Climate Change Intervention and Policy Framework

What is climate?

- Climate is the average daily weather for an extended period of time at a certain location.
- Weather reflects short term conditions of the atmosphere, it can change from minute-to-minute, hour-to-hour, day-to-day and season-to-season. Climate is the average of weather over time and space.
- Unlike ‘weather’, which means temperature, rainfall, humidity of a particular time at a local area, ‘climate’ has spatial and temporal components.
- It consists of many kinds of weather events, their periodicities, intensities, and nature of dynamism.

What is climate change?

- When we talked about climate change, we actually understand more than the literal changes of weather events over the time and space of that climate.
- Climate change is natural phenomenon and has been occurring since the earth came into being.
- Climate change is is a change in the average weather of a given area or region.
- This include temperature, wind patterns, and precipitation. This change is referred to in a global sense and concerns the earth as a whole.

Cont.

- Examples… Changes in ocean current, melting of ice, and loss of biodiversity are included in climate change; they are not discussed as conventional events of weather.
- By climate change, we understand detrimental effects in environment – emission of pollutants, temperature rise, precipitation change, sea level rise, flooding, intensified cyclones, abrupt frequency of events, ozone layer depletion, biodiversity loss, vegetation change, and drought – almost all negative impacts.
- Climate change is a term that refers to major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer.
- According to Working Group II of the Intergovernmental Panel on climate Change (IPCC): Climate change refers to any change in the climate over time, whether due to natural variability or as a result of human activity.

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- Global climate change
- Identifiable change in the climate of Earth as a whole that lasts for an extended period of time (decades or longer)
  - When due to natural processes, it is usually referred to as global climate variability
  - Usually refers to changes forced by human activities that change the atmosphere

Cont.

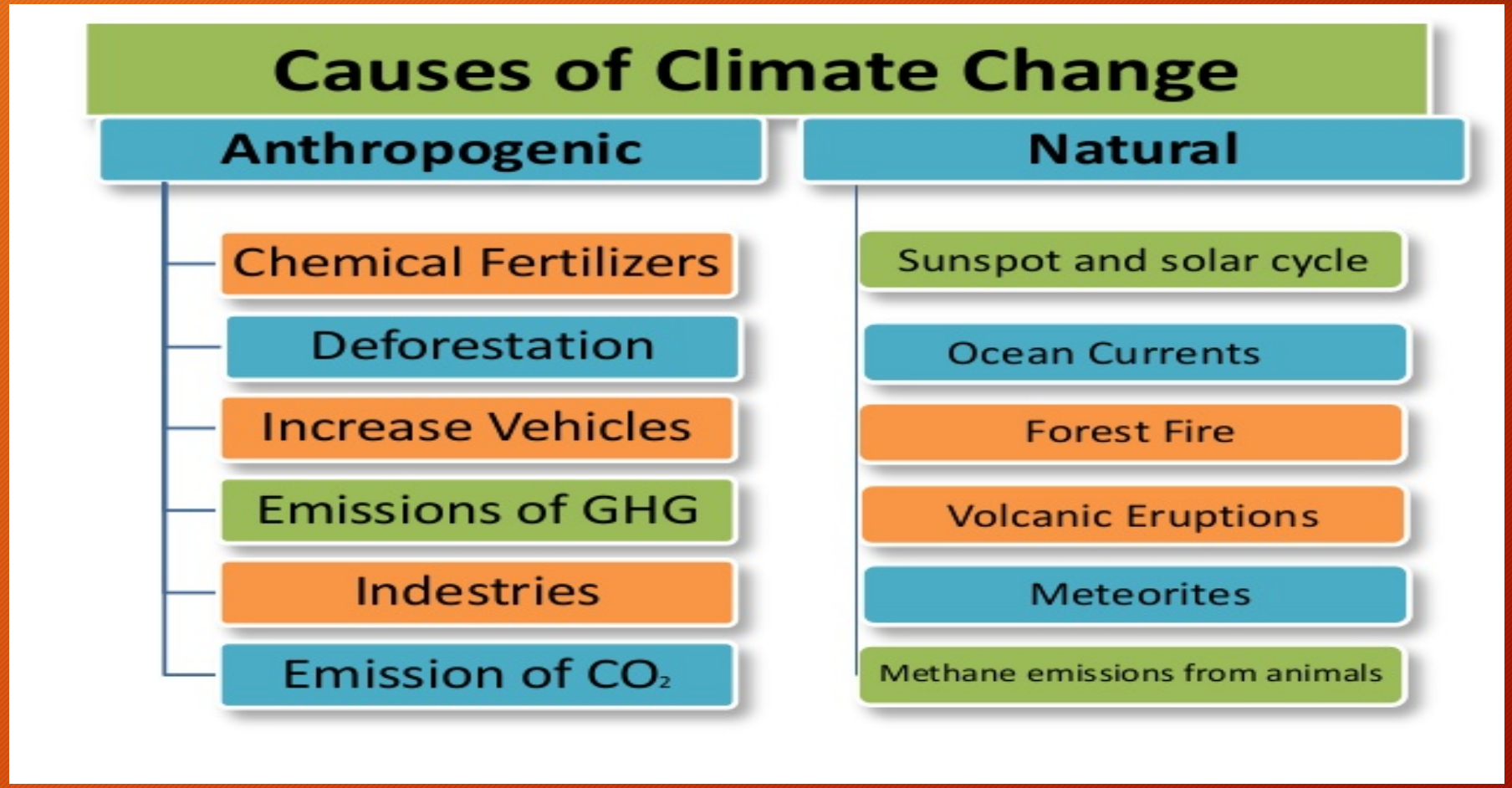
- **What causes Earth's climate to change?**
- Changes in the atmosphere
- Natural processes
  - Volcanoes
  - Tectonic plate movement
  - Changes in the sun
  - Shifts in Earth's orbit
- Human activities – any activity that releases "greenhouse gases" into the atmosphere

