

Climate Change Adaptations in India

Abstract

Climate change is one of the most important global environmental challenges, with implications for food production, water supply, health, energy, etc. Addressing climate change requires a good scientific understanding as well as coordinated action at national and global level. India is a growing economy and has to sustain its economic growth, despite challenges of climate change. India's vision is to create a prosperous, self-sustaining economy, mindful of responsibilities to both present and future generations. This paper addresses these challenges. National Action Plan on Climate Change (NAPCC) is a comprehensive action plan identifies a number of measures that simultaneously advance the country's development and climate change related objectives of adaptation and mitigation.

Keywords: Climate Change, Adaptation, Strategies, Achievements.

Introduction

Global warming is caused by an increase in the temperature of earth's lower atmosphere due to rising levels of greenhouse gases mainly carbon dioxide (CO₂) with sulphur dioxide (SO₂) and suspended particulate matters such as dust. By absorbing long wave outgoing infrared radiation, these gases disturb the flow of natural energy through atmosphere and causes 'Greenhouse Effect', which has been attributed to be responsible for climate change. Greenhouse Effect results climate induced natural disasters i.e. drought, floods, cyclones, forest fires.

Climate change is one of the most important global environmental challenges facing humanity with implications for food production, natural ecosystems, freshwater supply, health, etc. According to the latest scientific assessment, the earth's climate system has demonstrably changed on both global and regional scales since the preindustrial era. Further evidence shows that most of the warming (of 0.1°C per decade) observed over the last 50 years, is attributable to human activities (IPCC, 2001).

Analysis of instrumental climate data has revealed that the mean surface temperature over India has increased at a rate of about 0.4°C per century (Rao, 1995) which is statistically significant. Maximum temperature showed significant rising trend of 0.008°C/yr during monsoon season; 0.014°C/yr during post-monsoon season and 0.008°C/yr in the annual maximum temperature during the period 1914-2003 for Central Northeast (Subash et al., 2010). Minimum temperature showed significant rising trend of 0.012°C/yr during post-monsoon season and significant falling trend of 0.002°C/yr during monsoon season revealed in studies of the long-term trends and variations of the monthly maximum and minimum temperatures in various climatological regions in India.

Objectives of the Study

1. To explain the guiding principles of National Action Plan on Climate Change.
2. To find out necessity of adaptations in respect to climate change of Indian nations.
3. To identify the strategies and targets of different missions.
4. To shade light on major achievements to cope climate change.
5. To focus on the future challenges of different projects.
6. To evaluate constrains of adaptation measures.

Research Methodology

The researcher has reviewed previously published academic literature, including journal articles, conference proceedings, NGO publication, policy and government documents, best practice manuals and handbooks, press/popular media report on adaptation to climate change in India. To collect concepts, information, and opinion related to this study the researcher was adopted the analytical descriptive approach.



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Review of Literature

India, like other developing countries, is suffering the brunt of climate change. According to 2017 German Watch report (GWR, 2017) India is ranked as the fourth most vulnerable country. The Economic Survey 2017–18 reveals that on an average annual rainfall in India has declined by about 86 mm in the last three decades. While kharif rainfall has declined on an average by 26 mm, the decline in rabi rainfall has been by 33 mm. There has also been a 12.8 per cent decline in kharif yields and 6.7 per cent in rabi yields due to extreme rainfall shocks (MIF, 2018)

India has among the world's lowest per capita greenhouse gas (GHG) emissions, yet is the fifth largest source of GHG globally when accounted in total tonnes (Pew Centre, 2008). Poverty is widespread in the country, and around half a thousand million Indians live without basic access to electricity (ADB, 2009). A sense of limited financial and technological capacity is coupled with a belief that social and economic development priorities-including energy security and energy access-would be compromised by taking on any part of the burden of managing global environmental issues. Many fear that tackling climate change would redirect limited resources away from basic poverty reduction and economic development imperatives (Shrivastava and Goel, 2010).

