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Climate Change: Tackling the Challenge Confronting India

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Scientific evidence affirms that the anthropogenic emissions of Greenhouse Gases (GHGs), such as carbon dioxide, methane, nitrous oxide and several industrial gases, have been changing the Earth's climate since the Industrial Revolution started two and a half centuries ago. While naysayers remain, there is now overwhelming scientific certainty that increasing GHG concentration in the atmosphere due to human activities has been the dominant cause of the observed warming of our planet since 1950.[1] Current GHG emissions are the highest in human history while atmospheric carbon dioxide is at its highest level since at least 800,000 years. Over the years, the atmosphere and oceans have grown warmer. Snow, ice, permafrost and glaciers have reduced at the poles and elsewhere. Sea levels have risen and oceans have become more acidic by absorbing more carbon dioxide. Several extreme weather events have intensified. Over the last century, global temperatures have risen +0.85°C and sea levels by 19 centimetres.[2]

It is now over three decades that the world has not had a month when temperatures were below average. The rising temperatures of recent years, rather than the relative stability of the past have become routine.

Much of the latest scientific evidence of climate change derives from the 5th Assessment Synthesis Report and related documents of the Inter-Governmental Panel on Climate Change (IPCC)[3], reflecting the work of 830 expert authors from 85 countries. That Report emphasised that risks arising from warming of +2°C above pre-industrial levels poses challenges to human security, affecting development, food and water supplies, health,

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infrastructure, and livelihoods across many parts of the world, including India.[4] Irrespective of future GHG emissions, further warming is inevitable, and more dramatic climatic disruptions could follow in our lifetime unless we urgently take corrective steps.

Floods, Droughts, Lives and Habitats

Sudden onset of disasters displaced over 166 million people worldwide during 2008-2013 and this number is likely to rise due to the impact of global warming.[5] Natural hazards and vulnerabilities arising from economic, social and environmental circumstances already make India one of the more disaster-prone countries. Almost 85 per cent of India is susceptible to one or multiple hazards, while 45.64 million hectares of its land are subject to floods.[6] Climate change related risks will increasingly affect the Indian subcontinent via sea level rise, cyclones, floods and droughts, temperature rise, and change in precipitation patterns. The harsh consequences of climate change will deepen India's enormous development challenges, given the number of its poor and since many Indians depend on climate sensitive sectors for their livelihood.

The mean global sea level rise in this century and its future rate of growth will very likely exceed that of the past few decades. With a 7,517 km coastline and 14.2 per cent of its population residing in its coastal districts, India is amongst countries most vulnerable to the impact of accelerated sea level rise. India's urban population is projected to rise from 410 million in 2014 to 814 million in 2050,[7] and is already challenging services and infrastructure in stressed Indian cities. Coastal populations and assets exposed to risks in India will increase significantly due to urbanisation. Climate change will increase the risks of death, injury, and ill-health and disrupt livelihoods in low-lying coastal zones due to cyclones and flooding, storm surges and sea-level rise. Increased river, coastal and urban floods could cause considerable loss of life and widespread damage to infrastructure and settlements. Rising sea levels and delta subsidence have already led to the submergence of low-lying islands in the Sundarbans, displacing thousands as well as contaminating coastal freshwater reserves.[8] Melting Himalayan glaciers would reduce the downstream water supply in many of India's rivers in the dry season, impacting millions.

While the impact of climate change on tropical cyclones would vary by region, projections across models agree that more frequent and heavy rainfall days as well as an increase in extreme rainfall events related to monsoons are

very likely in South Asia.[9] Alteration in the Indian monsoon pattern can be expected, with the volume of rainfall during the monsoon season set to rise. Not only would there be more water, but the way in which it is delivered would also change. While the number of monsoon days is expected to be less, the intensity of rainfall would be more.[10]'

If global temperatures rise beyond +2°C, around seven million people are projected to be displaced by the 2070's due, *inter alia*, to the submersion of parts of Chennai, Kolkata and Mumbai.[11,12] Floods are an annual calamity in states like Assam: they take lives, harm livelihoods, and damage infrastructure. Floods due to glacial lake outbursts are an emerging threat in parts of the Himalayas. The flash floods in Kedarnath in 2013 highlighted the need for far better disaster preparedness.

The severe urban flooding that struck Indian cities, such as Mumbai in 2005[13], Srinagar in 2014, and Chennai in 2015, also suggests interaction between climate change and traditional stressors, such as rapid and unplanned urbanisation, that make drainage systems inadequate and reduce natural water storage areas. Despite Chennai (a coastal city) and Srinagar (nestling in a valley) having vastly differing topographies, the correctives to be applied are similar: for example, reversing the encroachment of housing on river floodplains, reviving natural drainage channels to serve as storm water drains, and implementing greener urban planning. Looking ahead, a disaster-sensitised population, an effective early warning communication system with an accompanying disaster response plan, and the provision of adequate flood insurance cover, would also be crucial.

