Climate change: a primer

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Climate Change: A Primer

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Abstract

Climate has inherent variability manifesting in gradual changes in temperature, precipitation and sea-level rise. The paper entitled "Climate Change: A Primer" attempts to analyse the policy response and adaptation to the need to address climate change at the international and domestic level both. Intense variations in climate would increase the risk of abrupt and non-linear changes in the ecosystem, impacting their function, biodiversity and productivity. The policy initiations and implementation for mitigating climate change risks have been intricately discussed pertaining to the International Panel on Climate Change (IPCC) (1988) by the United Nations Environment Programme (UNEP) and World Meteorological Organisation (WMO); United Nations Framework Convention Climate Change (UNFCCC) (1994); Kyoto Protocol (2005); India's Greenhouse Gas Emissions Report (2007), and the National Action Plan on Climate Change (NAPCC) (2008).

Introduction

Climate has inherent variability and can manifest in gradual changes in temperature, precipitation and sea-level rise, along with natural climate variability. Climate changes could also increase the risk of abrupt and non-linear variations in many ecosystems, which would affect their function, biodiversity and productivity. It impacts the ability of the earth's physical and biological systems (land, atmosphere and oceans) to provide goods and services essential for sustainable development.

Several studies have estimated the cost of unabated climate change in order to understand the benefits of mitigating climate change risks. It is well established that the

developing countries will be the hardest hit. Several aspects of a changing climate could be seen in agriculture by way of low productivity of crops, and in timber output due to changes in hydrologic regime. The expected poleward migration of forests may prohibit species migration. The rising sea level associated with climate change will impose costs in terms of coastal property damage from higher storm surges, lost land area and saltwater intrusion in drinking water aquifers. A changing climate will likely cause both an increase in the frequency of precipitation events and in the intensity of these events. A warmer climate could also exacerbate urban air pollution. Ground level ozone (smog) increases in the presence of high temperatures. The damages from climate change are unpredictable, partially reflecting the uncertainties in climate change science.

Objectives

The objectives of the study pertain to the analysis of the response of the community, both national and international, to the inherent climate variability. The subsequent policy developments to induce changes in greenhouse gas emissions, predominantly in the energy sector have been discussed at length in terms of International Panel on Climate Change (IPCC) (1988), United Nations Framework Convention Climate Change (UNFCCC) (1994); Kyoto Protocol (2005); India's Greenhouse Gas Emissions Report (2007), and the National Action Plan on Climate Change (NAPCC) (2008).

International Response to Climate Change: International Panel on Climate Change

The first step towards the global challenge of climate change was the establishment of International Panel on Climate Change (IPCC) in 1988 by the United Nations Environment Programme (UNEP) and World Meteorological Organisation (WMO) as a result of their concern that anthropogenic increases of emissions enhance the natural greenhouse effect and would result, on average, in an additional warming of the Earth's surface. The Panel would provide better understanding of the approaching plethora of problems related to environment and climate change and access the scientific knowledge and periodically review the existing literature on issues related to global warming and climate change. It is open to all Members of the UN and of WMO. Its assessments are based on the already published and peer-reviewed scientific technical literature. IPCC comprises of three working groups, one task force and a task group whose activities are coordinated by a Technical Support Unit. Working Group I (WGI) assesses the physical scientific aspects of the climate system and

climate change. Working Group II (WG II) assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. And Working Group III (WG III) assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere. To oversee the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP), the Task Force on National Greenhouse Gas Inventories (TFI) was established with the mandate to define the methodology and software to analyse the greenhouse gas emissions. The Task Group on Data and Scenario Support for Impacts and Climate Analysis (TGICA) was established to facilitate co-operation between climate modelling and climate impacts assessment communities. Till today, it has been instrumental in its objective in raising global awareness about the causes of climate change, potential impacts and options for mitigation through the four assessment reports which are discussed below.

The First Assessment Report released in 1990 documented the increase in global temperature by 0.5 degree Celsius over the past hundred years. The Second Assessment Report came out in 1996 with statistical evidence on climate change and its impact on water resources, ecosystem, agriculture, forestry, health, coastlines and regions of the world and the global average temperature was expected to warm more than 3.6-5.4 degrees F. It suggested a mix of adaptation and mitigation measures to reduce the risk of climate change. This report alarmed the world on the harmful effects of climate change and called for global action. IPCC released special reports on emission scenarios which became the input for the Third Assessment Report and the convention on climate change. In the Special Report on Emissions Scenarios, total cumulative carbon emissions from all sources through 2100 are predicted to be in the range of 770 GtC (giga tons of carbon) and 2540 GtC. These emission scenarios used as inputs for the Third Assessment Report of the IPCC released in 2001 showed that global GHG emissions recorded an increase of 70 per cent between 1970 and 2004. Moreover, the global average surface temperature has increased over the 20^{th} century by about 0.6^{o}C. With the current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to rise over the next few decades. The latest report, that is, the Fourth Assessment Report of the IPCC released in 2007, includes the input of more than 1,200 authors and 2,500 scientific expert reviewers from more than 130 countries. Some of the major findings of the Fourth Assessment Report are:

