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CLIMATE CHANGE AND ITS IMPACT ON INDIAN REGION

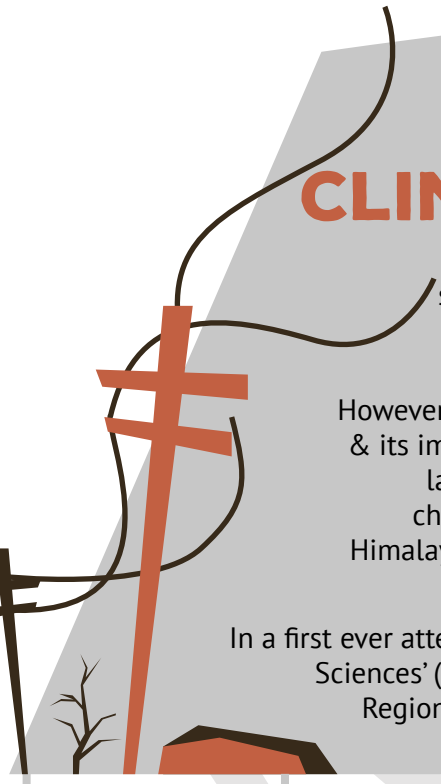
INTRODUCTION

Human activities since the nineteenth century have contributed to substantial increases in the atmosphericconcentrations of heat-trapping greenhouse gases (GHG), such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases. For instance, rapid increase of atmospheric CO2 levels from 280 parts per million during 1850 to more than 416 parts per million in February 2020. GHGs, along with other anthropogenic activities such as aerosols and changes in landuse and land cover (LULC) have caused global average temperatureto rise by around 1°C since pre-industrial times. Warming induced mainly by anthropogeic factors with minor contributions of natural climatic factorssince 1950s has already contributed to a significant increase in weather and climate extremes globally (e.g., heat waves, droughts, heavy precipitation, and severe cyclones). As the impacts associated with human-induced climate change pose serious threats to lives and livelihoods on the Indian subcontinent it becomes highly mportant to understand - how and why the climate is changing across India and how these changes are expected to evolve in the future; how it is impacting & will impact the Indian region and what steps have been taken to prevent and mitigate such impacts. Moreover, it is also important to understand the relevance of climate change study at regional level apart from global level. Going ahead, we will look for answers to these questions.

WHY UNDERSTANDING THE IMPACT OF CLIMATE CHANGE AT REGIONAL LEVEL IS IMPORTANT?

- While climate change is global, changes in climate are not expected to be uniform across the planet. For instance, Arctic temperatures are rising much faster than the global average, and rates of sea-level rise vary significantly across the world.
- At the same time, changes in climate are not understood as robustly at the regional level as at the global scale because
  - The causes of local climate change is much more complex. The local climate change is influenced not only by the increase in the greenhouse gases but also by the increase in air pollution and the local changes in land-use pattern.
  - In order to understand local climate change, we need more observations and a detailed analysis of the factors that lead to local changes in climate.
- Knowledge of present and expected changes in regional climate is critical to people and policy makers to plan for disaster management, risk mitigation and for formulating locally relevant adaptation strategies.

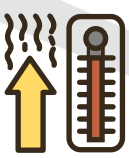
WHAT ARE THE OBSERVED AND PROJECTED CHANGES IN CLIMATE IN THE INDIAN REGION?



India is a vast country with many climate zones. The regional climate over the Indian subcontinent involves complex interactions of the atmosphere–ocean– land–cryosphere system on different space and time scales. In addition,anthropogenic activities have influenced the regional climate in recent decades.

However, there has been a poor understanding of the cause effect relationship of climate change & its impact on Indian landmass . For example, the IPCC Fifth Assessment Report (AR5) reported large inter-model spread (variations across different approaches of studies) in the climate change response of the Indian monsoon precipitation, Indian Ocean regional sea-level rise, Himalayan snow cover, and other aspects of the regional climate system. Such variations lead to uncertainty in understanding the definite impact of climate change on these attributes.

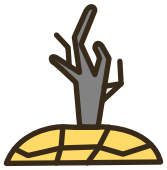
In a first ever attempt to document and assess climate change in different parts of India, Ministry of Earth Sciences' (MoES) has come up with the report titled 'Assessment of Climate Change over the Indian Region'. As per the report, following are the observed and projected changes in various climatic dimensions over the Indian region



Temperature Rise

- India's average temperature has **risen by around 0.7°C during 1901–2018**
- By the end of the twenty-first century, relative to the recent past (1976–2005 average) it is projected-
  - Average temperatures **to rise by approximately 4.4°C.**
  - Frequency of summer (April–June) **heat waves over India is projected to be 3 to 4 times higher**
- Amplification of heat stress is expected across India, particularly over the Indo-Gangetic and Indus river basins.
- **Causes:** The surface air temperature changes over India are attributed **mostly by greenhouse gases** and partially offset by other anthropogenic forcing **including aerosols and LULC change.**