History of Climate Change

- Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them
- But the climate we have come to expect is not what it used to be, because the past is no longer a reliable predictor of the future.
- Rapid changes – Our climate is rapidly changing with disruptive impacts, and that change is progressing faster than any seen in the last 2,000 years.

[Source: http://www.ecy.wa.gov/climatechange/whatis.htm]

Causes of Climate Change



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- Since the industrial revolution began in 1750 human activities have contributed substantially to climate change by adding CO2 and other heat trapping gases to the atmosphere. These greenhouse gas emission have increased the greenhouse effect causing Earth's surface temperature.
- Earth's temperature depends on the balance between energy entering and leaving the planet's system.
- When incoming energy from the sun is absorbed by the Earth system, earth warms.
- When the sun's energy is reflected back into space, earth avoids warming.
- When absorbed energy is released back into space, earth cools.

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- Many factors both natural and human can cause changes in earth's energy balance including
- 1) Variations in the sun's energy reaching earth
- 2) Changes in the reflectivity of earth's atmosphere and surface
- 3) Changes in the greenhouse effect, which affects the amount of heat retained by earth's atmosphere.

[These factors have caused earth's climate to change many times]

Cont.

- Climate change prior to the industrial revolution in the 1700 can be explained by natural causes, such as changes in the solar energy, volcanic eruptions, and natural changes in the greenhouse gas concentrations.
- Recent climate changes, however cannot be explained by natural causes alone as most research indicate that natural causes do not explain most observed warming since the mid-20th century.
- Humans are increasingly influencing the climate and the earth's temperature by burning fossil fuels, cutting down rainforests and farming livestock.

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- These human activities release large amounts of CO2 (which is the primary greenhouse gas) in addition to those naturally occurring in the atmosphere, increasing the greenhouse effect and global warming.
- Scientists have known that CO2 is one of the main greenhouse gases of importance to earth's energy balance.
- Since CO2 is one of the main greenhouse gases of importance to earth's energy balance.
- Since CO2 is already in the atmosphere naturally, why are emissions from human activity significant?
- Human activities have significantly disturbed the natural carbon cycle by extracting long-burned fossil fuels and burning them for energy thus releasing CO2 to the atmosphere.

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- The sun’s radiation that strikes the Earth’s atmosphere in the form of light, ultraviolet radiation (UV) and infrared radiation (IR).
- UV radiation has a shorter wavelength and a higher energy level than visible light, while IR radiation has a longer wavelength and a weaker energy level.
- 30 percent of the radiation striking earth’s atmosphere immediately reflected back out to space by clouds, ice, snow, sand and other reflective surfaces.