According to the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, climate change in India has about 4–9 per cent impact on agriculture each year, which results in a loss of about 1.5 per cent in the gross domestic product (GDP) annually (Down to Earth, 2017). The World Bank reports that by 2030, rice and wheat are likely to see a drop of about 6–10 per cent in yield (WB, 2014) A lack of trust in other parties in the climate negotiations process has been raised in previous literature (Jha, 2009). There were also signs of new behavior, including reports that India played a constructive leading role in seeking compromise between parties on issues such as the international monitoring of climate actions (Terradaily, 2010). Government of India develop a low carbon strategy for inclusive growth, as an input to India's Twelfth Five Year Plan (GoI, 2011).

IPCC published its fourth assessment report in the year 2007, that warned of a dangerous increase in frequency and intensity of extreme weather events, especially in tropical and sub-tropical countries. (IPCC, 2007), In response to these developments and the increasing extreme weather events faced domestically, the Indian government in 2007 established the Prime Minister's Council on Climate Change (PMCCC). The Council, in coordination with other government departments, published the National Action Plan on Climate Change (NAPCC) in 2008 within which eight missions were described. To decentralize the NAPCC, the government issued an order for all states to submit their respective State Action Plans on Climate Change (SAPCC), which have now been prepared for almost all states and Union Territories across India (PMCCC, 2008)

Developing countries have a limited capacity to deal with the impacts of climate change and are hence more vulnerable. For instance, according to the estimates stated in climate action plan or the Nationally Determined Contributions (NDC), India will require a whopping \$2.5 trillion to deal with the impacts of climate change by 2030 (MOEFCC, 2015).

Discussion**National Action Plan on Climate Change (NAPCC)**

National Action Plan on Climate Change (NAPCC) is a comprehensive action plan which outlines measures on climate change related adaptation and mitigation while simultaneously advancing development. It effectively pulls together a number of the government's existing national plans on water, renewable energy, energy efficiency agriculture and others and bundled with additional ones into a set of eight missions. The IPCC report was accompanied by the Bali Action Plan, an outcome of the global climate meeting in Bali, Indonesia in 2007 urging countries to step up climate action. It mandated developed nations to support climate actions in developing countries.

The NAPCC is Guided by the Principles of Protection

Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change.

Achieving National Growth

Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions.

Demand Side Management

Devising efficient and cost-effective strategies for end user demand side management.

Better Technology

Deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions extensively as well as at an accelerated pace.

Market Mechanism

Engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development

Inclusivity

Effecting implementation of programmes through unique linkages, including with civil society and local government institutions and through public private partnership.

International Cooperation and Funding

Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global IPR regime that facilitates technology transfer to developing countries under the UNFCCC (PMCCC, 2008).

The NAPCC describes eight missions, these are-

National Solar Mission

India is endowed with a vast solar energy potential, estimated to be over 750 GW. The National Solar Mission (NSM) was launched in 2010 with the primary aim of achieving grid parity by 2022 and with

coal-based thermal power by 2030. Under the Ministry of New and Renewable Energy (MNRE), NSM initially planned to adopt a three-phase approach—2011–13 as Phase I, the remaining four years of the 12th FYP as Phase II and the 13th FYP (2017–22) as Phase III (MNRE, n.d.).

Governing Ministry

Ministry for New and Renewable Energy-

Strategies

1. Promotion of already proved and commercially viable solar heating systems by making solar water heaters mandatory in buildings
2. Using solar as an off-grid solution to provide power to the power deprived poor through the remote village electrification programme
3. Creating conditions for research and application in the field of solar technology (WP, 2008).

Targets

1. Enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
2. Increasing capacity of grid-connected solar-power generation to 4000 MW by 2017. With international finance and technology, it was projected that the target could be increased to 10,000 MW.
3. Promoting programmes for off-grid applications, and reaching 1000 MW by 2017 and 2000 MW by 2022
4. Promoting 2000 MW of off-grid solar applications, including 20 million solar lights by 2022.
5. Supporting research and development and capacity building activities to achieve grid parity by 2022.
6. Creating favourable conditions for developing solar manufacturing capability in the country (MNRE, n.d.)

