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Government of India
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We 4 Climate

The lecture series promotes a dialogue for knowledge exchange and experience sharing about climate change challenges. The participants will comprise of 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 Himachal Pradesh with support from the Department of Environment, Science and Technology (DEST), Government of Himachal Pradesh.

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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 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?

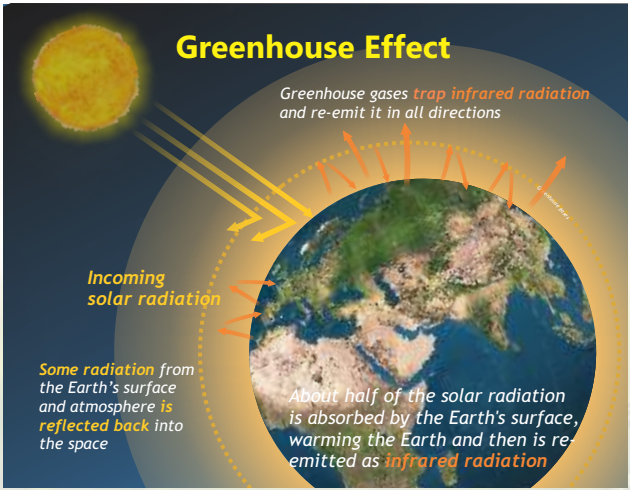
Climatic changes can take place either due to natural phenomena or human activities. The world authority on climate science, the IPCC (Intergovernmental Panel on Climate Change), is convinced that the currently observed changes are attributable to human activities, mainly the burning of fossil fuels.

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.**

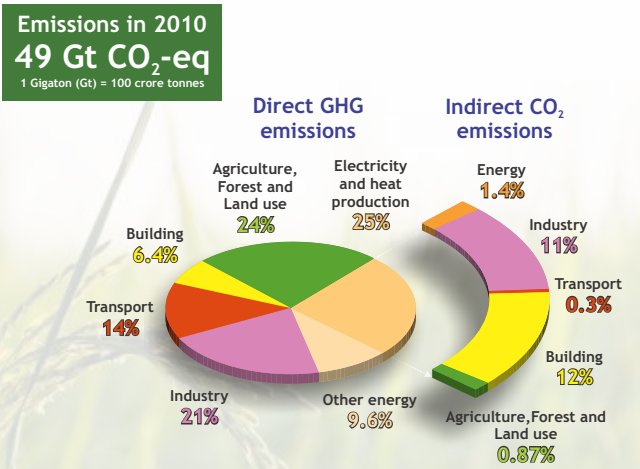
However, the concentration of the naturally present greenhouse gases in the atmosphere is increasing and new gases are being added, which leads to more heat being retained in the atmosphere. The result is the warming of our atmosphere. This is known as **enhanced greenhouse gas effect**, which is causing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