- The current atmospheric concentration of carbon dioxide and methane, two important heat-trapping gases, "exceeds by far the natural range over the last 650,000 years." Since the dawn of the industrial era, concentration of both gases has increased at a rate that is "very likely to have been unprecedented in more than 10,000 years."
- Eleven of the last 12 years rank among the 12 hottest years on record (since 1850, when sufficient worldwide temperature measurements began).
- Since 1961, the world's oceans have been absorbing more than 80 percent of the heat added to the climate, causing ocean water to expand and contributing to rising sea levels. Between 1993 and 2003 ocean expansion was the largest contributor to sea level rise.
- Melting glaciers and losses from the Greenland and Antarctic ice sheets have also contributed to the recent sea level rise.
- The full range of projected temperature increase is 2 to 11.5 degrees Fahrenheit (1.1 to 6.4 degrees Celsius) by the end of the century. The upper end of the range is higher than the prior IPCC assessment, mainly because of increased understanding that "warming tends to reduce land and ocean uptake of atmospheric carbon dioxide, increasing the fraction of [carbon dioxide] emissions that remains in the atmosphere."
- The best estimate range of projected temperature increases, extending from the midpoint of the lowest emission scenario to the midpoint of the highest would be 3.1 to 7.2 degrees Fahrenheit (1.8 to 4.0 degrees Celsius) by the end of the century.
- "Warming is expected to be greatest over land, most over high northern latitudes, and least over the Southern [formerly Antarctic] Ocean and parts of the North Atlantic Ocean."

The report concluded that it is "unequivocal" that Earth's climate is warming, "as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level."

United Nations Framework Convention on Climate Change (UNFCCC)

At the United Nations Conference on Environment and Development (Earth Summit) in Rio De Janeiro, Brazil, in June 1992, the world community endorsed the UNFCCC. This Convention which took effect in 1994 has been ratified by 160 countries including United States with the goal of preventing "dangerous" human interference with the climate system and reducing GHG emissions to the 1990 level. The ultimate objective of the UNFCCC is to

achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system within a sufficient time frame. In fact, limiting GHG emissions to specific levels now appears to be an internationally recognised objective. The convention has been divided into three categories:
Annex 1 parties comprised of the industrial nations, members of the OECD, countries with EIT (economies in transition), Russia Federation, the Baltic states and several Central and Eastern European states are subjected to mandatory reduction of Greenhouse Gases by 2012
Annex II parties consist of only OECD members of Annex 1, but not EIT parties.
Non-Annex 1 parties comprise developing countries. The developing countries are not bound by any mandatory commitments to reductions but due to the lower cost of abatements they can take part in the mitigation effort through Clean Development Mechanism (CDM) through the transferring of Certified Emission Reductions (CERs) to the developed country firms.

Conference of the Parties (COP) to the UNFCCC

This is a part of the UNFCCC that promotes and reviews the implementation of the convention which is done through the collective decisions taken at periodic meetings called COP (Conference of the Parties). The first COP was held in Berlin in March 1995 which came out with the Berlin Mandate, an agreement to set up a new negotiation process to include binding GHG limitations and reduce targets in an international protocol or treaty within a time-bound framework. Till date, COP has met sixteen times since 1995 and the COP-17 is to be held in Durban, South Africa in December, 2011. The historic Kyoto Protocol was signed during COP-3 in December 1997 in Japan. Some of the operational details of the provisions contained in Kyoto Protocol were considered at COP-6. Each session of the COP is critical to reaching the next step and coming closer to new global climate change treaty.

Kyoto Protocol

To develop a protocol to curb the growth in greenhouse gas emissions which was prompted by mounting scientific evidence during the 1990s of human-induced climate change, the global community eventually resulted in drafting a protocol which commenced with the negotiations in 1995. The protocol entered into force on 16 February 2005 and till 2007, it had been ratified by 175 countries. The Kyoto Protocol is an international and legally binding agreement to reduce greenhouse gas emissions worldwide. Under the protocol, 38

industrialised countries (Annex 1 Parties under the UNFCCC) agreed to fixed and legally binding responsibility targets for their greenhouse gas emissions during 2008-12, known as the first commitment period or CP1. Over all, Annex 1 parties agreed to an aggregate reduction in their emissions of 5 per cent relative to 1990 levels. To achieve these targets, Kyoto Protocol provided for the establishment of three so called "Flexible Mechanisms" for CP1: an International Emission Trading Regime[1], the Clean Development Mechanism[2] and Joint Implementation[3]. Developing countries agreed under Article 10 of the Protocol, to take a range of measures designed to improve the quality of the reporting of their anthropogenic emissions and to "formulate, publish, implement and regularly update national ....programmes containing measures to mitigate climate change and to facilitate adequate adaptation to climate change".

Following are the climate change milestones:

1. **1824**: French Physicist Joseph Fourier used greenhouse analogy to describe importance of atmosphere in trapping heat and influencing earth's temperature.
2. **1859**: Irish Physicist John Tyndall identified water vapour and carbon dioxide as heat trapping gases.
3. **1896**: Swedish Chemist Svante Arrhenius concluded that CO_2 emissions from industrial coal burning would enhance greenhouse effect; ***first suggestions that human activity produces greenhouse gases***.
4. **1938**: British Engineer Guy Callender first suggested that fossil fuel burning was responsible for observed warming of world's climate.