Achievements

1. A World Bank loan financing arrangement of \$100 million is being worked out for creating internal infrastructure of solar parks.
2. 36 solar parks in 21 states have been sanctioned with a cumulative capacity of 20,700 MW (MNRE, 2017)
3. The total capacity, when operational, will generate 64 billion units of electricity per year that will lead to an abatement of around 55 million tonnes of CO₂ per year over its life cycle.
4. International solar alliance was approved by the Cabinet in December 2016
5. Surya Mitra mobile app, a high-end technology platform to handle thousands of calls simultaneously and efficiently monitor all activities on the app, was launched (MNRE, 2012)
6. International and national banks are suppose to fund solar rooftops at less than 10 per cent interest (MNRE, 2016)

Challenges

1. We cannot generate energy during the night time with solar energy.
2. While installing a solar panel is quite cheap, installing other equipment becomes expensive. Land space remains occupied for many years altogether and cannot be used for other purposes.

3. Alluvial dust, sandy dust and the dearth of water are contributing to a significant increase in the cost of operating solar power plants in the country.
4. The solar panels that are used are not designed for such high temperatures (Kumar, 2017)

National Water Mission

National Water Mission (NWM) is run by the Ministry of Water Resources, River Development and Ganga Rejuvenation was came into action in 2011 to ensure integrated water resource management, conserve water, minimize wastage and ensure equitable distribution of water within states. A total allocation of Rs 20,630 crore granted under the 11th FYP (2007–2012), was reduced to Rs 15,000 crore during the 12th FYP (2012–2017) (MOWR, 2011)

Governing Ministry

Ministry of Water Resources

Strategies

1. Review the network of hydrological, automatic weather and automated rain gauge stations so that data can be collected on mountainous river flow, wetlands etc.
2. Provide guidelines for different water users in the context of basin-wise situations.
3. Enactment of a bill for the regulation and management of groundwater.
4. Expeditiously implement water projects in climate sensitive regions.
5. Need to promote water purification and desalination techniques.
6. Research in water use efficiency in industry, agriculture and domestic sectors.
7. Providing incentives for water neutral and water positive technologies.
8. Review national water policy be reviewed to include integrated water resources management, evaporation management and basin level management (WP, 2008)

Targets

1. Water data base in the public domain and the assessment of impact of climate change on water resource
2. Promotion of citizen and state action for water conservation, augmentation and preservation
3. Promotion of basin level integrated water resources management
4. Focused attention to over-exploited areas
5. Improving water use efficiency by 20% (MOWR, 2010)

Achievements

1. Establishing 6,376 new groundwater monitoring wells against the target of 9,360.
2. A total of 1,237 water bodies were restored as against the target of 10,000.
3. Establishment of 24 new and additional forecast stations against the target of 100.
4. Around 668 training sessions were conducted where 56,768 stakeholders were trained.
5. A total of 36 additional water quality monitoring stations have been installed against the target of 113

6. 702 new Hydrological Observation Station (HOS) established against the target of 800 (MOWR, 2017)

Challenges

1. Inter-linking of rivers
2. Generation of database and implementation of web enabled water resources information system in the country
3. Basin level planning and management
4. Efficient use of water for various purposes
5. Policy and institutional framework
6. Surface water management
7. Ground water management
9. Domestic and industrial water management (WP, 2008)

National Mission for Green India

The National Mission for Green India, or the Green India Mission (GIM), was adopted in 2014.37 With Rs 46,000 crore allotted for this mission, GIM aims at both increasing the forest and tree cover as well as improving the quality of the existing forest cover (MOEF, 2014).

Governing Ministry

Ministry of environment and Forests.

Strategies

1. Enhance the resilience of vulnerable species and ecosystems to adapt to climate change
2. Enable forest dependent communities to adapt to climate variability (WP, 2008)
3. Enhance carbon sinks in sustainably managed forests

Targets

1. Qualitative improvement of forest cover and grassland
2. Eco-restoration and a forestation in degraded ecosystem
3. Greenery in urban and pre urban ecosystem.
4. Increase forest-based livelihood income.
5. Agro-forestry.
6. Social forestry (Planning Commission, 2012)

Achievements

1. New technologies like GPS, GIS, and Remote Sensing have been used for better protection and management of the resources
2. Sustainable harvesting of timber and non timber products
3. Securing corridors for species migration across protected areas
4. Reduce forest fragmentation