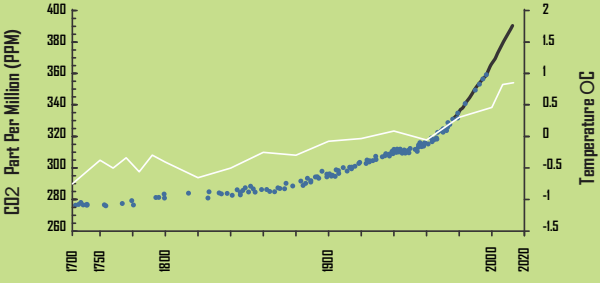
Paris Agreement, 2015

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

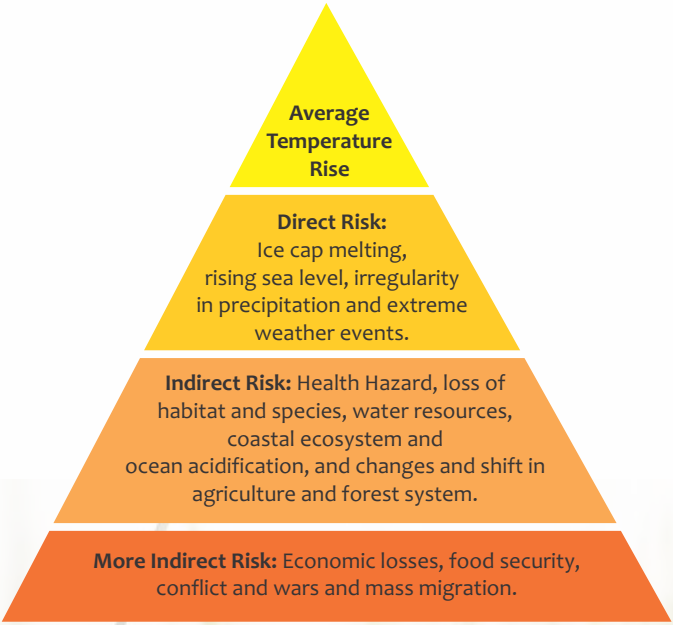
The impacts of climate change are already visible.

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 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 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 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]. 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 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.

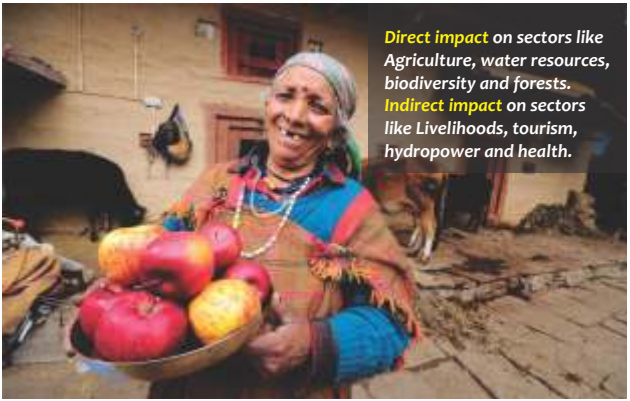
Power of the sun: India has an ambitious target of achieving 100 GW of solar power until 2022 under the National Solar Mission. To meet the target, 60 GW is targeted through large and medium scale grid-connected solar power plants while 40 GW is through rooftops. Until now, India has achieved around 22 GW of cumulative solar capacity. 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 Himachal Pradesh

Possible impacts of climate change on Himachal Pradesh

Rise in annual temperature between 1.5-2.8°C.
Mean annual rainfall likely to vary between 1250±225.2 & 1550±175.2 mm.
Increased rainfall variability leading to drought like conditions as well as flash floods.
Reduction in glacier area, shifting of tree line and increase in disease incidences.
Changing trends of seasons, snowfall, vegetation and apple contours.

Source- State strategy and action plan on climate change, Himachal Pradesh, Department of Environment, Science and Technology, Government of Himachal Pradesh, 2012

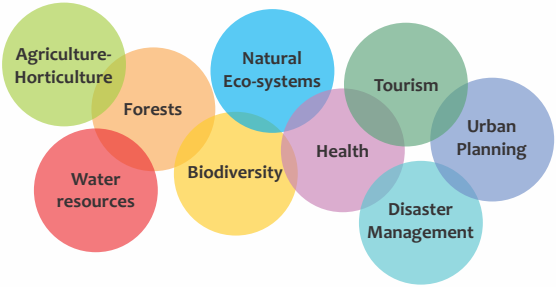


Himachal Pradesh State Action Plan on Climate Change (HPSAPCC)

Himachal Pradesh State Action Plan on Climate Change (HPSAPCC) has been designed keeping in mind the state's strategic location within the fragile Himalayan ecosystems and its immense responsibility towards securing livelihoods of the downstream communities. Being a large repository of natural resources, Himachal Pradesh's economy is largely dependent on hydro power generation, horticulture, agriculture, forestry and tourism. The negative impacts of climate change have posed a threat on these sectors majorly affecting the livelihood aspects of the state.