Melting of Polar Ice Sheets and Glaciers

- Large ice formations, like glaciers and the polar ice caps, naturally melt back a bit each summer. But in the winter, snows, made primarily from evaporated seawater are generally sufficient to balance out the melting.
- Higher temperatures caused by global warming have led to greater-than-average summer melting as well as diminished snowfall due to later winters and earlier springs.
- Increased heat is also causing the massive ice sheets that cover Greenland and Antartica to melt at an accelerated pace.
- Scientists also believe meltwater from above and seawater from below is seeping beneath Greenland’s and West Antartica;s ice sheets, causing them to move more quickly into the sea.

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- Increase in sea level which results in flooding and erosion of coastal and low lying areas.
- The two major causes of global sea-level rise are thermal expansion caused by warming of the oceans (since water expands as it warms) and the loss of land-based ice, such as fglaciers and ice sheets, due to increased melting.
- Extreme weather – flooding, forest fires, wildfires, droughts, heat waves

Possible Future Effects

- Warming and sea level rise will continue and will probably occur more quickly than what we've already seen
- Even if greenhouse gases are stabilized, this will probably continue to occur for centuries
- Some effects may be permanent
- Effects on Ecosystems
  - Coral systems and other unique ecosystems cannot handle higher temperatures well
  - Wildfires will increase
  - Up to 30% of species will be at increased risk for extinction due to the rapid changes in their ecosystems

Uniting to Tackle Climate Change

- United Nation Conference on Human Environment, 1972
- Vienna Convention for Protection of the Ozone Layer, 1985
- Montreal Protocol, 1987
- Intergovernmental Panel on climate Change, 1988
- Unite Nations Conference on Environment and Development, 1992
- Kyoto Protocol, 1997

Cont.

- IPCC Conclusion:
- “Their effects [those of human-caused greenhouse gases], together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.”
-

History of Climate Change Negotiations

- 1972: United Nations Conference on Environment, Stockholm, United Nation Environment Program (UNEP) formed.
- 1974: UN World Food Conference, Rome, which recognized the central role of climate in world food production.
- 1976: the UN World Water Conference in Mar Del Plata, Argentina
- 1979: In response to extreme climatic events, WMO, UNEP, FAO, UNESCO and WHO convened the First World Climate Conference (FWCC) in Geneva.
- 1987: Montreal Protocol on restricting chemicals that damage the ozone layer.

Cont.

- 1988: A historical year for climate change negotiations – Formation of Intergovernmental Panel on climate Change (IPCC) jointly by United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO)
- "…provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts".
- 1990: IPCC's first assessment report released. IPCC and second World Climate Conference call for a global treaty on climate change.
- 1990: United Nations General Assembly negotiations on a framework convention begin.

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- 1990: First meeting of Intergovernmental Negotiating Committee.
- 1992: Rio Earth Summit held. The United Nations framework Convention on Climate Change is opened for signature.
- Developed countries accept responsibility for the overwhelming majority of emissions and “aim to stabilize” those emissions at 1990 levels by the year 2000.
- Countries obliged to report emission. Voluntary in nature. Focus on mitigation.

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- 1994: UNFCC enters into force
- Convention – Ultimate objective
- “The ultimate objective ... is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”.

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- Convention – Principles
- Precautionary Principle – the lack of full scientific certainty should not be used as an excuse to postpone action when there is a threat of serious or irreversible damage
- Principle of Common but Differentiated Responsibilities(CBDR) and respective capabilities – the developed country Parties should take the lead in combating climate change and the adverse effects thereof
- Principle of Sustainable Development – policies and measures to protect the climate system should be appropriate for the specific conditions of each Party and should be integrated with national development programmes

Cont.

- 1995: IPCC Second Assessment Report released
- 1995: First Conference of the Parties (COP 1) takes place in Berlin
- The first Conference of the Parties, made up of signatories to the UNFCCC, acknowledge that the UNFCCC is inadequate without country-specific commitments.
- It agrees to negotiate emission reduction targets for industrialized countries.
- 1996: COP 2 held in Geneva
- 1997: COP 3 held in Kyoto, also known as the Kyoto Protocol
- The Kyoto Protocol agreement included “flexibility” mechanisms – focus on mitigation.
- “Flexibility” mechanisms that would allow industrialized nations to get credit for actions to reduce greenhouse gas emissions in other countries.

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- The Kyoto Protocol targets:

1) 5.2 % reduction of emission levels below 1990 levels by 2008-2012 for all industrialized countries
2) Specific targets for various countries: US –7%, EU –8%, Japan –6%, Canada –6%, Switzerland –8% but Australia +8%, Norway +1%, Iceland +10%
3) 6 greenhouse gases considered: CO2, CH4, N2 O, HFC (hexafluorocarbon), PFC (perfluocarbon), SF6 (Sulphur hexafluoride)

Cont.