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[1] Articles 6 and 17 of the protocol allow for emission reduction credits to be traded between Parties to the protocol. Trading emission credits allows countries with lower marginal abatement costs to reduce their emissions below their commitment level and then sell the credits to countries with higher marginal abatement costs. The net result of such trade is that overall emissions for Parties in Annex B would be maintained within the emissions cap but at lower economic cost than if there were no emissions trading.

[2] The clean development mechanism allows for abatement to be conducted on a project by project basis in developing countries where the marginal cost of emission reduction is low.

[3] Joint implementation allows emission reduction projects to be conducted by Annex B countries within other Annex B countries on a project by project basis. This mechanism will encourage foreign investment where the marginal cost of emission abatement is low.

5. **1958**: American Scientist Charles Keeling made the first direct measurement of atmospheric CO_2 at Mauna Coa, Hawaii.
6. **1965**: US Advisory Panel warned that greenhouse effect was a matter of real concern.
7. **1972**: The first recognition was given to environmental problems in the United Nations Conference on Human Environment in Stockholm in June 1972, attended by 112 nations. Mrs. Indira Gandhi, the then Prime Minister of India made her memorable statement that "Poverty is the greatest polluter" which is often quoted by the environmentalists. Its outcome was the establishment of United Nations Environment Programme (UNEP) with the objective of organising global environment planning and management.
8. **1975**: US Scientist Wallace Broecker introduced the term "global warming" into public domain.
9. **1979**: First world climate conference urged governments to foresee and prevent potential man-made changes in climate.
10. **1985**: Convention for Protection of the Ozone Layer was held in Vienna in 1985 in which 20 countries participated and agreed to protect human health and environment resulting from modifications in the Ozone Layer.
11. **1987**: Montreal Protocol: in September 1987, in which 24 countries signed (now increased to 160), restricting chemicals that deplete Ozone Layer. Although not established with climate change in mind, it had major impact on greenhouse gas emissions. The protocol got amended twice in 1990 and 1992 which stated that the "production and consumption of substances that deplete stratospheric O_3 such as CFCs, halons, and carbon tetrachloride are to be phased out by 2000 and methyl chloroforms by 2005".
12. **1988**: US Senator and Director, NASA, Timothy Wirth declared that temperatures were rising due to burning of fossil fuel. Also, the Conference in Toronto was attended by several hundred scientists, politicians, and officials from 48 countries and the UN which started the push for action by calling for a 20 per cent reduction in CO_2 by 2005. UN's General Assembly set up Intergovernmental Panel on Climate Change (IPCC) to collate and analyse evidence on global warming.
13. **1990**: IPCC and Second World Climate Conference called for a global treaty on climate change. In September, the UN General Assembly began negotiations on a

framework convention. The First IPCC Report (First Assessment Report) stated that human activities are significantly adding to concentration of greenhouse gases.

14. **1991**: Debris from eruption of Mount Pinatubo Volcano in Philippines shields earth from solar energy, causing global temperature to fall for two years before rising again. The Intergovernmental Negotiating Committee (INC) convened its meeting.
15. **1992**: UN Earth Summit in Rio de Janeiro created the Framework Convention on Climate Change; Developed countries agreed to cut emissions to 1990 levels.
16. **1994**: UNFCCC (United Nations Framework Convention on Climate Change) entered into force on 21st March 1994 which is currently ratified by 189 countries.
17. **1995**: The Conference of the Parties in Berlin (COP-1) was the first after the Climate Change Convention went into force. The parties decided to initiate negotiations (Berlin Mandate) for what later came to be known as the Kyoto Protocol. The goal for COP1 was that countries should take on legally binding obligations for the reduction of greenhouse gas emissions.
18. **1996**: COP-2 was held in Geneva in which US Senator Wirth announced that the US would support legally binding limits on emissions if other countries also did so. Further, the Ministerial Declaration or the Geneva Declaration emphasised the need to accelerate the Berlin mandate talks on strengthening the Convention. Also, the Second Assessment Report (SAR) of the IPCC was released with statistical evidences on climate change.
19. **1997**: After difficult negotiations, in particular between the EU and the USA, the Kyoto Protocol was passed at the Third Conference of the Parties (COP-3) which set binding targets for industrialised nations to reduce emissions by 5 per cent against 1980 levels over the period 2008-2012.
20. **1998**: Strong El NI-o (El Niño/La Niña-Southern Oscillation, or ENSO[4]) conditions combine with global warming to produce warmest year on record. At COP-4 held in Buenos Aires, Argentina, BAPA[5] adopted setting out deadline of COP-6 to finalise operational details of the protocol and strengthen the implementation of the UNFCCC.

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[4] El Niño/La Niña-Southern Oscillation, or ENSO is a combination of changes in the ocean and atmosphere that affect weather in many areas of the world.

[5] BAPA: Buenos Aires Plan of Action, 1998 for promoting and implementing Technical co-operation among Developing Countries.

