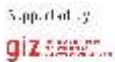


We⁴ Climate



CEE
Centre for Environment Education

We⁴ 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 Punjab with support from DST's Punjab State Climate Change Knowledge Centre, PSCST."



1 What is Climate Change?



Weather and Climate

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

The word climate is often interchanged 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 means the average of the weather conditions of a place - for least over 30 years.

For example, the statement, "30°C! It's hot today in Shimla." describes the weather condition for that day in the city. On the other hand, the annual mean temperature of Chandigarh



for the past 30 years is 24°C describes the city's climate. Another example from IPCC-2014 report, on long term changes, states that 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.

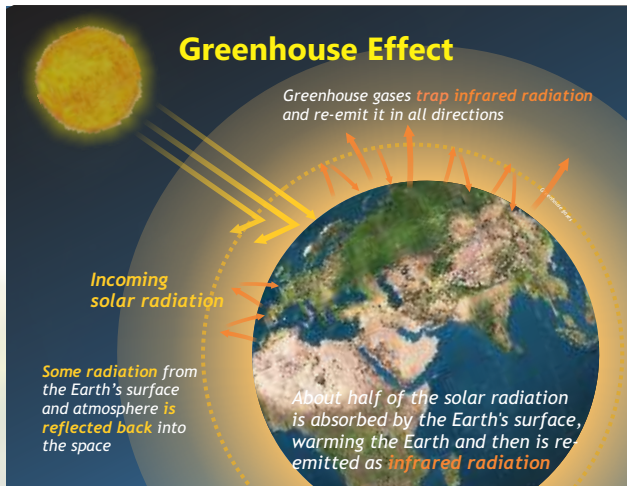
Before the industrial revolution started in the 1750s the global average surface temperature was 14°C , which has increased by 0.85°C and continues to rise due to increased release of greenhouse gases in the atmosphere.



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.



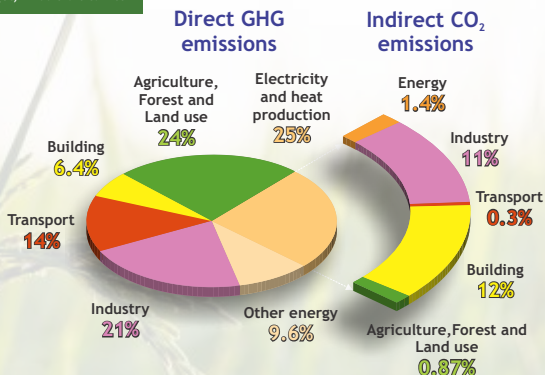
Why is the Concentration Of GHGs Increasing?

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 CO₂, CH₄ and N₂O) 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 SF₆, used in refrigeration and air conditioning, have been added. With urbanisation, population growth and fancier lifestyles greenhouse gas emissions have reached unprecedented levels.

Emissions in 2010
49 Gt CO₂-eq

1 Gigan (Gt) = 100 crore tonnes



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

Where do the global greenhouse gas emissions come from?



The Temperature Limits

Scientific evidences and political goal 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 compared to pre-industrial levels.

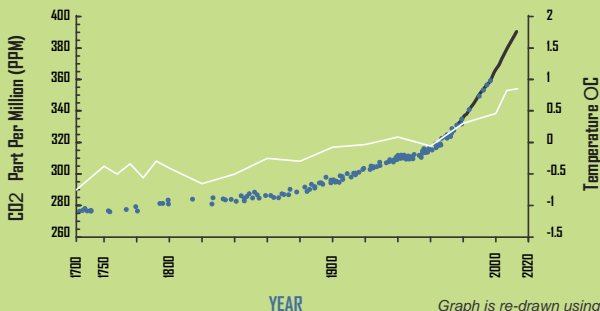
Paris Agreement, 2015

CO₂: The main culprit

Carbon dioxide acts as a thermostat regulating the temperature of Earth. Since industrial revolution, the concentration of CO₂ 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 CO₂ are more potent and have higher warming potential. However, the amount of CO₂ emitted is much higher and it remains in the atmosphere for thousands of years.