- The talks at the Sixth conference of the Parties in The Hague collapse.
- 2001: The IPCC releases its Third Assessment Report
- 2001: COP7, the Marrakesh Accords adopted – focus on adaptation
- The final elements of the Kyoto Protocol are hammered out. The US, Canada, Japan and Australia force the EU to accept major concessions in order to reach the final agreement.
- 2001: Two months after his inauguration, US President G.W. Bush announces his country's withdrawal from the Kyoto Protocol.

Cont.

- 2007: IPCC's Fourth Assessment Report released
- 2007: COP 13, Bali
- 2009: COP 15, Copenhagen Accord drafted
- 2009: G8 countries agree that 2 degrees Celsius of average global warming is a limit which should not be exceeded. To reach this goal, global greenhouse gas emissions should be reduced by at least 50% by 2050 and emissions from developed countries should be reduced by 80% or more.
- 2010: COP 16, Cancun Agreements drafted and largely accepted

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- 2011: COP 17, the Durban Platform for Enhanced Action drafted and accepted
- 2012: COP 18, Doha
- 2013: COP 19, the Warsaw Climate Change Conference 2013
- 2014: The first part of the IPCC's fifth assessment report (WG 1) says scientists are 95% certain that humans are the "dominant cause" of global warming since the 1950s
- 23 September 2014 – Ban Ki-moon Summit at UN Hq. New York; a pledge to commit money and technology for poor countries before COP meets in COP 20-21
- Green climate Fund - $100 billions/ year by 2020; developed countries commit this fund to invest in mitigation, adaptation and technology

India’s Climate Change Policy

- The National Action Plan on Climate Change (NAPCC) was released on 30th June 2008 to state India’s contribution towards combating climate change
- The plan outlines Eight National Missions running through 2017
- It outlines measures on climate change related adaptation and mitigation while simultaneously advancing development
- The plan consists of an overview and Technical Document

Cont.

- “…GHG generated through long term and intensive industrial growth and high consumption of lifestyle in developed countries”.
- Considers having ‘wider spectrum of choices’ precisely because it is at an early stage of development.
- Acknowledges and shows its commitment to engage actively in multilateral negotiations in the UNFCC.
- Maintaining a high growth rate to improve standard of living and reducing their vulnerability to the impacts of climate change.
- Promote developmental objectives, also yielding co-benefits for addressing climate change effects.

National Solar Mission

- To make solar energy competitive with fossil-based energy options
- By increasing the share of solar energy in the total energy mix, it aims to empower people at the grassroots level
- Launch an R&D programme facilitating international cooperation to enable the creation of affordable, more convenient solar energy systems
- Solar thermal Power Generation, Solar Photovoltaic generation, R&D collaborations, Technology Transfer and Capacity Building

National Mission for Enhanced Energy Efficiency in Industries

- The Energy conservation Act of 2001 provides a legal mandate for the implementation of energy efficiency measures through the mechanisms of the Bureau of Energy Efficiency (BEE)
- Aim of saving of 10,000 MW by 11th Five Year Plan, 2012
- A market based mechanism to enhance cost effectiveness of improvements in energy efficiency through certification of energy savings
- Shift to energy saving appliances
- Develop fiscal instruments to promote energy efficiency

National Mission on Sustainable Habitats

- Promoting energy efficiency in the residential and commercial sector
- Energy efficient building and building componenets
- Energy efficient appliances
- Management of Municipal Solid Waste Management
- Recycling of material is an important option for reducing environmental pressure
- Promotion of Urban public Transport
- Extensive use of Mass Transport Systems
- Use of CNG
- Promotion of Bio-diesel production
- Promotion of development of hydrogen powered vehicles

National Water Mission

- By 2050, India is likely to be water scarce. The mission aims at conserving water, minimizing wastage, and ensuring more equitable distribution and management of water resources.
- Aims to optimize water use efficiency by 20% by developing a framework of regulatory mechanisms
- Studies on management of Surface Water Resources
- Management and Regulation of ground Water Resources
- Upgrading Storage Structure for Fresh Water and Drainage System for Wastewater
- Conservation of Wetlands
- Development of Desalination Technologies

National Mission for Sustaining the Himalayan Ecosystem

- Increase in temperatures, changes in precipitation patterns, drought and melting of glaciers are obvious threats.
- Mission calls for empowering local communities especially Panchayats to play a greater role in managing ecological resources.
- Adopt appropriate land-use planning and watershed management for mountain ecosystem.