"GHG emissions inventory developed by the state for sectors and sub-sectors forms a major highlight of the HPSAPCC and shows that the state emits 10.083 million tonnes of CO_2 equivalent annually (i.e. ~0.67% of the annual emissions of India for the base year 2009)"

The plan charts out vulnerabilities, implemented initiatives and potential adaptation and mitigation actions as well as strategies across the following sectors:



Ongoing programmes aligned with National Missions

Himachal Pradesh has proactively adapted the National Missions and has been implementing varied initiatives under the umbrella of the eight state-level programmes (enumerated below) such as watershed development, rural participation, total sanitation, technology transfer, crop diversification, and promoting carbon neutrality, among others.

- Himachal Pradesh Solar Energy Programme
- Himachal Pradesh Energy Efficiency and Saving Programme
- Sustainable development programme for urban and rural areas
- Sustainable water management
- Sustainable development to save the Himalayan ecosystem
- Programme for greening of Himachal
- Sustainable agriculture
- Strategic knowledge for Climate Change- Towards Carbon smart growth

Source- State strategy and action plan on climate change, Himachal Pradesh, Department of Environment, Science and Technology, Government of Himachal Pradesh, 2012

Case Studies

1. Climate Smart Solutions for Sustainable Livelihoods

Around 70% of the state's population relies on agriculture for their livelihood but the vagaries of climate change often make the sector and the people vulnerable. The district of Sirmour is particularly water stressed with recurring droughts, decline in winter precipitation and snowfall, warmer and shorter winters and extreme weather events. Hence, to ensure a sustainable and resilient livelihood, a project was initiated wherein a drought related vulnerability assessment was conducted to design climate smart solutions for drought management. The project aims to train 25,000 farmers on climate smart agriculture practices with at least 25% women participation. Additionally, inter-cropping of maize and pulses, SRI cultivation, micro-irrigation practices and risk-transfer instruments such as weather insurance will also be promoted. The project is funded under the National Adaptation Fund for Climate Change.

Source- NABARD. (2018). Adaptation through NAFCC- Project Snapshot. [online] Available at: https://www.nabard.org/auth/writereaddata/File/HP%20NAFCC.pdf.

2. Paving way for Gender Responsive Adaptation & Local Climate Vulnerability Capacity Assessment at Village Level

The villages like Bhagli, Jadoini, Shilly, Klimo, Palwno, and others in the Dhamoon Panchayat are highly vulnerable to varying climate and diversified livelihood activities. To climate-proof the villages, the first ever fully automated Hi-Tech Green House has been piloted. Moreover, through integrated climate resilient actions and scientific management practices ecosystem services are also being strengthened.

Furthermore, the importance of gender-responsive climate adaptation is evident. Through the process of gender focused review, training and capacity building, women farmers have successfully restored their abandoned farmlands through cash-crop farming, community-based revival of traditional *kuhls* for irrigation, and conservation of local traditional crops. The shift in agriculture practices from traditional crops towards cash crop intensive production is driven by variations in climate and socio-ecological evolution in agriculture-horticulture practices. The initiative has successfully restored few traditional crops, motivated the women to collect, store and propagate traditional crops seeds, and to mainstream adaptation in their day-to-day life.

Source: Department of Environment, Science and Technology (DEST), and GIZ-India

3. Improving adaptive capacity of Kandraur Panchayat

Kandraur Panchayat, Bilaspur district is water-stressed with warmer winters, erratic rainfall, depleting groundwater table and inadequate irrigation infrastructure. Majority of the population is dependent on rain-fed agriculture for their livelihood and grow only food crops like wheat and maize.

As part of the Climate Change Adaptation in Rural Areas of India (CCA-RAI) project implemented by GIZ in partnership with the Department of Environment, Science and Technology- Himachal Pradesh, few progressive farmers are practicing crop diversification. Rakesh Kumar of Miyan Bandla village cultivates vegetables like colocasia, onion, spinach, garlic; spice crops like ginger, turmeric; essential oil crops like red and white sandalwood; and horticultural crops like mango, lemon, and pomegranate. He is also introducing new crops like yam, kiwi that are suitable for the regional climatic conditions. Another farmer, Surinder Pal Sharma has increased his income by growing bell-peppers in a poly-house using drip irrigation system.