21. **2000**: At the Sixth Conference (COP-6) in The Hague, negotiations collapsed. Amongst other reasons, this was due to insoluble disagreement between the EU and the USA. President George W. Bush removed US from Kyoto process.
22. **2001**: To get the process moving again after the collapse in The Hague, the UN Climate Change Secretariat (IPCCC) called an extraordinary conference of the parties in Bonn (COP-6) in 2001. At this conference, and at the following one in Marrakesh, Morocco (COP-7), the remaining countries succeeded in agreeing on most of the outstanding questions. Also, the Third Assessment Report (TAT) of IPCC was released emphasising the vulnerability towards climate change and adaptation and mitigation measures.
23. **2002**: Larsen B Ice Shelf over 3,000 sq. Km in size broke off the Antarctica Peninsula. In Delhi, under the Danish presidency of the EU, the latter tried unsuccessfully at the Eighth Conference (COP-8) to get the ministers to agree to a declaration about the need for further initiatives to limit climate change and the links with sustainable development.
24. **2003**: Europe's worst heat wave in 500 years killed an estimated 30,000, accelerating divergence between European and US public opinion. In Milan**,** the focus of the Ninth Conference (COP-9) was finding technical clarifications for some of the outstanding issues remaining from Marrakech. It concerned, for example, to what extent the giving off and absorption of CO2 in soil and forests should be calculated, and how the Flexibility Mechanisms- Joint Implementation (JI), the International Quota Trade as well as the Clean Development Mechanism (CDM) should be put together.
25. **2004**: In Buenos Aires, the parties worked further at finding technical solutions, just as they also started informal discussions about what should happen after 2012. The conference of the parties in Buenos Aires was the tenth under the Climate Change Convention (COP10).
26. **2005**: Kyoto Protocol came into force in February after Russia ratified it in November 2004. The first Meeting of the Parties (MOP)/COP-11 was held in Montreal, Canada in October. An agreement was reached that the process would continue on two tracks. The first was a global dialogue about a future long-term climate co-operation with all countries participating, including the USA and the large developing countries (China, India, Brazil, etc.). The second was concrete

negotiations under the Kyoto Protocol about industrialised countries' obligations after 2012. G8 Summit held at Gleneagles during 6-8 July in which G8 leaders signed a Communique (including a political statement and action plan on climate change and sustainable development). Also, Asia-Pacific Pact was signed by the US, Australia, India, China, Japan, and South Korea to promote cleaner green technologies.

27. **2006**: China undertook US as world's biggest emitter but US remains well ahead on per capita basis.The positive momentum from Montreal to start work towards a new binding agreement for after 2012 was maintained at the Twelfth Conference of the Parties in Nairobi (COP-12).
28. **2007**: IPCC stated that warming of climate is unequivocal and placed blame firmly on human activity. In G8 held at Helligendamm, the leading industrialised nations aimed to at least halve global CO2 emissions by 2050. In Bali (COP13), the Parties reached an accord - the Bali Roadmap, concerning the future process towards signing an agreement at the conference in Copenhagen (COP15). Furthermore, it was agreed that an Adjustment Fund would be established, which would help developing countries in adjusting to climate changes and the Global Enviornment Facility to provide secretariat services and the World Bank to serve as a trustee of adaptation fund on interim basis.
29. **Oct**. **2007**: IPCC and former US Vice-President Al Gore shared Nobel Prize for efforts to spread awareness of climate change; Arctic sea ice shrunk to the lowest extent on record.
30. **May 2008**: US listed polar bear as an endangered specie due to the rapid melting of its arctic sea-ice habitat. In November 2008, US President elect Obama vowed to engage vigorously in talks on climate change. G8 was held in Tokyo to share and adopt the goal of achieving at least 50% reduction in global emissions by 2050. COP-14 was held in Poznan, Poland in December, 2008. It was expected that the consensus on the UNFCCC meetings would be evolved in the Copenhagen.
31. **2009**: New evidence shows Antarctica is warming rapidly, leaving Wilkins Ice shelf largest of its kind on brink of breaking away.
32. **October 2009**: International Energy Agency says global crisis had lead to a fall of carbon emissions by 3 per cent in 2009, giving world leaders unexpected opportunity to take decisive action on global warming.

33. **December 7, 2009**: 193 governments convened for UN Summit in Copenhagen to negotiate New Climate Change Treaty during the COP-15. More than 100 Heads of States participated during the final days of the conference. The outcome was the Copenhagen Accord which is neither binding nor does it constitute a mandate for a new negotiating process under UNFCCC. It dealt with various elements of Bali Action Plan relating to issues of mitigation, adaptation, financing and technology in the context of climate change. The Copenhagen Accord delineated that global temperatures' rise should stay below 2C (3.6F). The treaty failed to include any numerical targets for cutting pollution. However, most of the countries agreed to international monitoring and report to outside world. It was agreed to continue the work of the two groups on long term Cooperative Action and Kyoto Protocol, envisaged under Bali Action Plan, to reach an effective outcome at the COP-16 in Mexico to be held in Nov-December, 2010.
34. **December, 2010**: Delegates at the 16th Conference of the Parties (COP-16) in Cancun adopted by consensus the Cancun Accords, a series of documents that will provide the basis for efforts to confront climate change after the Kyoto Protocol expires. The accords include a $30 billion-package for 2012 to aid nations taking immediate actions to halt effects of global warming, as well as financing for long-term projects to protect the environment through a Green Fund, which will provide $100 million annually for adaptation and mitigation measures. Delegates also approved the creation of the forestry program Reducing Emissions from Deforestation and Forest Degradation (REDD+) to facilitate the flow of resources to communities dedicated to forest conservation.
35. **November-December, 2011**: The 17th Conference of the Parties (COP-17) to the United Nations Framework Convention on Climate Change (UNFCCC) and the 7th Session of the Conference of the Parties serving as the meeting of the parties (CMP7) to the Kyoto Protocol will be held in the sunny city of Durban, South Africa.