Sea-level rise in the North Indian Ocean (NIO)	▶ Sea-level rise is intimately related to **thermal expansion** due to rising ocean **sea surface temperature** (SST), heat content, and the **melting of glaciers** that add water to the world's oceans. ▶ While, the major contribution to global mean sea-level rise is from glacier melt, **thermal expansion (thermosteric) has dominated sea-level rise in the NIO.** The NIO **rose at a rate of 3.3 mm year** during 1993–2017 against a rate of 1.06–1.75 mm per year during 1874–2004. The water along India's coasts is expected to **rise by 20-30 cm by 2100.** ▶ **SST of the tropical Indian Ocean has risen by 1°C on average** during 1951–2015, markedly higher than the global average SST warming of 0.7°C. ▶ **Causes:** Sea-level rise of the NIO during the recent 3–4 decades are closely linked to the **weakening trend of summer monsoon winds and the associated slowdown of heat transport** out of the NIO.
Change in Rainfall pattern	▶ **Summer monsoon rainfall (June to September) over India** which contribute to more than 75% of the annual rainfall has **declined by 6%** between 1951-2015 especially in the densely populated Indo-Gangetic plains and the Western Ghats. ▶ The **frequency of localized heavy rain occurrences has significantly increased** by 75% during 1950–2015. ▶ Monsoon onset dates are likely to be early or not to change much, and the monsoon retreat dates are likely to be delayed, resulting in **lengthening of the monsoon season.** o With changing rainfall pattern, **IMD in April this year announced new dates for onset and withdrawal of monsoon** for regions and states. ▶ **Causes:** Global-scale anthropogenic forcing such as GHGs as well as regional-scale forcing such as aerosols and LULC changes i.e. increasing urbanisation. ▶ The radiative effects of anthropogenic aerosol forcing over the Northern Hemisphere have considerably offset the expected precipitation increase from GHG warming and contributed to the observed decline in summer monsoon precipitation. **Indian monsoon's connections with other modes of climate variability** ▶ **El Nino Southern Oscillation (ENSO):** El Nino conditions in the Pacific play a major role in modulating the interannual variability **of Indian summer Monsoon (ISM)** rainfall. Almost 50% of the droughts are associated with ENSO however in the last few decades the **ENSO-Monsoon relationship has been weakened,** frequency and intensity of droughts have been increased and some of them are not associated with ENSO. ▶ **Pacific Decadal Oscillation (PDO):** It is a pattern of Pacific climate variability similar to ENSO in character, but which varies over a much longer time scale (20 to 30 years). The PDO, like ENSO, consists of a warm and cool phase which alters upper level atmospheric winds. **PDO can intensify or diminish the impacts of ENSO** according to its phase. If both ENSO and the PDO are in the same phase, El Niño/La Nina impacts may be magnified. Conversely, if ENSO and the PDO are out of phase, they may offset one another, preventing "true" ENSO impacts from occurring. ▶ **Indian Ocean Dipole (IOD):** The positive (negative) IOD significantly dilutes the influence of El Nino (La Nina) on the Indian monsoon. There are more frequent positive IOD events in recent decades due to the rapid warming of the Indian Ocean. ▶ **Equatorial Indian Ocean oscillation (EQUINOO):** In general, positive phase of the EQUINOO is favourable for a good monsoon. Association between EQUINOO & ENSO also determines the variations in ISM rainfall on the interannual time scale. ▶ **Eurasian snow cover:** Generally, positive Eurasian snow cover anomalies during winter and spring tend to be followed by an anomalous deficit rainfall over the Indian subcontinent in the subsequent summer monsoon season, while negative snow cover anomalies tend to be followed by abundant rainfall. It has been observed that all non-ENSO related droughts over India have been associated with excessive snow depth over Eurasia.