National Mission for a Green India

- Forest meets 40% of overall energy needs of the country and 80% of that in rural India.
- Increase in forest cover and density
- The final target is to bring one third of India’s geographic area under forest cover
- Conserving biodiversity

National Mission for Sustainable Agriculture

- Dryland Agriculture
- Development of drought and pest resistant crops
- Improving methods of conserving soil and water
- Financial support to farmers to adopt climate resistant technology.
- Risk Management
- Strengthening of agriculture and weather insurance scheme
- Use of GIS for soil resource mapping, pest and disease hotspots
- Access Information
- Development of regional databases of soil, weather, genotype, land-use pattern and water resources
- Use of Biotechnology
- Development of crops with better water and nitrogen use efficiency

National Mission on Strategic Knowledge for Climate Change

- Climate modelling and access to data

- Enhanced research on climate modelling in India (Regional Climatic Model)

- Promotion of Data Access

- A number of government agencies collecting wide spectrum of data but data sharing is difficult

- Strengthening networks

- Creation of Integrated Knowledge Networks

- Human Resources Development

Eastern Himalayas and Climate Change

Mountain Diversity

- Mountains are amongst the most vulnerable and hazardous environments in the world – they also harbour rich repositories of biodiversity.
- Mountains are early indicators of climate change (Singh *et al*. 2010).
- In the context of climate change, mountains could suffer wide-ranging environmental and socioeconomic impacts, for example on the hydrological cycle, and this in turn would alter the distribution, seasonality, and amount of precipitation and result in changes in river runoff, ultimately affecting not only mountain watersheds but also the lowlands below (Beniston 2003).
- Mountain areas are especially susceptible to global warming, which is the result of rising concentrations of greenhouse gases (GHGs) generated by human activity in the atmosphere.
- The Millennium Ecosystem Assessment (MEA) identified climate change as one of the major drivers having adverse affects on biodiversity and associated goods and services (MEA 2005).

The Eastern Himalayas

- The Eastern Himalayas (EH) are counted in the ‘crisis ecoregions’; ‘biodiversity hotspots’; ‘endemic bird areas’; ‘mega diversity countries’; and ‘global 200 ecoregions’ (Brooks et al. 2006).
- The forests of the EH sustain many rivers which are the lifeline for provinces and countries downstream.
- Threats to biodiversity from climate change could be acute in the EH which are rich in endemic species that have narrow and restricted ranges of distribution (Root et al. 2003): fragmentation and loss of habitat are already threatening the survival of some endemic species such as golden langur (*Trachypithecus geei*).

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- The EH are considered multifunctional because they provide a diverse range of ecosystem services (provisioning, regulating, cultural, supporting); this also makes them useful for studying the relationship between loss of biodiversity and loss of ecosystem services.
- The survival of these ecosystems and the wildlife within them is being threatened by human activities such as timber harvesting, intensive livestock grazing, agricultural expansion into forestlands, and, above all, by climate change.
- Identification and understanding of the key ecological and socioeconomic parameters of mountain ecosystems, including their sensitivities and vulnerabilities to climate changes, has become crucial for planning and policy making for the environmental management and sustainable development of mountain regions, as well as downstream areas (APN 2003).

Climate Change and the Convention on Biological Diversity

- All five countries of the Eastern Himalayas (Bhutan, China, India, Myanmar, Nepal) are signatories to the 1992 Convention on Biological Diversity (CBD), and their commitment was renewed during the World Summit on Sustainable Development (WSSD) in 2002.
- In 2004, the CBD adopted the Programme of Work on Mountain Biological Diversity with the overall purpose of achieving a significant reduction of loss of mountain biological diversity by 2010.
- Natural ecosystems play a critical role in the carbon cycle, and, hence, act as sources and sinks for greenhouse gases. They are also extremely vulnerable to the impacts of climate change.

Mountain Ecosystems

- Ecosystems are of fundamental importance to environmental functioning and sustainability, and they provide many goods and services critical to individuals and societies.
- Climate is an integral part of mountain ecosystems and organisms have adapted to their local climate over time.
- Human societies depend on ecosystem provisioning, regulating, cultural and supportive services for their wellbeing.
- Traditional resilience is being rapidly eroded leading to dependence on external inputs and the overexploitation of selective resources, threatening their sustainability.