CO₂ and Temperature Rise: Correlation



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

2 Impacts of Climate Change



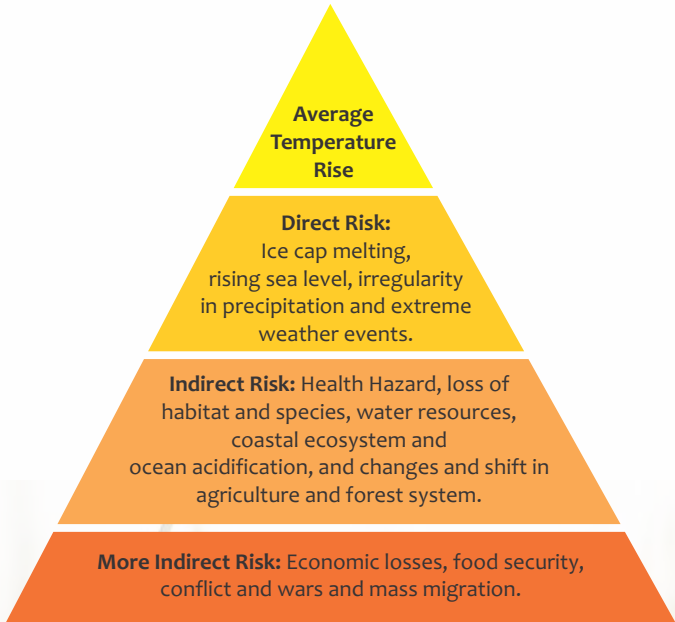
The impacts of climate change are already visible.

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 increase in conflicts.

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 as well as socio-economic systems.

Cascading Impacts of Climate Change



Observed and Possible Impacts of Climate Change for India

High Health Risk due to increased incidence of vector borne diseases and epidemics.

- Increase in number of heat strokes between 30 and 40 every year
- Change in spatial and temporal frequency of vector borne diseases
- Loss of life due to increased frequency of flood, drought, cyclone and



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 extreme weather events

- Loss of life and infrastructure due to intense and frequent extreme weather events.
- Irregularity in energy production and industrial process



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]. Available at <http://www.downtoearth.org.in/news/climate-change-causes-about-1-5-per-cent-loss-in-india-s-gdp-57883>
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The Hindu. Business line. (2018). 14,000 sq.km. land at risk with rising sea level: Report. [Online]. Available 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 in order to limit temperature rise.

Adaptation: Coping with the impacts of climate change.

Adjustments in ecological, social and economic systems to the observed and 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 (NDC)** 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. Additionally, 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 Punjab



Possible impacts of climate change on Punjab

Climate projections show that by 2021-50, the annual precipitation and mean maximum temperature would increase by about 13.3 - 21.5 percent and 1.0-1.8°C respectively leading to extreme precipitation, heat-related events as well as flood-like situations. The negative impacts of these climate change events would be manifested in the form of increased vector-borne outbreaks, plant diseases, habitat alterations, and reduction in agricultural yield and forest-based livelihoods, among others.

Source- Punjab State Action Plan on Climate Change, Department of Science, Technology and Environment, Government of Punjab, 2014.



Punjab State Action Plan on Climate Change (PbSAPCC)

Punjab State Action Plan on Climate Change (PbSAPCC) is developed in line with the objectives of the eight missions as part of the National Action Plan on Climate Change (NAPCC) and encompasses strategies to address the innumerable developmental and climatic challenges faced by the state with respect to water and agriculture, forests, ecosystem and biodiversity, urban habitats, and energy.

The plan largely focuses on ameliorating vulnerabilities due to climate change across sectors through inter-sectoral approach, inter-departmental coordination as well as collaboration with technical expertise at the state, national and international level.

Punjab State Council for Science and Technology is the designated nodal agency to assess, identify and implement climate-related programmes within the state.

Missions and related targets/strategies

The plan encapsulates state level missions with broad targets (as enumerated below) and underlying strategies to achieve these targets.

Water Mission

Increase in water use efficiency, prevention of water wastage, reduction in water pollution and equitable distribution of water.

Sustainable agricultural practices, use of new technologies and usage of agricultural residue for energy generation.