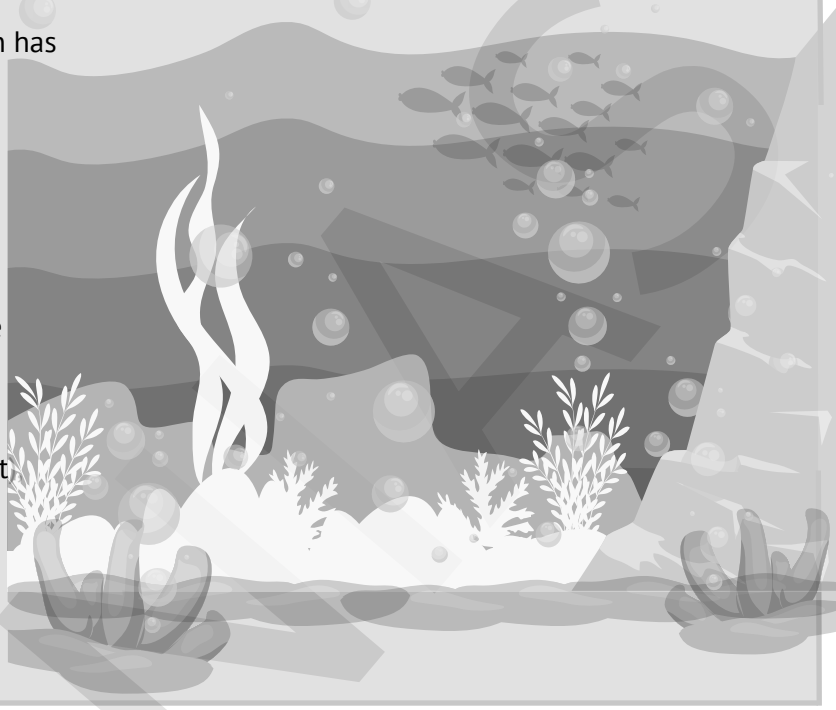
	▶ **The Atlantic and western North Pacific circulation changes** also play a role in monsoon interannual and decadal variability of monsoon.
 **Floods**	▶ Flooding events over India have also **increased since 1950,** in part due to enhanced occurrence of localized, short-duration intense rainfall events. ▶ Flooding occurrences due to intense rainfall are **projected to increase in the future.** ▶ Higher rates of glacier and snowmelt in a warming world would enhance stream flow and compound flood risk over the Himalayan river basins. **The Indus, Ganga and Brahmaputra basins are considered particularly at risk of enhanced flooding** in the future in the absence of additional adaptation and risk mitigation measures.
 **Droughts**	▶ The overall decrease of seasonal summer monsoon rainfall during the last 6–7 decades has led to an **increased propensity for both the frequency and spatial extent** of droughts.**The area affected by drought has increased by 1.3% per decade** over the same period. ▶ Climate model projections indicate a **high likelihood of increase in the frequency (>2 events per decade), intensity & area under drought** conditions in India by the end of the twenty-first century. ▶ **Causes: increased variability of monsoon precipitation** and **increased water vapour demand** in a warmer atmosphere that tend to **decrease soil moisture content.**
 **Tropical Cyclonic Storms**	▶ The intensity of tropical cyclones (TC) is closely **linked to ocean SST and heat content.** ▶ There has been a significant **reduction in the annual frequency of tropical cyclones over the NIO** basin since the middle of the twentieth century (1951–2018). In contrast, the **frequency of very severe cyclonic storms (VSCSs) during the post-monsoon season has increased** significantly (+1 event per decade) during the last two decades (2000–2018). ▶ Climate models **project a rise in the intensity of tropical cyclones** in the NIO basin during the twenty-first century.
 **Himalayan Cryosphere**	▶ The Hindukush Himalayas (HKH) (largest area of permanent ice cover outside the North and South Poles, also known as the 'Third Pole') underwent **rapid warming at a rate of about 0.2°C per decade** during the last 6–7 decades. Higher elevations of the Tibetan Plateau (> 4 km) experienced even stronger warming in a phenomenon alluded to as **Elevation Dependent Warming.** With continued global warming, the **temperature in the HKH is projected to rise by about 5.2°C** during the twenty-first century. ▶ The HKH experienced a **significant decline in snowfall and glacial** area in the last 4–5 decades. With continuing warming, climate models project a continuing decline in snowfall over the HKH during the 21st century. ▶ The Kathmandu-based International Centre for Integrated Mountain Development's (ICIMOD) "Hindu Kush Himalaya Assessment" reveals that **more than one-third of the glaciers in the region could retreat by 2100, even if the global temperature rise is capped at 1.5°C.** **Elevation-dependent warming (EDW)** ▶ It is one of the expressions of global warming wherein there is an enhancement of warming rates with elevation. ▶ One of the possible reasons could be that reductions in mountain snow cover exposes the dark colored earth beneath. This reduces the surface albedo & increases the absorbed solar radiation that can lead to elevation-dependent amplification of warming via the **snow albedo feedback (SAF).**

HOW AEROSOLS AFFECT REGIONAL CLIMATE?