Impact on Human Health

Extreme weather events also often collapse health and emergency services as well as electricity and water supply. Moreover, increased heat-related mortality and heat stroke due to rising and extreme temperatures could undermine India's modest progress in recent decades in tackling disease, malnutrition, and early deaths.[14] Disease causing pathogens and parasites will multiply faster at higher temperatures, escalating the incidence of many tropical diseases. Japanese encephalitis and dengue fever outbreaks are also associated in India with higher temperature and rainfall.[15] Malaria prevalence in India has been linked to rainfall patterns.[16] Studies show an association between higher temperatures, heavy rainfall, and diarrhoea and cholera outbreaks.[17]

Temperature trends show that the frequency of hot days in India is likely to increase further. Record high temperatures are already occurring more

often. In urban areas, where child mortality is already high, extreme temperatures will cause more deaths and greater heat stress. There are recent reports of a new kind of chronic kidney disease, occurring in hot areas, which may be one of the first epidemics due to global warming.[18] A warmer atmosphere could worsen existing respiratory and cardiovascular illnesses, and spread tropical diseases and pests to new areas. Greater incidence of mental disorders and post-traumatic stress syndrome would also be seen in disaster-struck areas. Contaminated urban flood waters will increase exposure to disease and many toxic compounds.

Programmes like 'Integrated Disease Surveillance Programme' and 'National Vector Borne Disease Control Programme' are being implemented in India to deal with vector-borne diseases, such as dengue and malaria.[19] However, India must also actively pursue strategies to address the adverse health impact of climate change on vulnerable populations, analyse epidemiological data in a timelier manner, build up community expertise, awareness and involvement, and deploy efficient heat-health early warning systems. These should be incorporated into the proposed new Health Mission envisaged under India's ongoing National Action Plan on Climate Change.

Implications for Food Production and Livelihoods

Climate change will seriously impact global food production as drought, increased unpredictability of precipitation, and rising temperatures would reduce global crops yields, while warming and acidification of the oceans would affect marine wildlife and fisheries. Most of the food-insecure are in South Asia,[20] where over 400 million poor and undernourished people currently live. Climate change will disproportionately harm them. Many Indian rural households depend on agriculture for a living and, if you add fisheries and forestry, it is amongst the larger contributors to India's GDP. Moreover, many Indians who earn livelihoods in coastal regions will be affected.

Heat stress would decrease labour productivity and could cause substantial food yield and production declines. Sorghum production, for example, is expected to decline by 14 per cent. Warmer temperatures and more erratic rainfall in parts of India could depress rice yields, an important staple for the region, and lead to higher food prices and living costs.[21] Projections for the Indo-Gangetic plains – which produce 90 million tonnes of wheat a year or 14–15 per cent of annual global production – projections indicate a substantial fall in yields of up to 51 per cent unless there is a shift in crop varieties and

management practices.[22] Increased drought-related water and food shortages linked to rising temperatures may increase malnutrition and worsen rural poverty. Climate-related food productivity decline will affect livelihoods and exports.

Climate change will also negatively impact livelihoods through its effects on ecosystems, some of which are highly vulnerable. The geographic range, seasonal activities, and migration patterns of several land, freshwater, and marine species have shifted in response to climate change.[23] Permafrost degradation has been reported in parts of the Tibetan Plateau. Earlier greening has been observed in Himalayan forests, and could increase their vulnerability to wildfires. Coral reefs off the Lakshadweep and Andaman Islands are bleaching due to higher sea temperatures.[24]

On the other hand, there is high agreement amongst scientists, though only a medium level of evidence, that the cooler regions are likely to benefit from warmer temperatures leading to an increase in arable area.[25] Climate change may also boost wheat production in some hilly areas, where warmer temperatures would make it possible to grow at least two crops annually of maize and wheat.[26]

India and International Efforts to Address Climate Change

Seeking to address climate change, the world community agreed at the Rio Summit in 1992 on the UN Framework Convention on Climate Change (UNFCCC), which is based on the principle of common but differentiated responsibilities and respective capabilities (CBDR&RC) of its ratifying states. In negotiations leading to its adoption, India consistently highlighted equity, historical responsibility, and per capita emissions as the bases for a differentiated approach to the collective arrangements being considered. The notions of fairness, justice, and equity underlying its idea of differentiation between developed and developing countries in terms of responsibilities and capabilities remains as relevant even today.

As developed countries have been responsible historically for excessive GHG emissions and remain their main emitters on a per capita basis, the primary responsibility devolves on them to address the problem, especially since they also have the financial and technological capacities to do so. As part of international cooperation, developed countries also need to extend new and additional financial and technological cooperation on preferential terms to developing countries to enable them to more effectively respond to climate change. In turn, developing countries can consider binding mitigation

commitments provided incremental costs are met by the developed world. Indeed, the UNFCCC recognises that developing countries cannot be required to divert scarce resources from their overriding priorities of social and economic development and poverty eradication.[27]

To tackle its massive development challenges, India needs sustained economic growth at a high level. It does not want to follow the environmentally harmful development path unwittingly followed by developed countries in their process of industrialisation. However, India cannot finance the huge investments needed to adapt to climate change unless its economy grows at a fast tempo. India seeks to meet the climate change challenge by expanding the use of low carbon and renewable technologies, as well as by improving the energy efficiency of buildings, factories, appliances, etc. In the long run, some low-carbon development options may also be less costly for India, and could offer new economic opportunities.