Hazards and Disaster

- The region has witnessed unprecedented melting of permanent glaciers during the past three decades, with the vast Himalayan glaciers showing the fast rate of retreat, resulting in increases in glacial runoff and glacial lake outburst floods (GLOFs), and an increased frequency of events such as floods, mudflows, and avalanches affecting human settlements.
- Earthquakes pose another risk in the region and can amplify the potential impacts of climate change and exacerbate vulnerability. Frequent slope failure, mass wasting, and landslides along the Himalayan foothills are evidence of these reinforcing stresses causing ecological damage and economic losses.

Drivers of Change & Ecosystem Stresses

- Temperature rises and reduced precipitation - alpine meadows and shrubs may migrate to places higher up the mountains; Wetlands will shrink in response to high evaporation, which is further exacerbated by the expansion of settlements and other human activities.
- Ecosystems in the EH are being impaired and destroyed by a wide variety of human activities.
- The survival of the ecosystems and wildlife in the EH is being threatened by human activities like timber harvesting, intensive grazing by livestock, and agricultural expansion into forestland.
- Threats to ecosystems are driven by rapid growth in population, economic production, and social consumption behaviours.

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- As a result, environmental deterioration in mountains is driven by numerous factors, including deforestation, overgrazing by livestock, and the cultivation of marginal soils leading to soil erosion, landslides, and the rapid loss of habitat and genetic diversity. The obvious outcomes are widespread unemployment, poverty, poor health, and bad sanitation (Price et al. 2000).

- These problems are amplified by the unequal impacts of ecosystem degradation and the unequal distribution of benefits from ecosystem services.

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- The EH suffers from both water overabundance and extreme water shortages and acute moisture stress during the dry months, which adversely affect the ecology and agricultural production.
- Forest ecosystems are stressed by habitat change and fragmentation, which occurs as humans subdivide forest plots into ever smaller and more isolated sections.
- Forests are also threatened by the invasion of non-native species. Pollution can also stress forest trees, especially in urban, industrial, and heavily populated areas.
- The most irreversible of human impacts on ecosystems will most likely be the loss of native biodiversity.

Sensitivity of Biodiversity to Climate Change

- The EH, has diverse climatic conditions and complex topography, and thus contains different types of forests and vegetation.
- The majority of people living in the EH depend on pastoralism, agriculture, and agroforestry systems for their subsistence livelihoods. These farming systems support a wide range of agrobiodiversity that nurtures and maintains the region's genetic resources for food, nutrition, and economic prosperity.
- The consequences of biodiversity loss from climate change are likely to be the greatest for poor and marginalised people, who depend almost exclusively on natural resources.
- Land cover and land use changes can lead to deforestation, land degradation, habitat modification, forest fragmentation, and biotic attrition, besides transmitting positive feedback to the climate system and thereby accelerating climate change.

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- The EH contains numerous critical habitats and species.
- The extreme relief of the mountains coupled with monsoonal vagaries has left communities vulnerable to natural hazards like floods, landslides, and droughts (Pathak et al. 2010).
- The fragile Himalayan geology facilitates mass wasting when intense precipitation occurs.
- Changing climatic conditions are likely to modify the frequency of fire outbreaks and intensity.
- Climate change directly affects human wellbeing through extreme weather events and indirectly through a reduction in water quality and quantity, and poor sanitation leading to higher incidences of water-related diseases.

Potential Impacts of Climate Change and Implications for Biodiversity and Human Wellbeing

- Climate change is projected to compound pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic development.
- The biggest challenge for the EH is to adapt to the impacts of climate change by integrating responses to climate change and adaptation measures into strategies for poverty reduction at the local level to ensure sustainable development.
- Mountains are susceptible to the impacts of a rapidly changing climate

Ecosystem impacts when changes in climate and climate variability interact with existing stresses

Ecosystem	Existing stress	Interaction with climatic changes
Multiple ecosystems	Non-native invasive species	Climatic changes will probably tend to favour invasive species over rare and threatened species.
	Air pollution	Adverse interactions with climatic changes
Forests	Fragmentation	Fragmentation may hinder the migration of some species, and the loss of genetic diversity within fragments will reduce the potential for populations to respond to changing conditions through adaptive evolution.
Wetlands	Habitat loss	Habitat loss reduces the resilience of wetlands to the negative effects of storms, because wetlands play a role in moderating destructively high stream flows and pollution runoff.
Freshwater systems	Habitat degradation	Increases in the frequency or intensity of storms could exacerbate this problem.
	Pollution	Increased precipitation could increase pollution runoff.