- Atmospheric aerosols are tiny solid/liquid/mixed particles suspended in the air originating from natural or anthropogenic sources
- With a typical lifetime of days to weeks in the troposphere and about a year in the stratosphere, aerosol size ranges from a few nanometres to several tens of micrometres and influence the climate in different ways:
  - **Absorb and scatter incoming solar radiation** modifying the global and regional radiative budget.
    - ✓ **Non-absorbing aerosols** like sulphate, nitrate, and sea spray **scatter shortwave radiation** back to space **leading to a net cooling** of the climate system while **absorbing aerosols produce the opposite effect.**
    - ✓ **Carbonaceous aerosols** (black carbon, organic carbon) and mineral dust **can absorb & scatter** sunlight producing either warming or cooling effects determined by aerosol properties and environmental conditions.
    - ✓ The non-uniform distribution of aerosols in the atmosphere **creates uneven atmospheric heating and surface cooling patterns,** which drive changes in atmospheric circulation and regional rainfall.
  - **Affect climate when present in surface snow:** Absorbing aerosols **lowers surface albedo,** leading to increased absorption of shortwave radiation affecting the surface snowmelt.
  - **Significant impact on cloud properties and precipitation:** Aerosol particles **act as cloud condensation nuclei (CCN) and ice nuclei (IN).**
    - ✓ An increase in CCN forming aerosols in a cloudy region produces **more, but smaller, cloud droplets** reflecting more solar radiation to space leading to a cooling of the Earth's surface, known as the **first indirect effect (cloud-albedo effect).**
    - ✓ Also, **smaller droplets suppress collision** coalescence requiring longer growth time to reach raindrop size, increasing the cloud albedo and enhancing the cooling effect, known as the **cloud-lifetime effect or the second indirect effect.**
    - ✓ Additionally, aerosols can **cause suppression of rainfall during monsoon breaks** via atmospheric stabilization and increased moisture divergence.
  - **Alter the air temperature:**
    - ✓ Absorbing aerosols cause an **increase in lower level static stability** inhibiting convection leading to a decrease in cloud cover, known as the **semi-direct effect.**
    - ✓ Local and remote aerosols **alter the land–sea temperature contrast** as well as the tropospheric temperature structure, both of which have a profound influence on the onset and sustenance of south Asian monsoon.

THE CASE OF INDIAN OCEAN WARMING

- The **rate of warming in the tropical Indian Ocean is the fastest among tropical oceans** and accounts for about one quarter of the increase in global oceanic heat content over the last two decades. Warming in the Tropical India Ocean (TIO)has been basin-wide but spatially non-uniform, with the largest increasing trends seen in the central equatorial Indian Ocean & lowest warming trends off the Sumatra & Java coasts.
- The observed surface warming over the Indian Ocean has been linked to natural and anthropogenic causes.
  - **Change in radiation equilibrium** due to the increased greenhouse gas concentrations is the major factor.
  - **Changes in the tropical circulation-** Redistribution of heat from the Pacific Ocean via various mechanisms like the Walker circulation, the deep meridional overturning circulation (MOC consists of asystem of warm poleward surface currents and coldequatorward deep currents as a part of the globalpoleward oceanic heat transport and from the Southern Ocean.
- While ocean currents and winds in the Atlantic and Pacific can disperse heating water, the large Asian landmass tothe north of the Indian Ocean makes it particularly **susceptible to retaining heat.**



WHAT ARE THE IMPLICATIONS OF CHANGING CLIMATE ON VARIOUS ASPECTS OF INDIAN REGION?

- **Food Security**

  Due to lack of irrigation, a large number of farmers are dependent on monsoon rainfall to practice agriculture (between **50 to 60 percent of Indian agriculture is rainfed,** without access to any form of irrigation).

  Rising temperatures, heat extremes, floods, droughts and increasing year-to-year rainfall variability **can disrupt rainfed agricultural food production and adversely impact crop yield.**

  - ✓ For instance, as per the NITI Aayog document, of the total pulses, oilseeds & cotton produced in the country, **80% pulses, 73% oilseeds and 68% cotton come from rain-fed agriculture.**
  - Ocean warming has **reduced the abundance of some fish species** by killing parts of the coral reefs they depend on.

Water security

- The growing propensity for droughts & floods because of changing rainfall patterns would be detrimental to surface and groundwater recharge. Also,the rising sea level leads to intrusion of saltwater in the coastal aquifers contaminating the ground water. E.g. in Gujarat, Tamil Nadu, and Lakshadweep etc. Declining trend in snowfall and retreat of glaciers in HKH region may impact the water supply in the major rivers and streams including the Indus, Ganges, and Brahmaputra.
  - ✓ These rivers collectively provide about 50% of the country's total utilisable surface water resources.

Energy infrastructure and supply

- Rising temperatures are likely to increase energy demand for space cooling, which if met by thermal power would further add to the global warming by increasing GHG emissions.
- In addition, thermal power plants require substantial amounts of water for cooling to generate electricity. A rise in water withdrawal by power plants would directly compete with water withdrawal for agriculture and domestic consumption, particularly in water stressed areas.
- On the other hand, power plants sited around the coast that use sea water for cooling are vulnerable to damage from sea-level rise, cyclones, and storm surge.

