Climate Change and Mitigation Strategy in India

I. Introduction

India, the seventh largest country in the world in terms of geographical area, is home to more than 1.21 billion [1]people. Its geographical location in the subtropics, surrounded by the Himalayas in the north, the Indian Ocean on the south, the Arabian Sea in the west, and the Bay of Bengal in the east, leads it to experience a wide variety of climatic conditions and have a diverse biogeography. This unique geography also exposes the country to a range of extreme climatic events, such as cyclones, floods, and droughts, which have put lives at risk, damaged infrastructure, and slowed economic and social progress. These hazards are expected to become more pronounced as climate change increases exposure to risks such as changing and extreme weather, sea-level rise, glacier retreat, and snow melt.

India's diverse climate zones, ecosystems and topography translate to unevenly distributed climate risks across the country. In the agriculturally important regions of central Maharashtra, the Indo-Gangetic plains and southern coastal zones, rising temperatures and increased extent and incidence of droughts have caused declines in rice and wheat yields, **which could lead to a 1.8 percent loss[2] of GDP by mid-century**. India's most important river systems (Indus, Ganges and Brahmaputra) are fed by Himalayan glaciers, which are under threat from increased temperatures, severely impacting water availability for agricultural, domestic and industrial use. Drought has negatively impacted energy production as coal-fired power plants have shut down when there is insufficient water for cooling and hydropower production has been reduced. **An estimated 12.6 million[3] people live directly on land that is at risk from sea level rise and nearly 171 million**[4] people depend on coastal ecosystems vulnerable to sea level rise, cyclones and storm surges.

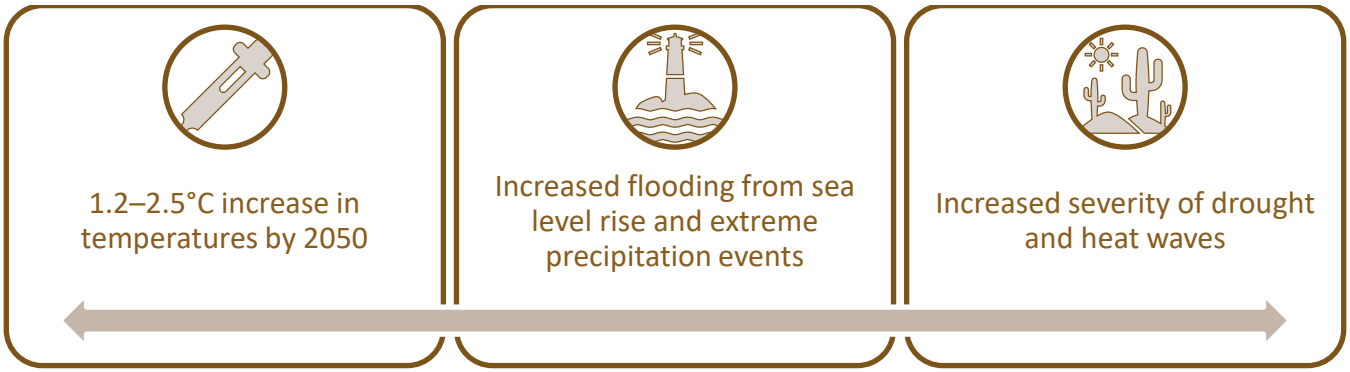

Figure 1: Climate Change Projections

[1] Census 2011
[2] Asia Development Bank. 2014. Assessing the costs of climate change and adaptation in South Asia.
[3] Climate phenomena and their relevance for future regional climate change. IPCC 5th Assessment Report.
[4] Climate Central. 2014. New analysis shows global exposure to sea level rise.

II. Sector Impacts and Vulnerabilities

A. Human Health

In recent years India experienced various extreme weather events that directly or indirectly impacted health. A heat wave during the 2018 drought left much of northern India above 40°C for weeks, increasing the risk of heat-related issues such as stroke, exhaustion and even death. A 2015 heat wave claimed 2,300 lives[5]. Flood risk is increasing in the country's interior, including in the capital Delhi, and along both coasts due to the combination of increasing heavy rainfall events, sea level rise and poorly managed urban development. In July 2013, a heavy rainfall event in Uttarakhand led to flooding that affected 4,200 villages and left more than 5,500 dead[6]. Diarrheal disease is expected to increase by 21 percent[7] in northern India due to warming trends (favoring pathogen growth), increased rainfall and extreme precipitation (straining sanitation systems and distributing pathogens), and drought (causing people to resort to low-quality water sources). India already has high rates of child mortality due to diarrheal disease (about 300,000 deaths per year[8]). **Temperature and precipitation trends are projected to expand the transmission window of malaria and dengue by 2–3 months** (mainly in the north) and the geographic coverage into new areas of Himachal Pradesh and the northeastern states.