Changes in primary climate change drivers and climate system responses in the EH from 1977-2000

Climate change drivers

- Average annual temperature increased by 0.01°C in the foothills, 0.02°C in the middle mountains, and 0.04°C in the higher Himalayas
- Night-time temperatures increased across most of the EH in spring and summer
- Annual precipitation changes are quite variable, decreasing at one site and increasing at a site nearby

Biophysical responses to climate change

- Duration of snow cover reduced and snow disappears earlier Less snowfall
- Flow in river basins reduced/increased
- Glacier retreat 20-30 m/year
- Net primary production (NPP) increased
- Wetlands contract
- Early spring and late autumn flowering

Impacts on Biodiversity

- There is a high confidence probability that the resilience of many ecosystems will be undermined by climate change, with rising CO2 levels reducing biodiversity, damaging ecosystems, and compromising the services that they provide.
- The loss of ecosystems and biodiversity is intrinsically bad for human development and the poor, who depend most heavily on ecosystem services, will bear the brunt of the cost.
- The increase in GHGs also affects species composition and the structure of ecosystems, which, in turn, affects ecosystem functions (Schutze and Mooney 1994).

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- As mountains are the source of the region’s rivers, the impact of climatic change on hydrology is likely to have significant repercussions, not only in the mountains themselves, but also in populated lowland regions that depend on mountain water resources for domestic, agricultural, hydropower generation, and industrial purposes.

Impacts on Water

- With rising temperatures, changes in runoff patterns and increased water evaporation will impact on the distribution of water and on the timing of flows.
- Water quality is expected to decrease drastically increasing the risk to human health.
- It is likely that tropical cyclones will become more intense as oceans warm, with higher peak speeds and heavier precipitation.
- Droughts and floods will become more frequent and widespread.

Impact on surface water availability

- Water availability, in terms of both temporal and spatial distribution, is expected to be highly vulnerable to climate change. Growing populations and the concentration of the population in urban areas will exert increasing pressure on water availability and water quality.
- The potential changes in precipitation (amount and seasonality) will affect soil moisture, groundwater reserves, and the frequency of flood and drought episodes.
- There is growing concern that climate change may accelerate the damage to wetlands and freshwater ecosystems such as lakes, marshes, and rivers.
- Wetlands are highly vulnerable to hydrological changes, not only in quantity and quality, but also in the frequency, duration, and timing of water availability.

Impacts on Human Wellbeing

- Climate change is providing us with a reminder of the symbiotic relationship between human culture and ecological systems. [This relationship is very evident in the EH, where some of the world's most fragile ecosystems are being affected by rapid warming. Indigenous people have become sentinels for a world undergoing climate change and the EH, in effect, a global climate change barometer.]
- The livelihoods of subsistence farmers and pastoral peoples, who make up a large portion of the rural populations, could be negatively affected by such changes.
- Climatic changes are predicted to reduce the livelihood assets of poor people, alter the path and rate of national economic growth, and undermine regional food security due to changes in natural systems and infrastructure impacts.

Impacts on Health

- Climate change will have a wide range of health impacts all across the EH through, for example, increases in malnutrition due to the failure of food security strategies, stress, disease, and injury due to extreme weather events (Epstein et al. 1995).
- Endemic morbidity and mortality due to diseases primarily associated with floods and droughts are expected to rise with projected changes in the hydrological cycle.
- Changes in temperature and precipitation could also expand vector-borne diseases into high altitude locations that hitherto have been uninfected.

Responses to Climate Change

- Many communities have adapted and continue to adapt to environmental changes.
- In food production, they maintain a portfolio of crop species and varieties to adjust the cropping pattern and crop calendar to the prevailing and anticipated changes in the growing environment.
- In extreme cases, people migrate to more benign environments and reconnect with new sets of ecosystem services.