Damage to coastal infrastructure

- Potential coastal risks include loss of land due to increased erosion, damage to coastal projects & infrastructure such as buildings, roads, monuments, and power plants, salinization of freshwater supplies and a heightened vulnerability to flooding.
- For example, higher sea levels and receding coastlines escalate the destructive potential of storm surge associated with cyclonic storms that may be additionally compounded by land subsidence occurring in parts of the country due to factors such as the declining water table depth.

Human Health:

- Studies indicate that climate change may seriously compromise human health particularly among children and the elderly. Higher temperatures, extreme weather events, and higher climate variability could elevate risk of heat strokes, cardiovascular and neurological diseases, and stress-related disorders.
- Heat stress in urban areas is often compounded by the heat island effect. Warmer, higher moisture conditions, on average, are also more favourable for the spread of vector-borne diseases such as malaria and dengue fever.
- In addition, a decrease in the availability or affordability of food and potable water caused by climate change may lead to reduced nutritional intake, particularly among economically weaker sections.

Biodiversity:

- With the climate changing more rapidly than the usual pace of evolutionary adaptability of many species, they may face increasing threats on account of these changes. Species specially adapted to narrow environmental conditions are likely to be affected the most.
- For example, the Indian Ocean is home to 30% of the world's coral reefs and 13% of global wild-catch fisheries. This marine ecosystem, including corals and phytoplankton, and fisheries are being impacted by a rise in heat waves in the ocean, known as marine heat waves.

Social issues

- Large scale migration induced due to climatic disasters such as droughts, cyclones and floods cause social distress at the source and destination places. This reflects into unorganised nature of jobs, slums in urban areas and also social tensions.
  - ✓ According to World Migration Report 2020 released by the UN, Climate change displaced 2.7 million Indians in 2018. Report also highlights that the largest new internal displacements in Asia resulted from disasters.
- Moreover, repeated crop failures add to the burden of already distressed farmers who then resort to suicides.

Cascading of climatic hazards: Multiple negative climate events when acting in tandem could create an extreme situation.For instance, a region may experience an abnormally long or intense summer heat wave followed by intense monsoon floods that alternate with lengthening dry spells.

WHAT ARE THE KEY ACTIONS TAKEN BY INDIA TOWARDS COMBATING AND ADAPTING TO CLIMATE CHANGE?

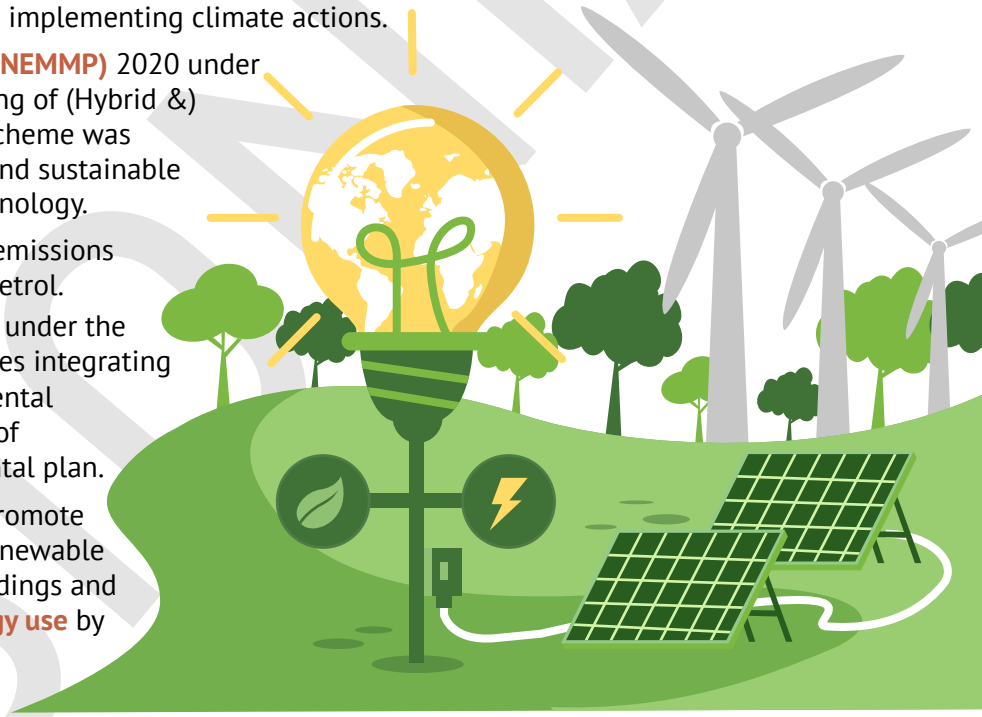
Plans and policies

- **National Action Plan on Climate Change (NAPCC)** identifies measures that simultaneously advance the country's development and climate change related objectives of adaptation and mitigation through focused National Missions. India has **decided to revise the NAPCC** in line with the NDCs under the Paris Agreement to make it more comprehensive in terms of priority areas.