India: Taking on Climate Change

According to the last official updated Report on India's Greenhouse Gas Emissions 2007 released by the Ministry of Environment and Forests, India ranks fifth in aggregate GHG emissions in the world, behind USA, China, EU and Russia in 2007. Interestingly, the emissions of USA and China are almost 4 times that of India in 2007. It is also noteworthy

that the emissions intensity of India's GDP declined by more than 30% during the period 1994-2007, due to the efforts and policies that are proactively being put in to place. According to this Report, the net Greenhouse Gas (GHG) (from Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O)) emissions from India in 2007, that is emissions with LULUCF[6], were 1727.71 million tons of CO2 equivalent (eq) of which:

- CO_2 emissions were 1221.76 million tons;
- CH_4 emissions were 20.56 million tons; and
- N_2O emissions were 0.24 million tons

GHG emissions from Energy, Industry, Agriculture, and Waste sectors constituted 58%, 22%, 17% and 3% of the net CO_2 eq emissions respectively. Energy sector emitted 1100.06 million tons of CO_2 eq, of which 719.31 million tons of CO_2 eq were emitted from electricity generation and 142.04 million tons of CO_2 eq from the transport sector. Industry sector emitted 412.55 million tons of CO_2 eq. LULUCF sector was a net sink. It sequestered 177.03 million tons of CO_2. India's per capita CO_2 eq emissions including LULUCF were 1.5 tons/ capita in 2007.

As proclaimed by Shri Jairam Ramesh, Minister of Environment and Forest that no country in the world is as vulnerable on so many dimensions to climate change as India. Whether it is the long coastline of 7000 kms, Himalayas with their vast glaciers, and 70 million hectares of forests (which incidentally house our key mineral reserves), the country is exposed to climate change on multiple fronts. It is likely that anthropogenic activities have resulted in some irreversible influence on physical and biological systems.

Burgeoning population (over 1.5 billion, 2nd largest), coupled with rapid economic growth (over 9 percent), industrialization and an economy closely tied to its natural resources is highly vulnerable to climate change. The changes in temperature and precipitation are likely to have a significant impact on climate sensitive sectors such as agriculture, forestry, coastal resources, water resources, infrastructure, energy and the country would face additional risks to the livelihoods of people and human health. According to the Indo-UK Climate Impacts Programme, it is found that temperatures in India were likely to rise as much as 3-4^{o}C (degree Celsius) towards the end of the 21st century. The warming will be widespread over the country, and relatively more pronounced over northern parts. Population growth and climate change together are predicted to reduce the per capita availability of fresh

[6] **Land Use Land Use Change and Forestry (LULUCF):** Includes emissions and removal from changes in areas of forest land, crop land, grass land, wet land, settlements and other lands.

water in India from 1900 m^3 currently to 1000 m^3 by 2025. A significant part of the annual variation in India's GDP growth over the past half century is attributable to yearly variations in rainfall. Rainfall in India is projected to increase by 15-40 per cent with high regional variability by the end of the 21st century. The surface air temperature has warmed up by 0.4^0 C over the period 1901-2000. The change in temperature and large concentration of CO_2 is already shown to have an effect on the productivity of crops mainly staple crops such as wheat and rice.

National Response to Climate Change

Recognizing that climate change is a global challenge, India has engaged actively in multilateral negotiations in the UN Framework Convention on Climate Change with the objective to establish an effective, cooperative and equitable global approach based on the principle of common but differentiated responsibilities and respective capabilities, enshrined in the United Nations Framework Convention on Climate Change (UNFCCC). Such an approach must be based on a global vision inspired by Mahatma Gandhi's wise dictum—

> **"***The earth has enough resources to meet people's needs, but will never have enough to satisfy people's greed. Thus we must not only promote sustainable production processes, but equally, sustainable lifestyles across the globe.*"

Climate change is integrated into the national development planning process, and overseen by the Prime Minister's Council on Climate Change. In order to achieve a sustainable development path that simultaneously advances economic and environmental objectives, Government of India approved the National Action Plan on Climate Change (NAPCC) in June, 2008 with Eight National Missions including:

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

Status Report of the National Missions

Among the above listed National Missions, the Government of India has approved "Jawaharlal Nehru National Solar Mission" (JNNSM) in January, 2010 which aims at development and deployment of solar energy technologies in the country to achieve parity with grid power tariff by 2022. The objective of the National Solar Mission is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible. The Road Map for JNNSM is given below:

Table 1: Road Map for JNNSM

Application Segment	**Target for Phase I (2010-13)**	**Cumulative Target for Phase 2 (2013-17)**	**Cumulative Target for Phase 3 (2017-22)**
Grid solar power (incl. roof top)	1,100 MW	4,000 MW	20,000 MW
Off-grid solar Applications (incl. rural solar lights)	200 MW	1,000 MW	2,000 MW
Solar collectors	7 million sq. meters	15 million sq. meters	20 million sq. meters

Source: Ministry of New and Renewable Energy

In June, 2010, National Mission on Enhanced Energy Efficiency (NMEEE) has been approved by the Prime Minister's Council on Climate Change which is the second of eight missions under India's National Action Plan on Climate Change. It enables about Rs 75,000 crore worth of transactions in energy efficiency. By 2015, this mission will help in saving of about 5% of annual energy consumption and nearly 100 million tonnes of carbon dioxide every year. The Mission includes several new initiatives which will cover facilities that account for more than 50% of the fossil fuel used in India, and help reduce CO_2 emissions by 25 million tons per year by 2014-15. Four Initiatives to enhance energy efficiency:

- A market based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded. (Perform, Achieve and Trade)
- Accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable (Market Transformation for Energy Efficiency (MTEE))
- Creation of mechanism that would help finance demand side management programmes in all sectors by capturing future energy savings. (Energy Efficiency Financing Platform (EEFP)).