B. Agriculture

Half of the population and most of the country's poor depend directly or indirectly on agricultural production. Principal food crops are rice, wheat, millet and legumes. Climate-sensitive rainfed agriculture accounts for 60 percent of cultivated area and 40 percent of national production. Increasing temperatures and more severe dry seasons are likely to exacerbate drought impacts, and by 2030, India's agriculture sector is expected to **suffer more than $7 billion of annual losses due to drought alone**. Studies indicate that a temperature increase beyond 1°C during the cropping cycle will diminish yields and quality (protein and micro-nutrient content) in rice, potato, mung bean and soybeans. In the fertile Indo-Gangetic Plains, an area that produces 14–15 percent of the global wheat yield, a 50 percent[9] reduction in wheat yield due to heat stress is projected in the most productive areas by 2050.

Risks for India's plantations vary by region and species. Coconut palm, a tree that benefits from increased CO_2 concentrations, for example, is expected to experience increased productivity in cooler regions where increasing temperatures will not exceed the tree's threshold, but decreased productivity in warmer regions where climate change will push temperatures over the threshold. Warming trends will increase heat stress on dairy animals (mainly water buffaloes and cows), leading to a decrease in milk production of up to 15 million tons annually by 2050. Along the coasts, sea level rise poses an additional threat to agriculture, particularly rice and aquaculture, through inundation and saline intrusion[10].

[5] NOAA. 2015. India heat wave kills thousands.
[6] World Bank. 2016. India Country Snapshot.
[7] World Bank. n.d. India Climate Risk and Adaptation Profile.
[8] Climate change and threat of vector-borne diseases in India.
[9] Droughts in India from 1981 to 2013 and Implications to Wheat Production.
10 FAO. 2015. Aquastat India.

C. Ecosystems

India is home to parts of three global biodiversity hotspots – Himalaya, Indo-Burma, and Western Ghats – that are rich in endemic flora and fauna, including the Indian rhinoceros and the endangered Indian elephant and Bengal tiger. **Warming is projected to lead to shifts in species distribution and reduce the range of endemic plant species by 41 percent by 2080**[11]. Projections show that more than 2,000 plant species and up to 214 vertebrate species in the Indo-Burma hotspot could be lost under a scenario in which atmospheric CO_2 concentrations are doubled. In west and central regions, forest cover is expected to shift to drier forest types as the drying effect of increased evaporation outpaces increases in precipitation. Forest fires, which already account for the loss of an average of 1 million hectares each year, may increase with warmer temperatures. Any change in forest cover would impact the 275 million people[12], including many indigenous communities, who are directly dependent on forests for their livelihoods.

Sea level rise, increased salinity and heat stress are expected to diminish mangrove forests (i.e., Sundarbans, Pichavaram, and Bhitarkanika) that provide habitat for wildlife, wood for fuel and housing, and storm surge protection.

D. Water Resources

India's water resources, once considered abundant, are now under considerable stress due to population growth, increased production of water-intensive crops, pollution and lack of government planning. This reduction in quantity and quality of water supplies is likely to be exacerbated by increased temperatures and rainfall variability. Himalayan glaciers feed some of India's most important river systems – the Indus, Ganges, and Brahmaputra – which support 660 million people and feed canal systems and groundwater aquifers across the country. **The glaciers help to moderate river flows in a country where 50 percent of precipitation falls in just 15 days and over 90 percent[13] of river flows occur in just four months**. Increased temperatures have led to a net loss in Himalayan glacial cover in recent decades, exposing communities that depend on glacial water to shortages during the dry season and flooding during the wet season. In the long term, loss of glaciers will reduce available water for agriculture (currently accounting for 90 percent of withdrawals), drinking and hydropower production.

Increased evaporation and decreased precipitation in some regions are expected to increase the risk of drought. Particularly at risk are areas of the southern peninsula (Krishna basin), northeast (Brahmaputra basin), and north central region (Narmada basin). Drought is already an issue in India; in early 2016, after two years of below average rainfall, India's 91 reservoirs were at just 17 percent of capacity, leaving 300 million people with water shortages[14].

[11] Satendra and Kaushik. 2014. Forest Fire Disaster Management. National Institute of Disaster Management.
[12] World Bank. n.d. India Climate Risk and Adaptation Profile.
[13] Bolch et al. 2012. The state and fate of Himalayan glaciers.
[14] Government of India. 2016b. Storage status of 91 major reservoirs.