Challenges

1. Increase green house gas removals by Indian forest
2. Enhance resilience of forests and ecosystem falling under the mission
3. Double the area to be taken up for a forestation

National Mission for Sustaining the Himalayan Ecosystem

The only site-specific mission under NAPCC, the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) came in to action on February 2014 is run by the Department of Science and Technology (DST). The mission aimed at evolving conservation measures for sustaining and safeguarding the Himalayan glaciers and mountains

through establishment of a monitoring network, and promotion of a community-based management human resource development and strengthening regional cooperation (MOEF, 2017)

Governing Ministry

Ministry for Science and Technology.

Strategies

1. Human and knowledge capacities - Trained personnel are required who can capture, store and apply knowledge relating to vulnerability and changes in this region
2. Institutional capacities - On creating capability to conduct long term observations, studies to understand and warn of changes in the Himalayan eco-system
3. Capacities for evidence based policy building and governance - The mission will also create a platform for Himalayan states and the centre to interact with various bodies
4. Continuous self learning for balancing between forces of Nature and actions of mankind - This will be done by creating strong linkages with community based organisations etc (WP, 2008)

Targets

1. Natural and Geographical Wealth by the Wadia Institute of Himalayan Geology
2. Forest Resources and Plant Biodiversity by GB Pant Institute on Himalayan Environment and Development, Almora
3. Micro Flora and Fauna, Wildlife and Animal Population by Wildlife Institute of India, Dehradun
4. Traditional Knowledge Systems by JNU
5. Water, Ice, Snow and Glaciers by National Institute of Hydrology, Roorkee
6. Himalayan Agriculture by Indian Council of Agricultural Research (ICAR)

Achievements

1. Indo-Swiss Capacity Building Programme on Himalayan Glaciology' was launched by DST
2. Capacity-building programme on adaptation planning and implementation has been developed
3. Framework for integrated 'vulnerability, risks and hazard assessment' has also developed
4. State climate-change centres have been set up in the seven Himalayan states (DST,2017)

Challenges

1. Himalayan glaciers and the associated hydrological consequences
2. Biodiversity conservation and protection
3. Wild life conservation and protection
4. Traditional knowledge societies and their livelihood
5. Planning for the sustaining Himalayan ecosystem (WP, 2008)

National Mission on Strategic Knowledge for Climate Change

The National Mission on Strategic Knowledge for Climate Change (NMSKCC) came into existence in 2010, with the aim of building a knowledge platform and infrastructure, sharing information and data to set the climate change agenda, building excellence through collaborative synergies and activities, making viable investment in

all existing knowledge capacities of partners and building new capacities for filling gaps.

Governing Ministry

Ministry of Science and Technology.

Strategies

1. Assess various technological scenarios along with alternatives
2. Leverage international cooperation.
3. Develop regional climate science

Targets

1. Creation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitates data sharing
2. Establishment of global technology watch groups with institutional capacities to carry out research
3. encouraging research in the areas of climate change impacts on important socio-economic sectors
4. Providing an improved understanding of the key climate processes and the resultant climate risks and associated consequences
5. Building alliances and partnerships through global collaboration in research & technology development on climate change (Anwar, 2018)

Achievements

1. Global Technology Watch Group (GTWG) has been set up which aims to keep track of state-of-the-art technologies emerging globally
2. Centres for Excellence on Climate Change have been launched at IIT Bombay
3. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been setup in Hyderabad
4. Ocean Acidification and Sea-level Rise projects were launched under the National Institute of oceanology (NIO), Regional Climate Modelling and Storm Surges under IIT-Delhi; Extreme Rainfall studies under the University of Allahabad
5. National Network on Climate Change Impact on Human Health and National Network on Climate Modelling launched (MOEF, 2010)

Challenges

1. Need for a strong strategic knowledge system on climate change
2. Emerging technology must be Cost competitive and suited to Indian context
3. Technology infrastructure to support research and development
4. Deep and wide collaboration and co-ordination
5. Framework readiness for adoption
6. Policies must be Science/evidence based
7. Budget must be sufficient.