With these demonstration cases, the project aims to, benefit more than 2300 farmers in four villages of the panchayat, by developing adaptive capacity with more irrigation infrastructure, watershed structures, introduction of micro irrigation techniques for water-use efficiency, and knowledge management and capacity building.

Source: GIZ-India

4. Restoring traditional Irrigation Systems : *Kuls*

Kuls are community managed traditional irrigation systems in Himachal Pradesh. These surface channels divert water from natural flowing streams, on an average serving around 6 to 30 farmers and irrigating around 20 Ha of land. *Kuls* consists of informally constructed outlets channelling water for irrigating nearby terraced fields, where the water flows from one field to the next. Any surplus water drains back to the stream from which the water was initially diverted.

The government has taken several initiatives and programmes to restore and protect these *kuls*. 12 *kuls* have been repaired and 325 Ha of Cultural Command Area has been created for irrigation. Moreover, 903 farmers were provided HDPE irrigation pipes and encouraged to adopt micro irrigation systems. 69 water users' associations and 18 watershed committees were established to maintain the restored *kuls* and farmers were trained on sustainable irrigation and latest agriculture technology.

Source- NITI Aayog. (2017). Selected Best Practices in Water Management [online] Available at: http://www.niti.gov.in/writereaddata/files/document_publication/BestPractices-in-Water-Management.pdf.

5. On-grid Roof-top Solar Power Plant

The Department of Environment, Science and Technology, Government of Himachal Pradesh has installed 35 KW roof-top solar system on the roof of Paryavaran Bhawan in Shimla. A total of 112 photovoltaic panels have been installed with each panel having a wattage of 315 Watts. The total project budget is around 19.23 lakh. One bi-directional meter has also been installed which is essential for energy inflow and outflow from solar plant to the main electricity grid. A grid tied inverter/power conditioning unit of 40 kW has also been installed. The plant reduces the use to electricity generated through fossil fuels and eventually helps in offsetting carbon dioxide in the atmosphere. It has been estimated that the return on the investment made on the installation and connection of the rooftop solar power plant will be made in approximately 5 years which will lead to revenue saving for the Government. As per estimation, about 97 lakhs would be saved in the next 25 years.

Source- Department of Environment, Science and Technology (DEST)
Shri Panna Lal Sharma. (2018). Grid Connected Solar Rooftop Power Plant Installed In State Paryavaran Bhawan in Shimla, Himachal Pradesh. [online] Available at: https://mnre.gov.in/file-manager/akshay-urja/june-2018/Images/40.pdf.

6. Model Eco Village Scheme of Himachal Pradesh

Eco-village is an emerging concept in India. To demonstrate villages as models of sustainable development, Government of Himachal Pradesh has launched Eco Village Scheme through Department of Environment, Science & Technology (DEST) in active collaboration with local communities. In the first phase five villages have been identified to be developed as eco-villages, key elements of which include environment sustainability through responsible natural resource management practices, community participation, use of modern and clean technology & practices, convergence of resources available for development to promote climate resilient and ecologically sustainable development with interventions in the areas of water management, waste management and irrigation, sustainable agriculture/ horticulture, energy conservation, spring-shed and natural resources management & climate change adaptation. The approach will not only help those stakeholders who are working to implement sustainable community development programmes but also will set benchmarks for others to adopt and bring a radical change in thinking process of the communities at large in the state, especially in inculcating environmentally responsible behaviour.

Source- Department of Environment, Science and Technology (DEST). (2017). Eco-village Scheme Guidelines. [online] Available at: https://desthp.nic.in/notifications/Eco-village_Scheme_Guidelines.pdf.

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

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Kandraur Panchayat, Bilaspur. CTRAN Consulting Ltd. Permission sought.

The diversion—The kuhl (left) is diverted from the glacier-fed stream (right). 2014. India Water Portal. CC BY-NC-SA 2.0. IWP Flickr page.

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