III. Climate Change Initiatives and Mitigation Plan

NAPCC was launched by the Government of India (GoI) to provide the guiding framework/principles for addressing issues related to climate change mitigation in the country. The action plan identified eight national missions running through 2017 to 2022 highlighting India's most pressing climate concerns and outlines independent targets for emission mitigation within the different sectors. The missions are:

- National Solar Mission (mitigation focus)
- National Water Mission (adaptation focus)
- National Mission on Enhanced Energy Efficiency (mitigation focus)
- National Mission on Sustainable Habitat (mitigation and adaptation focus)
- National Mission on Sustainable Agriculture (adaptation focus)
- National Mission on Sustainable Himalayan Eco-systems (adaptation focus)
- National Mission on Strategic Knowledge Management (mitigation and adaptation focus)
- National Mission for a Green India (mitigation and adaptation focus)

Each individual mission has been designed as an umbrella of the existing mitigation policies relevant to the sector to streamline them to meet the common goal of emission reduction. A range of policy instruments have been identified to create an impetus for mitigation in all target economic sectors. Some of the policy instruments identified to address climate change mitigation are price instruments (such as coal cess and feed-in-tariff), regulatory instruments (legislations), quantity instruments (Renewable Purchase Obligation (RPO), Renewable Energy Certificate (REC), Perform-Achieve-Trade (PAT)), voluntary instruments (awareness building programmes and labeling of appliances) , and targeted research and development (R&D) policy support instrument to the different sectors. NAPCC provides a starting point for the various stakeholders and states to engage with the respective missions to build on, develop, expand, enable and implement the required programmes and strategies on climate change.

The State Action Plan on Climate Change (SAPCC) in India is the most notable policy reflecting the nature of decentralized climate change mitigation framework of the country. The states are required to seek prior approval from the MoEFCC before implementation of activities. The Government of India created the National Clean Energy Fund (NCEF) in 2010 for the purpose of financing and promoting clean energy initiatives and funding research in the area of clean energy in the country. The corpus of the fund is built by levying a cess of INR 50 (subsequently increased to INR 100 in 2014 and INR 200 in 2015) per tonne of coal produced domestically or imported.

IV. Initiatives for strengthening state of knowledge on climate change

Energy technologies, economic modeling and forecasting are considered important in planning and preparations of the domestic policies. In this direction, following steps have been taken by the national government:

Indian Network for Climate Change Assessment: To enhance knowledge about the impacts of climate change at the national and subnational level, Indian Network for Climate Change Assessment (INCCA).

It was conceptualized as a network-based scientific programme designed to assess the drivers and implications of climate change through scientific research and to prepare climate change assessment reports once every two years including assessments for GHG estimates, climate impacts and associated vulnerabilities. INCCA aims at building capacity towards management of climate change related risks and opportunities and to develop decision support system for the government.

Climate Change Action Programme: Under a Central Government scheme (MoEFCC) on climate change, Climate Change Action Programme (CCAP) was launched during the 12th FYP (Economic Survey, 2013-14). The scheme will be implemented with full funding from the central budget and intends to support actions by the central and state governments and other key stakeholders in areas of climate change. CCAP is envisioned to launch studies and projects to address the challenge of climate change in all dimensions and would also augment activities including Coordination of NAPCC, SAPCC and setting up of an autonomous body called the Rajiv Gandhi National Institute for Climate Change Studies and Actions (NICCSA). The Institute will conduct analytical studies on scientific, environmental, economic development and technological issues related to climate change.

V. India Scenario Towards Renewable Energy

India looks to meet its ***energy demand*** on its own, which is expected to reach ***15,820 TWH by 2040***, renewable energy is set to play an important role. The Indian renewable energy is ranked 4th in wind power, 5th in solar power and 5th in renewable power installed capacity as of 2018. The Ministry of New and Renewable Energy, Government of India, has formulated an action plan to achieve a total capacity of ***60 GW from hydro power and 175 GW*** from other RES by March, 2022, which includes ***100 GW of Solar power, 60 GW from wind power, 10 GW from biomass power and 5 GW from small hydro power.***