Perceived changes in primary climate change drivers and climate system responses in the EH

Climate change drivers

- Temperatures have been rising across the entire region, with winter and spring temperatures rising more rapidly than those in summer
- The daily temperature range has gone down
- Total annual precipitation has increased in some areas and decreased in others

Biophysical responses to climate change

- Longer growing season
- Reduced snowfall in frequency and amount
- Tree line moving to higher elevation
- Ice fields contracting
- Biomass increase in wetlands

Vulnerability of Biodiversity to Climatic Threats

- Poverty and biodiversity have emerged as sources of vulnerability, predicated on the synergy between human and biophysical subsystems of mountain ecosystems.
- Biodiversity is still valid as a measure of ecosystem resilience, and poverty metrics are still relevant for evaluating the autonomous and adaptive capacity of human systems.
- Climate variability and change directly increase the vulnerability of people through flooding, drought, changes in average temperatures, temperature extremes, and extreme weather events.

Vulnerability in the EH

- Population pressure and devastation of natural biodiversity are the main factors that make these places highly sensitive to climate change.
- Biodiversity is at enormous risk of being degraded further as resource extraction is intensified to cope with the threats to food security and in improvised strategies for relief and recovery following each disastrous event.
- Poverty and low human development, which make the poor intrinsically vulnerable because they have fewer resources with which to manage risks.

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- Gender inequalities intersect with climate risks and vulnerabilities. Women's historic disadvantages, such as their limited access to resources, restricted rights, and muted voice in shaping decisions, make them highly vulnerable to climate change.
- Lack of climate-defence infrastructure that could serve as a buffer between risk and vulnerability; for example, flood defence systems, water infrastructure, early warning systems, and so forth.
- Protected areas (PAs) – These conservation areas and other smaller ones are considered to be vulnerable as they are located within the most vulnerable parts of the EH.

Adaptation Policy Frameworks for Climate Change

- Adaptation is a process by which individuals, communities and countries seek to cope with the consequences of climate change.
- The development of the Adaptation Policy Framework (APF) is intended to help provide the rapidly evolving process of adaptation policy-making with a much-needed roadmap.
- Ultimately, the purpose of the APF is to support adaptation process-es to protect – and enhance – human well-being in the face of climate change.

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The Adaptation Policy Framework is built around four major principles that provide a basis from which integrated actions to adapt to climate change can be developed:

- Adaptation to short-term climate variability and extreme events serves as a starting point for reducing vulnerability to longer-term climate change;
- Adaptation occurs at different levels in society, including the local level;
- Adaptation policy and measures should be assessed in a development context; and
- The adaptation strategy and the stakeholder process by which it is implemented are equally important

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- Prerequisites for developing effective adaptation strategies include an understanding of current perceptions and coping strategies at local levels to deal with emerging climate change challenges, and of ecological knowledge systems and ecosystems conditions; recognition of the existence of multiple stresses on the sustainable management of resources; and collaboration between locals and scientists.

- The potential for successful adaptation to climate change in the EH lies in sustainable natural resources management, poverty reduction, ecosystems and biodiversity conservation, integrated watershed management, human development, and disaster risk reduction.

Mitigation

- Conservation of forests and soil offers triple benefits: climate mitigation, people, and biodiversity. Mitigation actions that have complementary adaptation benefits, and vice versa, should be preferred. The restoration of degraded landscapes with vegetation and the implementation of agroforestry systems are two examples where carbon sequestration benefits can be achieved simultaneously with reduced soil erosion and improved water quality, both of which can provide biodiversity conservation benefits (Watson 2005).

Summing up

- Effective conservation and the sustainable use of natural resources are the overarching precepts of sound biodiversity management.
- Humans are integral parts of the ecosystems that are now being increasingly exposed to climate change stress. Without addressing the socioeconomic wellbeing of people, there is very little incentive for them not to overexploit or to protect biodiversity resources.
- Adaptation strategies must be people-oriented within the framework of protecting landscapes, ecosystems, habitats, and species so that anthropogenic interferences are kept to a minimum for natural resilience to take over and sustain the ecosystem structure and functions.

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- Traditionally, communities that depend on biodiversity resources have informal institutions and customary regulations in place to ensure that external perturbations do not exceed natural resilience beyond a certain threshold.
- Maintaining resilience in ecosystems is the primary objective of adaptation strategies for protecting wildlife and habitats (IPCC 2007).
- Activities that conserve biological diversity, reduce fragmentation and degradation of habitat, and increase functional connectivity among habitat fragments will increase the ability of ecosystems to resist anthropogenic environmental stresses, including climate change.