National Mission on Enhanced Energy Efficiency

The National Mission for Enhanced Energy Efficiency (NMEEE) was approved by the Cabinet in June 2010. Estimated to run at a cost of Rs 74,000 crore, the mission is based on the Electricity Act, 2001 and falls under the Bureau of Energy Efficiency (BEE) (MOEF, 2017,a)

Governing Ministry

Ministry of Power.

Strategies

1. Create demand for energy efficient products by spreading awareness about their efficacy, amending government policy etc
2. Ensure adequate supply of energy efficient appliances, goods, and services by forming a cadre of energy professionals, labelling end use equipment etc
3. Create financing platforms that will create risk guarantee funds, financial derivatives of performance contracts etc
4. Formulate well thought out evaluation and monitoring mechanisms to capture energy savings in a transparent manner
5. Overcome market failures through regulatory and policy measures.
6. Ensure adequate supply of energy efficient appliances, goods, and services by forming a cadre of energy professionals, labelling end use equipment etc (WP, 2008).

Targets

1. To reduce the energy consumption of appliance without diminishing the services it provides to consumers
2. Integrate renewable energy sources in building design with the inclusion of passive design strategies
3. Bring accelerated market transformation for super-efficient appliances by providing financial stimulus
4. Achieve national fuel security

Achievements

1. Standards & Labelling programme for equipment and appliances
2. Energy Conservation Building Code (ECBC) was launched by Ministry of power for new commercial buildings
3. Energy savings certificates (ESCerts) for appliances for their excess savings of power.
4. Use of LED lights using the institutional structure of BLY Programme
5. MoUs have been signed with financial institutions to work together for the development of energy efficiency market
6. Promotion of energy efficiency in schools through the establishment of Energy Clubs.
7. Promotion of hybrid and electric vehicles in the country (Kumar, 2018).

Challenges

1. Development with energy efficiency as a key criterion
2. Ever-increasing shortage of coal and natural gas supplies required for power generation.
3. High environmental and social costs are always associated with high dependence on coal.
4. Delayed mining due to sluggish land acquisition procedures and strict ecological permissions

National Mission on Sustainable Habitat

The National Mission on Sustainable Habitat (NMSH), aimed at integrating mitigation and adaptation into the urban planning process with a view to make cities sustainable through improvements in energy efficiency of buildings, management of solid waste and shift to public transport (PIB, 2010).

Governing Ministry

Ministry of Urban Development.

Strategies

1. To create and adopt a more holistic approach to solid and liquid waste management that will ensure their full potential for energy generation, recycling and reuse, and composting is tapped
2. To encourage alternative transport systems that not only mitigate climate change but can also adapt to vagaries of climate.
3. To provide the right environment for adoption and creation of technologies that mitigates climate change to encourage community involvement to ensure sustainable development (WP, 2008).

Targets

1. Creation of one building code for the entire nation
2. A system to enforce these laws and provide incentives
3. Establish financial incentives based on green rating
4. Reduced need for pumping of water proper treatment of waste water and use of better designed toilets conversion of solid waste into energy
5. Strengthen the urban transport system through a mix of promotional, regulatory and fiscal measures
6. Comprehensive urban renewal - implementing master plan proposals etc (WP, 2008).

Achievements

1. Launched the Energy Conservation Building Code (ECBC) in June 2017 for new commercial buildings to be constructed across India (2017).
2. National Building Code (NBC) the state-of-the-art and contemporary international practices in building construction initiated in 2016.
3. BEE has also developed design guidelines for energy-efficient multi-storey residential buildings (BEE 2016).
4. National Urban Transport Policy (NUTP) was introduced to make urban transportation an important parameter at the planning stage, bringing about a more equitable allocation of road space with people (MOUD, 2014).
5. A total of 197,142 individual toilets in households were built till March 2017 against the target of 127,105.
6. Draft National Water Framework Bill came out in 2016 to provide uniform national legal framework to manage water supply, river rejuvenation, integrated river basin management, and storm-water drainage (MOWR,2016)

Challenges

1. To make urban areas more climate friendly and less susceptible to climate change.
2. Need for a multi-pronged approach to not only mitigate climate change but also to adapt to it.