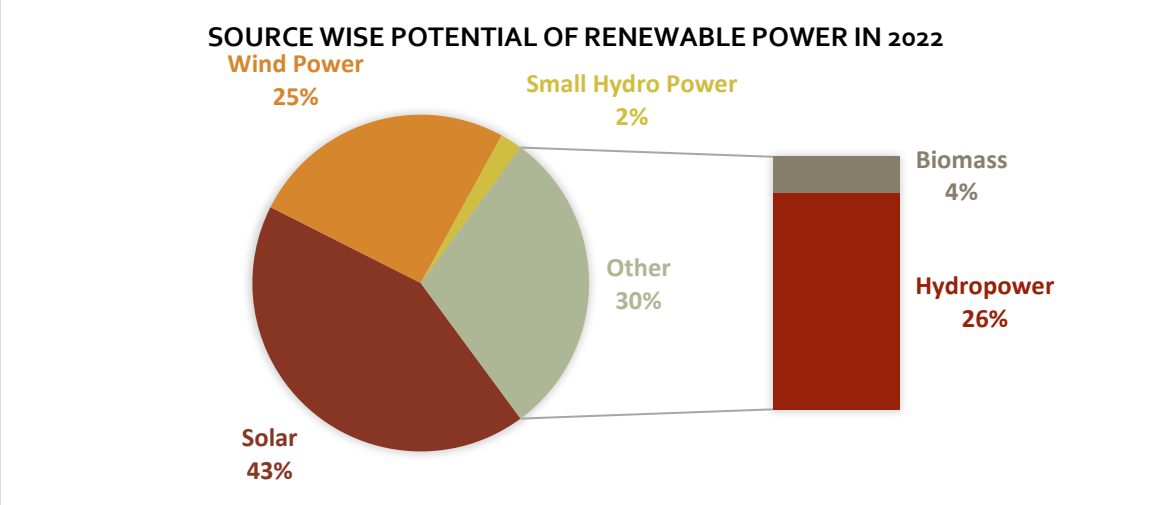

Figure 2: Sourcewise Renewable Energy for 2022

Government plans to establish ***renewable energy capacity of 500 GW by 2030***. This has been proving to be the major thrust for the sector in India as the market players have enough incentives to move to clean source. Government of India is aiming to achieve ***225 GW of renewable energy capacity by 2022***, much ahead of its target of 175 GW as per the Paris Agreement.

VI. Opportunities towards Mitigation

A. NAMA as Support Mechanism for Mitigation

The response of Indian industries towards the Clean Development Mechanism has showed the possibility of leveraging finance to trigger the dynamism towards low carbon and green practices. With the developments in the **NAMA mechanism** and global progress with experimentation with NAMA projects, the Indian government may also consider NAMAs as a means to reduce its greenhouse gas emissions. A coordinating office for implementing NAMAs is established in the Indian Ministry of Environment. Under the Indo-German cooperation, on behalf of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), GIZ advises the Indian Ministry of Environment on carrying out NAMAs in India and on technical and institutional issues. The technical support includes conducting feasibility studies on the waste and forestry sectors. The NAMA plans that are subsequently formulated on the specific activities should ideally build on existing Indian Government programmes or policies. At the same time, they should promote implementation of the NAMAs and provide incentives for emission reductions. In order to develop realistic plans, there is a need for innovative financial solutions, which use publicly – and potentially internationally – available funds as a catalyst to make investments that have a mitigation impact.

B. REDD+

The National REDD+ Strategy suggests channelizing funds for REDD+ projects from all possible sources including the budgetary support for REDD+ cell; international funding from multilateral, bilateral channels like World Bank, GEF, FAO, JICA, USAID etc.; project based funding; domestic funding from public sector/private sector support through CSR; funding through National Clean Energy Fund (NCEF) or CAMPA Funds. The government has set itself a time frame of 3 years to achieve REDD+ readiness in the country in accordance with the National REDD+ Policy and strategy framework wherein the Policy document will be reviewed every 3 years to update it in accordance to the latest UNFCCC decisions and agreements.

VII. Conclusion

India's climate change vulnerability context is changing as many life-supporting economic sectors and ecosystems are becoming more exposed to climate risks. Climate-related stress and shocks have negatively affected agriculture, forest, and water resources, which are key to the livelihood security of tens of millions of people. India has been proactive in identifying its climate change priorities and established the NAPCC. Climate change issues in general, and those relating to adaptation in particular, are gaining new ground in policy planning and public discourse in India. The new government has been undertaking definite policy

decisions to further strengthen climate change adaptation actions in India; primary among these decisions was the establishment of the National Adaptation Fund for Climate Change.

India's federal structure of governance very often poses institutional and financial challenges to the planning and implementation of regular development programs. To deal with such challenges in climate change adaptation and mitigation planning, the national action plan provided a common framework for the subnational governments to prepare their respective SAPCCs. The entire process of preparing such action plans and their subsequent endorsement by the federal ministry of environment was initially plagued by a lot of confusion and a lack of clear understanding. But continuous engagement between the federal government and subnational governments has been instrumental in developing clarity of purpose on climate change actions.