Eight National Missions under the NAPCC

- ✓ National Mission for Enhanced Energy Efficiency
- ✓ National Solar Mission
- ✓ National Water Mission
- ✓ National Mission for a Green India
- ✓ National Mission on Sustainable Habitat
- ✓ National Mission for Sustainable Agriculture
- ✓ National Mission for Sustaining the Himalayan Ecosystem
- ✓ National Mission on Strategic Knowledge for Climate Change

- **Climate Change Action Program (CCAP)** is a central sector scheme to build and support capacity at central and state levels, strengthening scientific and analytical capacity for climate change assessment, establishing appropriate institutional framework and implementing climate actions.
- **National Electric Mobility Mission Plan (NEMMP)** 2020 under which Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) scheme was formulated to promote manufacturing and sustainable growth of electric & hybrid vehicle technology.
- **Adoption of the BS-VI norms** to reduce emissions from the vehicles based on diesel and petrol.
- **Environmental Impact Assessment (EIA)** under the Environment Protection Act, 1986 enables integrating environmental concerns into developmental activities and encourages the adoption of mitigation strategies in the developmental plan.
- **Energy Conservation Building Code** to promote low carbon growth by integrating the renewable energy sources in the design of the buildings and **achieve a 50 per cent reduction in energy use** by 2030.
- Solar cities, Ultra mega solar parks, National Biofuel Policy, National Offshore Wind Energy Policy, Renewable Purchase Obligation etc **to promote renewable energy development** in the country.
- **Other schemes** such as Ujjwala, **UJALA, AMRUT, Swachh Bharat Mission,** Green Rating for Integrated Habitat Assessment (GRIHA) etc.



Financial tools

India has aligned the financial system with sustainability through following measures:

- **National Adaptation Fund on Climate Change** that supports concrete adaptation activities for the States/UTs that are particularly vulnerable to climate change & are not covered under on-going schemes.
- **RBI had sensitized banks** to various international initiatives and was asked to keep abreast of the developments in the field of sustainability and dovetail/modify their lending strategies/plans in the light of such developments.
- **Green bonds** issued by financial, non-financial or public entities where the proceeds are used to finance 100% green projects and assets specifically linked to climate-change mitigation, adaptation & resilience. **India also has the second largest Emerging green bond market after China.**

- **Other measures** include **Polluter Pay Principle, Perform Achieve and Trade (PAT) scheme, Carbon tax, Energy Saving Certificates (ESCerts).**

- **Satellite technology** to observe and tackle Climate Change includes HySISMegha-TropiquesSARAL mission, Oceans at 3-Argos mission etc.

- **At International stage**
  - **International Solar Alliances (ISA)** to provide a dedicated platform for cooperation among solar resource rich countries to harness their solar energy potential by collaborative efforts in the field of solar technologies.
  - **Coalition for Disaster Resilient Infrastructure (CDRI)** launched by India to promote the resilience of new and existing infrastructure systems to climate and disaster risks.
  - India joined the **International Platform on Sustainable Finance (IPSF)** that acknowledges the global nature of financial markets which has the potential to help finance the transition to a green, low carbon and climate resilient economy by linking financing needs to the global sources of funding.
  - **India's NDCs targets submitted under the Paris Climate agreement.** India's NDCs is threefold:
    - ✓ reducing the emission-intensity of its GDP by 33%–35% (vis-à-vis 2005) by 2030;
    - ✓ achieving 40% cumulative electric power installed capacity from non-fossil fuel resources by 2030;
    - ✓ creating **additional carbon sink** of 2.5–3 billion ton of CO2 equivalent by 2030 through forest and tree cover.
  - **Clean Development Mechanism (CDM)** for achieving GHG emissions reduction under the Kyoto protocol.

WHAT ARE THE CHALLENGES AND POLICY OPTIONS FOR INDIA TO TACKLE CLIMATE CHANGE?

If India is to successfully tackle climate change—both in terms of mitigation and adaptation—it will need to address several complex, intertwined challenges- local as well as global. Following challenges, in particular, loom large.

- **Managing the politics of global climate change policy**
  - This involves ensuring equity in climate actions based on **Common but Differentiated Responsibility and Respective Capabilities (CBDR–RC).** India is the world's fourth-largest emitter of GHGs, but in terms of cumulative emissions, it has imparted marginal harm. This principle is **important for India** to gain finances, technology, and knowledge from the developed world **to enhance its capacity** for the climate response.

