation (CCU) technology which is installed at one of the boilers at the Tuticorin plant. The plant operates a coal-fired boiler for making steam, which emits CO_2 and other pollutants. A mist containing a new-patented chemical strips out CO_2 from the boiler's chimney flue gas. The separated CO_2 stream is then mixed with salt and ammonia to produce the final product, which is then used as an ingredient for baking soda and other compounds.

Source- BBC news. (2017). India's double first in climate battle. [Online]. Available at https://www.bbc.com/news/business-38391034

The Guardian. (2017). Indian firm makes carbon capture breakthrough. [Online]. Available at https://www.theguardian.com/environment/2017/jan/03/indian-firm-carbon-capture-breakthrough-carbonclean

6. World's largest single location solar park

In the mid-2016, world's largest solar plant was commissioned in Kamuthi, Ramanathapuram, Tamil Nadu with a capacity of 648 MW. In tune with the Tamil Nadu state solar energy policy, the Adani Group had entered into an agreement with the Government of Tamil Nadu in 2015 to set up this large-scale solar park.

The park is part of the state solar target of 3,000 MW and was built in a span of eight months. The plant hosts 25,00,000 solar modules across 2,500 acres. It got connected to the grid after being linked to a 400-kilovolt substation of Tamil Nadu Transmission Corporation making it the world's largest single location solar plant. The 648 MW of power produced from the solar park is purchased by the state government at a fixed rate of Rs. 7.01 per kWh for a period of 25 years.

Source- Ecowatch. (2016). World's largest solar plant goes online. [Online]. Available at http://www.ecowatch.com/worlds-largest-solar-plant-2011318629.html

International Business Times, India Edition. (2016). World's largest solar plant unveiled by Adani Group in Tamil Nadu. [online] Available at: http://www.ibtimes.co.in/worlds-largest-solar-plant- unveiled-by-adani-group-tamil-nadu-694542

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Fossil Fuel Gives Way To Solar Power. 2013. Gerry Machen. CC BY-ND 2.0. Flickr Creative Commons.

Chennai weather. 2013. Sriram Jagannathan. CC-BY-2.0. Wikimedia Commons.

Kids swimming in duck pond India Gate. 2009. Brian Gratwicke. CC BY 2.0. Flickr Creative Commons.

Forest fire in Chir Pine forests near Chitai, Almora District, Uttarakhand. 2016. Ramwik. CC BY-SA 3.0. Wikimedia Commons.

Broken end of footbridge over the Mandakini river at rudraprayag sangam. 2013. Mukerjee. CC BY-SA 3.0. Wikimedia Commons.

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Udumalpet windmill farm landscape farms rural Tamil Nadu India. 2011. Thangaraj Kumaravel. CC BY 2.0. Flickr. Wikimedia Commons.

A frame-filling portrait of a male polar bear (Ursus maritimus) jumping in the pack ice. Svalbard, Norway. 2011. Bering Land Bridge National Preserve. CC BY 2.0. Flickr. Wikimedia Commons.

Women harvesting rice paddy in Tamil Nadu, India. 2012. McKay Savage. CC BY 2.0. Flickr. Wikimedia Commons.

Tamil fishermen dragging boat. 2011. Mohanatnow. CC BY-SA 3.0. Wikimedia Commons.

India - Faces - Rural women driving their own change. 2008. McKay Savage. CC BY 2.0. Flickr. Wikimedia Commons.

Kamuthi Solar Park. 2017. CC-BY-SA-4.0. Wikimedia Commons.

NTPL (2 x 500MW) Thermal Power Plant, Tuticorin, Tamil Nadu. 2015. NLC India Ltd. CC-BY-SA-4.0. Wikimedia Commons.

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