- Developing fiscal instruments to promote energy efficiency namely Framework for Energy Efficient Economic Development (FEEED).

The National Mission on Sustainable Habitat (NMSH) was recently approved as one of the eight National Missions under the Prime Minister's National Action Plan on Climate Change (NAPCC). A comprehensive strategic plan is being drafted for the implementation of this Mission. The key objectives of the NMSH include: Promoting energy efficiency in residential and commercial sectors, to develop a comprehensive approach to managing water, solid waste and wastewater that takes into account potential for recycling, re-use and energy creation, to refurbish urban transportation to increase usage and energy efficiency through a combination of promotional, regulatory and fiscal measures, including mandatory fuel efficiency standards to be notified shortly.

The Green India Mission , also one of the eight National Missions under NAPCC is under finalisation with the overarching target to double the area to be taken up for afforestation/ eco-restoration in India in the next 10 years, taking the total area to be afforested or eco-restored to 20 million hectares.

The National Mission for Sustaining the Himalayan Ecosystem has been approved and launched. This Mission focuses on evolving suitable management and policy measures for sustaining and safeguarding the Himalayan glacier and mountain ecosystem. It will establish an observational and monitoring network for the Himalayan environment to assess freshwater resources and health of the ecosystem.

Other Initiatives

Along with active and constructive involvement with international community, the country is adopting strong domestic agenda to combat climate change. Recognising the significance of strategy of sustainable development which is proposed to be the core theme of the approaching Twelfth Five Year Plan (2012-17) also, the following efforts and initiatives have been taken by the Government of India:

1. The Government of India has set up an Expert Group on Low Carbon Strategy for Inclusive Growth with multi-stakeholder representation from industry, leading think tanks, research institutions, civil society and government. The Group would develop strategy towards low carbon development path which is expected to be effective from the base year of Twelfth Five Year Plan 2012.

2. The government has announced a "Carbon Tax" on coal to fund clean energy at the rate of Rs. 50 (US$ 1) per ton, which will apply to both domestically produced and imported coal. The expected earnings from this cess are around USD 500 million for the financial year 2010-11.

3. Regional and International Cooperation

- In efforts towards regional and international cooperation, South Asian Association for Regional Cooperation (SAARC), which comprises the eight South Asian countries, adopted the Thimpu Statement on Climate Change on 29th April 2010. The Statement calls for, among other things, an Intergovernmental Expert Group on Climate Change to develop a clear policy direction for regional cooperation on climate change.
- India has also announced the grant of US $ 1 million each to SAARC Forestry Centre, Thimpu, Bhutan and SAARC Coastal Management Centre, Male, Maldives.
- India and Bangladesh have also planned to set up the India-Bangladesh Sunderbans Ecosystem Forum to conserve the Sunderbans – the world's largest riverine delta where climate change will be the central component.

4. India's first CDM PoA (Bachat Lamp Yojana): The Bachat Lamp Yojana (BLY) conceived as CDM Programme of Activity (PoA) for mass distribution of Compact Fluorescent Lamps (CFLs) in India has been registered successfully by the CDM-Executive Board. This is the first PoA to be registered from India and third in the world. The Programme has been developed to promote energy efficient lighting in India. State-level Electricity Distribution Companies (DISCOMs) that join this programme would distribute high quality CFLs at about Rs. 15 per piece. The Programme would not only help the reduction of peak load in the country but also lead to a potential reduction of over 6,000 MW in electricity demand.

5. State governments have been asked to prepare State-specific Action Plans on Climate Change, that draw upon India's National Action Plan and to operationalise state level measures in mitigation and adaptation. These Action Plans will help communities and ecosystems to adapt to climate change effectively and become a part of the sustainable development agenda and contribute towards the objective of NAPCC. In this context, Delhi and Orissa have already announced their Action Plans. Other States like Himachal Pradesh, Karnataka are also in the process of preparation of

these Plans. The Central Government has also announced an incentive –based additional special grant of US $ 1.2 billion to all States for sustainable forestry management.

6. To enable informed decision-making and to ensure transparency, the government released its Greenhouse Gas (GHG) Emissions Inventory (2007), on 10th May 2010 in a two-year cycle going forward which is much more frequent than the requirement under its NATCOM commitments. Until now, the only official emissions estimates available were for the year 1994 and India has become the first "Non-Annex I" developing country to publish such updated numbers. According to the results, India's emissions are less than a fourth of the USA and China. Results also show that the emissions intensity of India's GDP declined by more than 30% during the period 1994-2007 due to the efforts and policies that India has proactively put in place. Despite its already low emissions intensity, India intends to do even more.