- **Reforming Fragmented domestic climate policy:**
  - At present, India has **not formulated any law** for the purpose of giving effect to the goals of the Paris Agreement. NAPCC- the official recognition of India's climate change concerns is "too broad and lacks specificities". Institutional, systemic & process barriers, including financial constraints, inter-ministerial coordination, lack of technical expertise & project clearance delays, deficiency of knowledge on climate change impacts stand as major challenges in the efficient implementation of the missions.
  - **"Climate change" does not figure on either list under seventh** schedule as a distinct head of legislative competence. However, Climate change, and more broadly, environmental concerns, can be traced to a number of areas of legislative competence, with **no overall authority or clear responsibility** being identified at either the central or the state level.
  - **Budgetary allocation for the implementation of climate policy** by the centre & states does not recognise relative vulnerability of certain states. Most states have also shown reluctance in adopting the Energy Conservation Building Code (ECBC) even after a decade of its release.

Thus, India's domestic climate policy urgently needs a coherent vision for tackling climate change that should be clearly reflected in the framing of legislation and policy documents addressing multiple sectors & aligned with multiple levels, and in the design of appropriate institutional frameworks to achieve climate policy objectives of mitigation and adaptation in a holistic and non-fragmented way.

Reducing India's coal dependency

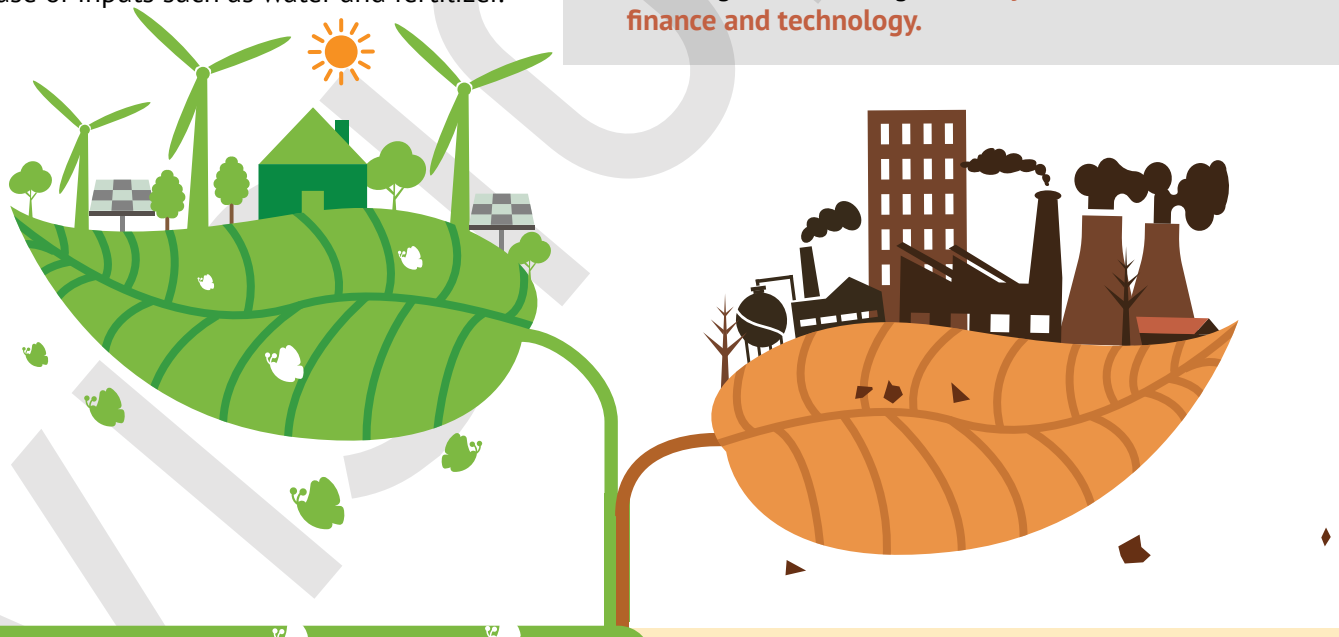
- More than 2/3rd of India'sGHG emissions come from energy production, which remains largely reliant on coal power plants. Government is trying to **wean off coal by investing significantly in renewable energy,** expanding capacity and incentivizing private sector investment. Yet, given coal's centrality to the country power, it is being questioned how far it can be displaced, especially since integrating renewable energy into the grid can be costly.

Reforming climate-insensitive agriculture policy

- India's agricultural policies aggravate water shortages, encourage crop burning and do little for climate change mitigation. For instance, the minimum support price combined with helpful electricity and fertilizer subsidies, encourages farmers to grow water-intensive crops, such as paddy, even if their land is ill-suited to do so (for instance, Punjab). This is partly why, despite widespread water shortages, **India is a net exporter of water** due to the excess water used in agricultural exports.
- Changing these policies may be politically delicate, but one potential solution put forth by several economists is cash transfers. **Rationalization of food subsidy along with cash in hand,** may make farmers more judicious in their use of inputs such as water and fertilizer.