National Mission on Sustainable Agriculture

The National Mission of Sustainable Agriculture was launched in 2013 with special emphasis on soil and water conservation, water use efficiency, soil health management and rain-fed area development (MOE, 2013)

Governing Ministry

Ministry of Agriculture.

Strategies

1. Development of strategies to evolve low input agriculture by creating crops with enhanced water and nitrogen use efficiency.
2. Nutritional strategies for managing heat stress in dairy animals and developing salt tolerant and disease resistant fish and prawns
3. Strengthening agricultural insurance, develop system based on GIS and remote sensing to map soil resource and land use.
4. Providing information on off-season crops, collation of information on block level data on agro-climatic variables, and preparation of state-level agro-climatic atlases (WP, 2008)

Targets

1. Development of drought and pest-resistant crop varieties.
2. Improving methods to conserve soil and water to ensure their optimal utilization.
3. Strengthening existing agricultural and weather insurance mechanisms.
4. Development of GIS and remote-sensing methodologies for detailed soil resource mapping and land use planning.
5. To improve and expand the data bases on (a) Soil Profile, (b) Area Under Cultivation, Production And Yield, and (c) Cost of Cultivation.
6. To build public awareness through "National Portal" on agricultural Statistics.
7. Genetic engineering to convert C-3 crops to the more carbon responsive C-4 crops to achieve greater photosynthetic efficiency for obtaining increased productivity at higher levels of carbon dioxide in the atmosphere and to sustain thermal stresses (G K Today, 2016).

Achievements

1. Rain-fed Area Development is an area-based approach for development and conservation of natural resources along with farming systems.
2. On-Farm Water Management for residue management, organic farming practices by ways of creating and linking soil fertility maps with macro-micro nutrient management.
3. Climate Change and Sustainable Agriculture Monitoring, Modelling and Networking providing creation and bidirectional dissemination of climate change related information and knowledge.^[76]

Challenges

1. Most of the proposed strategies target the big farmers, while the small and marginal farmers are left vulnerable.
2. Water use efficiency has been given importance but the chemical fertilisers have been largely ignored in the strategies.
3. Chemical fertilizers are also a major driver of rising demand for irrigation water
4. NMSA lacks adequate regulatory framework required to meet climate change related challenges to agriculture (G K Today, 2016)

Conclusion

India, with 17 percent of the world's population, contributes only 4 percent of the total global greenhouse gas emissions in terms of per capita GHG which is about 23 percent of the global average. Around 55 percent of India's population still does not have access to commercial energy. India's stand as a developing country is that GHG abatement in any form involves significant economic costs and will adversely impact GDP growth as it requires a shift from cheap fossil fuels to costlier non-carbon energy. Efforts to address climate change adaptation and mitigation needs should not take resources away from the core development needs and growth objectives of the developing countries.

NAPCC is a holistic national programme to respond to the global climate change. NAPCC's initiation was in 2008 which has been in existence for close to a decade but most missions it has only been three to four years since they came into effect. It is also clear that progress has been almost uncertain for most of the missions. National Solar Mission, NMEEE have high confidence and performance. These missions have clear and quantified targets. For some missions, such as GIM, quantified targets do exist but their long-term nature, lack of clarity in objectives, financial constraints. Shortage of a skilled workforce and technical expertise proved to be major barriers in implementing the objectives. In the case of the National Mission on Strategic Knowledge for Climate Change should pay attention to development of green technology. Missions dealing with subjects as sustainable habitat, water, and agriculture and forestry are multi-sectoral, overlapping and multi-departmental in nature. They are advisory and holistic and have been slow moving. Major challenge for the missions is their monitoring systems, which are either ineffective or absent. Progress reports for NSM, NMEEE, and NWM are currently available in the public domain but mapping of progress for other missions has been difficult due to their cross-cutting nature. Finally it can concluded that institutional, systemic and process barriers-including financial constraints, inter-ministerial coordination, lack of technical expertise and project clearance delays-stand as major challenges in the efficient implementation of the missions.

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