7. The Indian Network for Climate Change Assessment (INCCA) has undertaken a major "4X4" assessment of the impacts of climate change on four sectors in 2030– water resources, agriculture, forests and human health – in four critical regions of India – the Himalayan region, North east, Western Ghats and Coastal India which was released in the beginning of November 2010. According to this Assessment, the annual mean surface air temperature is projected to rise by 1.7°C and 2.0°C in 2030s. Seasons may be warmer by around 2.0°C towards the 2030s. The variability of seasonal mean temperature may be more in winter months. All the regions including Himalayan, North-Eastern, Western Ghats and Coastal regions under consideration show a small increase in annual precipitation in the 2030s with respect to the baseline, that is 1970s. Sea level along the Indian coast has been rising at the rate of about 1.3mm/year on an average and is expected to rise further. Productivity of crops is also expected to decline in almost all regions. A qualitative assessment indicates that morbidity and mortality of the population in the regions under focus are likely to increase with warming temperatures and variable precipitation as they have direct as well as indirect effects. Direct effects can manifest as heat stress and indirect effects can be in terms of vector borne diseases, water borne diseases and malnutrition etc.

8. India also hosted Ministerial and High-Level Conference on Technology and Climate Change in November, 2010 where representatives from over 35 countries across the world participated to discuss the creation and operationalisation of a Technology

Mechanism under the UNFCC. General consensus evolved over the importance of international cooperation for dissemination of currently available new technologies, the role of intellectual property and finance in the negotiations enabling technology mechanism.

Recently, in the Major Economic Forum, the Minister for Environment and Forest has taken a step further on climate arena by proposing the method by which India and other developing countries actions could be scrutinized for their domestic and voluntary climate actions. He proposed that international consultations and analysis (ICA) will take place under the UN process once every two-three years for countries with a share of world emissions in excess of 1 per cent whereas all other countries will have the scrutiny once every four/five years. The reporting requirements will be uniform for all countries whose emissions cross 2 per cent of world GHG emissions, the content of the ICA report will differ for developed and developing countries. But if this proposal is accepted by the International Community, it will be the first time that the biggest historic emitter US and the four emerging economies-China, South Africa, India and Brazil would have the same level of reporting and scrutiny.

A Snapshot of the recent initiatives related to Climate Change undertaken by the Government of India is at Box.1

Box 1: Recent Initiatives on Climate Change

Area	Initiative/Event	Contribution
Science & Research	**Indian Network for Climate Change Assessment (INCCA)**	Network of 120 research institutions and 250 scientists launched; submitted its first report in November, 2010.
	Himalayan Glaciers Monitoring Programme	Comprehensive programme to scientifically monitor the Himalayan glaciers – Phase I completed; Phase II launched; Discussion Paper on State of Himalayan Glaciers released.
	Launch of Indian Satellite to Monitor Greenhouse Gases	ISRO to launch a micro-satellite in 2010 to study aerosols (soot particles), followed by a comprehensive satellite in 2011 to monitor GHG gases; India to join elite club of countries to do so.
	India's Forest and Tree Cover as a Carbon Sink	Research estimates the value of India's forests as a carbon sink – assessment shows that they neutralise 11% of India's annual GHG emissions Science & Research.
	India's GHG Emissions Profile	India's GHG Emission Pathways until 2030 under different assumptions made public; shows India will remain a minor per capita emitter even in 2030.
Policy Development	**Expert Group on Low Carbon Economy**	Planning Commission-led Group set up to develop strategy for India as a low carbon economy; to feed into Twelfth Plan process.
	State Action Plans on Climate Change	Delhi: First State to release Climate Change Action Plan; other States finalising their Plans Policy.
	National Policy on Bio-fuels	National Policy on Bio-fuels approved by Cabinet to promote cultivation, production and use of Bio-fuels for transport and in other applications.
Policy Implementation	**National Missions under National Action Plan on Climate Change**	National Missions on Solar Energy, Energy Efficiency and Strategic Knowledge approved; other Missions in final stages of preparation.
	First National Conference on Green Building	Materials and Technologies Conference to stimulate green building sector; to set an example the Govt proposes that all its new buildings will be GRIHA 4* compliant

		subject to site conditions.
	30 "Solar Cities	In-principle approval given to 30 'Solar Cities' with aim of 10% deduction in projected demand of conventional energy through a combination of energy efficiency and renewable.
	Energy Efficiency Standards for Appliances	Energy efficiency ratings made mandatory for 4 key appliances — refrigerators, air conditioners, tubelights and transformers from January 7, 2010; more to follow through 2010.
	Fuel Efficiency Norms	Plan for fuel economy norms for vehicles announced; to be made operational in two years Policy Implementation.
	CDM Program	India assessed as Best CDM Country; Indian projects to neutralise 10% of emissions by 2012.
International Cooperation	**India to host Rio+20'**	India to host 11th COP of Convention on Biodiversity (CBD) in 2012, mark 20th anniversary of Rio.
	UN Climate Technology Conference	India successfully hosts global Conference on technology, Delhi Statement adopted.
	SAARC Environment Ministers Conference	India successfully hosts SAARC Ministers Conference and agrees joint actions on Climate Change; 2010 SAARC Summit to be on the theme of Climate Change International Cooperation.
	India's Submissions to UNFCCC	Report documenting India's 12 proactive submissions to UNFCCC released.
Forestry	**State of Forests Report 2009**	Latest State of Forest Report released; shows continued rise in India's forest cover.
	Launch of CAMPA	Ambitious Rs. 11,700 crore (US $ 2.5 Billion) Programme for forest conservation launched.
	Green India Mission	New mission under NAPCC to fast-track re-forestation being finalised.
	Capacity Building in Forestry Scheme	New Rs 369 crore (US$ 80 Million) scheme for HRD for forest personnel.
	Intensification of Forest Management	New Rs 600 crore (US$ 125 Million) scheme to improve forest management.