Sustainable Agriculture Mission

Green Punjab Mission

Increase forest cover to 15% by 2022 and improve the quality of degraded forests and ecosystem services.

Conserve flora, fauna, wetlands as well as biodiversity, especially to sustain Shivalik Ecosystem.

Sustaining Himalayan Ecosystem

Sustainable Habitat Mission

Design adaptation policies for urban areas, strategies for reducing heat island effect, management of solid waste and public transportation

Increase solar energy mix by 2000MW by 2022

Solar Mission

Enhanced Energy Efficiency Mission

Increase energy efficiency by 3-5% in large energy consumers, and 15-20% in small and medium enterprises.

Deeper understanding of climate change processes, its implications and related vulnerabilities

Knowledge Mission

Case Studies

1. Climate-Smart Village

The Climate-Smart Village is a community-based approach to limit the effects of climate change especially on agriculture and water for irrigation by engaging stakeholders and promoting localised best practices along with new-age technology. The idea is to mainstream climate-smart agriculture practices into the village development plans.

An assortment of climate-smart agriculture practices such as weather forecasting, index-based insurance schemes, efficient irrigation management, resilient cultivars, and other low greenhouse gas emitting options are used. These also include direct seeded rice, raised-bed farming, maize-based system, precision land levelling, alternate wetting and drying technology, crop residue management, information and communication channels for raising awareness, and gender empowerment, among others.



Source- Climate and Development Knowledge Network. (2018). India promoting Climate Smart Agriculture. [online] Available at: https://cdkn.org/2015/10/feature-climate-smart-villages-in-punjab-india-promoting-climate-smart-agriculture/?loclang=en_gb

2. Crop residue management

Burning of crop residue in Punjab is a huge menace not only for the state but also for several downwind regions in Northern India. Punjab, along with three other Indian states initiated a project to sustainably utilise paddy straw as an alternative fuel in brick kilns, thereby reducing air pollution from open burning of paddy straw and reducing dependence on fossil fuel in the local brick industry.

In addition to benefitting environmental and human health, the farmers also secure an alternative source of income by selling the briquetted crop residue. The project aims to mitigate climate change impacts and enhance adaptive capacity in the project areas through awareness-raising among farmers and promoting alternate uses of crop residue; to develop sustainable and implementable entrepreneurial models in rural areas by engaging different stakeholders, upscaling successful and innovative initiatives for crop residue management; to improve the income generation potential of farmers; and to suggest policy interventions. The project is sanctioned under the National Adaptation Fund for Climate Change (NAFCC).



Source- NABARD (2018). *Climate Resilience Building among Farmers through Crop Residue Management*. [online] Available at: http://www.moef.gov.in/sites/default/files/Regional%20Project%20DPR_on_Crop_Residue_Management_-_15_January_2018.pdf.

3. Climate Resilient Livestock Production System

Punjab ranks among the top five milk-producing states of India, with animal husbandry being the second most important economic sector, after agriculture. Climate change and the projected rise in temperatures are expected to reduce livestock production. To address these challenges, the Punjab State Council for Science and Technology, Government of Punjab, is implementing a project to ensure sustainable levels of livestock production through scientific interventions, assisted reproductive technologies, water-use efficiency in fodder cultivation, climate resilient housing for cattle, disease forecasting for preventing breakout of bovine diseases. The project also encourages livestock farmers to harness co-benefits by housing stray cattle. Another measure being developed under the project is weather-linked insurance for compensating these farmers when there is a decrease in milk yield. The project also focuses on effective gender participation with 30 percent of the project beneficiaries being women.



Source- Punjab State Council for Science & Technology (2015). Towards Climate Resilient Livestock Production System in Punjab. [online] Available at: <http://www.moef.gov.in/sites/default/files/Punjab.pdf>.

4. Farm pond revival

Over the past years, Punjab has consistently recorded below normal rainfall that has taken a toll on the groundwater levels due to over-extraction. However, a few farmers in Patiala have rediscovered the potential of farm ponds, which can solve the water crisis in the state to a certain extent and also aid in reducing the intensity of floods. During monsoon, the ponds are filled with water that can be used for irrigating the fields during dry spells. This reduces the dependence on groundwater and consumption of GHG emitting diesel fuel in pumps, which require less power to lift pond water. The initiative started with an individual farmer, without any push from a governmental or non-governmental organisation, and has managed to spread to around 15 farmers from nearby villages. With erratic rainfalls becoming a jarring reality for Indian farmers, farm ponds become a necessary fall back.