New Debate on Global Climate Negotiations/ Climate Diplomacy:

- In light of various recent reports & publications including the Emission Gap Report, and WMO Green House Gas Bulletin etc. there are **increasing demand to accelerate and step-up the climate action pledges.** The **IPCC's 1.5°C report** has put a question mark on current climate efforts which may fall well short of the required action.
- The current negotiations are being accused of **ignoring the principle of Equity (historic versus current responsibility for climate change), Climate Justice (Loss& Damage) and CBDR-RC** which would restrict the success of global efforts.
- **CBDR–RC** is a principle within the United Nations Framework Convention on Climate Change (UNFCCC) that acknowledges the different capabilities & differing responsibilities of individual countries in addressing climate change.
  - ✓ Reflecting CBDR-RC, the UNFCCC divided countries into "Annex I" and "non-Annex I," the former generally referring to developed countries and the latter to developing countries. Under the Convention **Annex I countries have a greater mitigation role than non Annex-I countries.**
- **Negotiations on Loss & Damage (L&D)** under the UNFCCC are stuck between demands for **climate justice, understood as compensation,** for increases in extreme & slow-onset event risk, and the reluctance of developed countries to consider L&D different from adaptation.
- The debate over climate change is no longer about what causes global warming. The **major focus has now shifted to finance and technology.**



CONCLUSION

Tackling climate change is a balancing act between the present and the future. One way to do this would be to frame more holistic goalposts. Current policies seek to maximize GDP, which does not capture the potential for future prosperity entirely. An alternative could be something like the UN's Inclusive Wealth Index, which measures three different types of capital: Produced (infrastructure, etc.), human (education, etc.) and natural (land, forests, etc.), all of which are important for prosperity to sustain. The UN measure is not perfect but is useful to track multiple indicators that feed into a society's progress.

ASSESSMENT OF CLIMATE CHANGE OVER THE INDIAN REGION

REASONS

- **Anthropogenic (Human Caused) factors-GHGs,** aerosols & pattern of land use changes.
- **Natural Factors:** continental drift, volcanoes, ocean currents, the earth's tilt, and comets and meteorites.

Why climate change study at regional level?

- ✓ Changes in climate are not expected to be uniform across the planet
- ✓ Changes in climate are not understood as robustly at the regional level as at the global scale
- ✓ Critical to people and policymakers to plan for disaster management, risk mitigation and for formulating locally relevant adaptation strategies

1 Observed changes

- ✓ Temperature Rise- 0.7°C during 1901–2018
- ✓ Sea-level rise in the North Indian Ocean (NIO) at a rate of 3.3 mm year during 1993–2017
- ✓ Warming of India Ocean
- ✓ Change in Rainfall pattern - declining summer rainfall, changing dates for monsoon
- ✓ Increasing frequency of floods and droughts
- ✓ Increasing frequency of **very severe cyclonic storms**
- ✓ **Significant decline in snowfall and glacial area in the** Hindukush Himalayas (HKH)

2 Implications

- ✓ **Food Security-** rainfed agriculture, crop failure, marine fisheries
- ✓ **Water security-** intrusion of saltwater in the coastal aquifers, glacier retreat
- ✓ **Energy infrastructure and supply-** increase energy demand for space cooling, damage due to climatic disasters
- ✓ **Damage to coastal infrastructure-** due to sea level rise and increased cyclonic storms
- ✓ **Human Health-** heat stress, heat island effect,vector-borne diseases
- ✓ **Biodiversity-** affected evolutionary adaptability of many species
- ✓ **Social issues -** climatic migrants, farmer suicides
- ✓ **Cascading of climatic hazards**

3 Steps taken by India

- ✓ **Plans and policies:** NAPCC, SAPCC, NEMMP, BS-VI norms, Energy Conservation Building Code, AMRUT, Swachh Bharat Mission etc.
- ✓ **Financial tools:** National Adaptation Fund on Climate Change, Perform Achieve & Trade (PAT) scheme, Carbon tax, Energy Saving Certificates (ESCerts), Green Bonds etc.
- ✓ **Satellite technology:** HySIS Megha-Tropiques SARAL mission, Ocean sat 3-Argos mission etc.
- ✓ **At International stage:** International Solar Alliances (ISA), Coalition for Disaster Resilient Infrastructure (CDRI), India's NDCs targets, Clean Development Mechanism (CDM) etc.

4 Challenges and policy options

- ✓ Managing the politics of global climate change policy.
- ✓ Reforming Fragmented domestic climate policy
- ✓ Reducing India's coal dependency
- ✓ Reforming climate-insensitive agriculture policy