	Inclusion of Forestry within NREGA	Forestry related activities included as part of India's flagship employment guarantee scheme to fast-track reforestation; Pilots being implemented.

India at Copenhagen Climate Summit

India's proposal for a worldwide network of innovation centres for climate friendly technologies met with broad consensus at the conference that can help the countries meet pressing energy and climate challenges while advancing sustainable development. These centres will represent an international collaborative effort that can bring together global capabilities and the needs of the developing countries

The Prime Minister has emphatically announced that India would reduce the emissions intensity of its GDP by 20-25% between 2005 and 2020, even as it accelerates infrastructure development and the growth of its manufacturing sector. He has stated that an agreement on climate change should respect the need for development and growth in developing countries and the equitable burden sharing should underlie any effective global climate change regime.

India came out strongly in the Copenhagen Climate summit by not only protected its national interests but also enhancing the same. One of the notable features of the conference has been the close coordination between the BASIC (Brazil, South Africa, India and China) countries which was reflected positively fostering of "active South-South cooperation". These along with other developing countries have been successful in ensuring that there was no violation of the Bali Action Plan, 2007. Given that intellectual property rights on technology remain a major barrier to achieving higher energy efficiencies, such joint efforts involving India and China hold great promise.

India at Cancun, Mexico

India has virtually agreed to death of Kyoto Protocol that protects interests of the developing countries but ensured some safeguards to achieve high economic growth and its right for sustainable development to eradicate poverty. In the give-away, India has agreed for a binding commitments, international review of its domestic mitigation commitments once in two years and to have low carbon growth in the context of sustainable growth, in a proposal submitted for adoption at the Cancun climate summit of 194 nations stating that the new agreement will be signed in Durban, South Africa, in 2011.

India's Proposal for COP-17

In order to promote cooperation and provide a context to the convention in the seventeenth session (COP-17) to be held in December, 2011 in South Africa, India has submitted a three point agenda which has been included in the upcoming meeting of the Conference of Parties, COP-17 to be held in December, 2011 in Durban, South Africa. The three-point agenda includes accelerated access to critical mitigation and adaptation technologies and related intellectual property rights; equitable Access to Sustainable Development and Unilateral Trade Measures. However, it has also been clarified that an early resolution to these agenda will be helpful in unlocking disagreements in other areas as well but COP-17 should act as the forum to initiate the discussion on these agenda items.

Policy Implications

To help highly vulnerable countries pilot and demonstrate ways to integrate climate risk and resilience into core development planning while complementing other ongoing activities, the World Bank Group has adopted Strategic Framework on Development and Climate Change (SFDCC) in October 2008. WBG provides technical assistance on mainstreaming climate resilience through its Pilot Projects on Climate Resilience (PPCR). Asian Development Bank (ADB) is also working in partnership with the countries of the region to address transboundary issues and share experience in tackling common challenges brought about by climate change through finance, technical support, advice and knowledge. In 2009, ADB launched the Climate Change Fund (CCF) to address the climate change challenge facing Asia and the Pacific by providing concessional finance to scale up DMCs' mitigation, adaptation, forest conservation, and land use management activities.

To use market and financial incentives in order to reduce the emissions of greenhouse gases from deforestation and forest degradation, United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) programme was created. The REDD mechanism is an effort to create a financial value for the carbon stored in forests and provides incentives for developing countries to reduce emissions caused by deforestation and forests degradation and invest in low-carbon paths to sustainable forest management. It is estimated that the opportunity costs for reducing deforestation and forest degradation via REDD is $ 12.2 billion per year and it would result in reduction of emissions by 5.8 Gt Co_2 in 2030. Further, REDD+ has been adopted which goes beyond deforestation and forest degradation and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. The North-South flow of funds from

REDD+ could go a long way in meaningful reduction of carbon emissions, pro-poor development, conserve bio-diversity and help in securing vital ecosystem services. India has also set up a Technical Group to develop methodologies and procedures to make assessment and monitoring of REDD+ actions. In principle approval has been given to set up a National REDD+ Coordinating Agency. Also, methodologies for National Forest Carbon Accounting are being institutionalized.

The adherence to the principle of common but differentiated responsibilities is critical for international cooperation on climate change. The demands of the developing countries in forcing the developed countries to be the first mover are quite justified in a sense that they are the ones who have utilized the natural resources the most and have led to a rise in emissions. The responsibility lies with developed countries to meet the commitments before the climate change efforts become irreversible.

To conclude, sustainable lifestyles across the globe are imperative to promote sustainable development. Thus the importance of international cooperation for dissemination of currently available new technologies, the role of intellectual property and finance in the negotiations enabling technology mechanism is a debatable issue of grave importance. A worldwide network of innovation centres for climate friendly technologies helping countries to meet pressing energy and climate challenges representing collaborative effort can go a long way to mitigate the greenhouse effect.

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