Source- Manu Moudgil. (2018). Ponds--once a lifeline of India's agriculture--are being revived by some Punjab farmers. [online] Available at: <http://www.indiawaterportal.org/articles/ponds-once-lifeline-indias-agriculture-are-being-revived-some-punjab-farmers>.

5. Solar Powered Micro Irrigation Project

People in Jugial, a village in the Talwara and Hajipur Blocks of Hoshiarpur district are mainly dependent on agriculture. Since the village is at an elevation from the irrigation canal, agriculture in the region is mainly rain-fed. However, in the past decade, rainfall has reduced drastically affecting crop productivity and livelihoods.

The Department of Soil and Water Conservation, Punjab implemented an Integrated Solar-powered Community Lift Micro-Irrigation Project on the Kandi Canal in the two blocks to support sustainable agriculture in the region. Major initiatives under the project include field level installation with high-tech micro irrigation systems complete with automation. The project is first of its kind in Punjab with large-scale water-use efficiency (70 percent saving) from the canal and other inputs through an underground pipeline and micro irrigation. The project has benefited 664 hectares area owned by 800 farmers of 14 villages with assured irrigation and productive cultivation. The intended socio-economic development of the beneficiaries through optimum yields is also expected to increase by 40-80 percent.



Source- GIZ-India.

6. Model Solar City Chandigarh

The Ministry of New and Renewable Energy, Government of India selected the city of Chandigarh to be developed as a Model Solar City. As per the Master Plan for the Model Solar City, the short term target for 3 years (until 2014) for Rooftop Solar photovoltaic system was 2.5 MW and the long-term target is 10 MW for 10 years (until 2022).

The Model Solar City of Chandigarh was launched in July 2013 with the inauguration of two Roof top Grid Interactive SPV Plants at Paryawaran Bhawan in sector 19-B (50 kWp) and at Model Jail, Burrail (100 kWp). By the end of 2016, around 5.2 MWp Roof top SPV Plant had been commissioned on more than 99 government buildings in Chandigarh, ranking the city third in the country in Rooftop Solar Plant installation. Another plant with the capacity of 1000 kWp has been commission at Punjab Engineering College.



Source- ENVIS Centre of Chandigarh's State of Environment. (2016). Chandigarh A Model Solar City. [online] Available at: <http://chenvis.nic.in/index3.aspx?ssid=1341&subsublinkid=357&langid=1&mid=1>.

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Photo credits:

Tierra (NASA) – 05. Banco de Imágenes Geológicas.2010. CC-BY-2.0. Wikimedia Commons.

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 rudraprag sangam. 2013. Mukerjee. CC BY-SA 3.0. Wikimedia Commons.

Own work. 2016. MrGauravBhosle. CC-BY-SA-4.0. Wikimedia Commons.

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.

A farmer in Sangrur district, Punjab tends to his vegetable garden. 2012. Nirmal Sigta (IWMI). CC BY-NC-SA 2.0. Climate Change, Agriculture and Food Security (CCAFS) Flickr page.

Threshing, near Sangrur, SE Punjab, India. 2011. Neil Palmer. CC-BY-SA-2.0. Wikimedia commons

Agro Waste Briquettes. Indiamart website.

Climate Smart Villages- Karnal. 2014. Prashanth Vishwanathan. CC BY-NC-SA 2.0. Climate Change, Agriculture and Food Security (CCAFS) Flickr.

Farm Pond. 2008. Serge Birtel. Permission sought.

Solar powered micro irrigation. GIZ-India. Permission sought.

An aerial view of the solar panels set on the roof top of Punjab Engineering College in Chandigarh. 2016. Chandigarh Metro.

CEE

Centre for Environment Education

Thaltej Tekra, Ahmedabad 380054

Phone: 91-79-26858002 to 05

Fax: 91-79-26858010

E-mail: cee@ceeindia.org

Website : www.ceeindia.org

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