India: Responding to the Climate Change Challenge

At the domestic level, India's response to climate change must be guided by its national plans, programmes and priorities, and not by the push and pull of international negotiations. For India, inclusive growth too is integral to an effective climate change policy, and recent studies show that low carbon growth pathways are consistent with inclusive growth in India.[28] India needs to undertake enhanced adaptation measures besides such mitigation efforts that restrict GHG emissions without compromising its development compulsions.

(a) Mitigation: In spite of the enormous task of eradicating poverty and ensuring electricity, housing, and food security to all, India declared in January 2010 that it would endeavour to bring down the emission intensity of its GDP (excluding agriculture sector emissions) by 20-25 per cent by 2020 over 2005 levels.[29] It did so despite having no mitigation obligations under the UNFCCC, and is on course to achieve this voluntary goal. Mitigation efforts can deliver early benefits, and there are several ways to reduce GHG emissions and the magnitude of climate change. These include switching from conventional fossil fuels (oil, coal and natural gas) to low or renewable carbon energy sources like wind, solar, ocean, geothermal, hydroelectric, and nuclear energy, energy conservation, more efficient energy usage (that is, via more fuel efficient vehicles, the spread of Metro mass transportation, the use of less energy consuming LED bulbs and home appliances), reducing energy wastage, as well as by more effective

urban planning (reduced vehicle usage and emissions) and better building design. Since forests serve as sinks, mitigation can also be achieved by increasing area under forests, and thus expanding their carbon sink capacity.

(b) Adaptation: India must also adapt to meet some climate change risks. Adaptation delivers many immediate and future benefits, but has its limits. Improving ecosystem resilience and helping local communities is a low-regrets path to successful adaptation in India. Specific opportunities to implement adaptation measures emerge, for example, by:

- Reducing water use via drip irrigation and water recycling
- Enhancing water harvesting and water storage
- Planting drought-resistant crop varieties
- Enabling cities to cope with increasingly frequent extreme weather
- Building infrastructure to protect coastal cities from sea-level rise
- Using more porous materials for urban berms/footpaths
- Reducing heat islands through better urban planning
- Improving land governance and ensuring security of land tenure
- Extending microfinance especially to the rural poor
- Creating sustainable and climate resilient agricultural production systems
- Implementing adaptation measures for forest-dependent communities
- Developing sustainable habitats for vulnerable species and ecosystems
- Safeguarding the Himalayan glaciers and mountain ecosystem
- Boosting disaster-relief preparedness
- Building social protection systems and safety nets
- Using satellite imagery to expeditiously verify crop insurance claims
- Raising skill levels for better absorption of new technologies
- Empowering individuals and communities, and
- Involving all stakeholders from the outset in planning processes.

While there is a tendency to avoid or postpone disaster prevention expenditure, as it counts less with voters compared to post-disaster assistance, the return from disaster prevention is invariably better than from reconstruction. Spending US$6 billion annually on prevention during 2015-2030 could save the world an estimated US$360 billion by 2030.[30] Disasters cost India an

average loss of US$10 billion annually,[31] primarily due to flooding. Thus, securing disaster risk reduction is a smart investment that needs to be made as part of our adaptation efforts.

Ultimately, the key to effective adaption lies in empowering individuals and communities by promoting a two-way flow of information and perspectives, enhancing disaster risk reduction efforts, and backing assurances with financial and technological resources. Vulnerable local communities should have the opportunity to share their traditional knowledge, and present their grassroots perspective to policy makers. In turn, scientific analysis and information needs to be presented and shared in a simple manner that is appropriate to local context. Local institutions need to have a meaningful dialogue with scientists, government officials, policy makers, and community members. Huge gaps in climate change knowledge-sharing have led to adaptation information not reaching the most vulnerable communities, especially in developing countries, and this must be corrected. Outreach via community radio is one largely untapped way of doing so.

India's National Action Plan on Climate Change incorporates eight National Missions, outlining mitigation and adaptation priorities to combat climate change. Amongst the initiatives recently taken, for example, is a national lighting programme, UJALA, by which over 118 million ordinary bulbs have been replaced by less energy consuming LED bulbs.[32] Moreover, via a market based energy efficiency trading mechanism called the Perform, Achieve and Trade (PAT) programme, 478 designated plants in eight energy intensive industrial sectors, accounting for one-third of India's total energy consumption, produced 5 per cent more products in 2015 compared to 2012, while consuming the same quantum of energy.[33] This noteworthy scheme is being broadened in the next cycle to encompass sectors like oil refineries, railways, and electricity distribution, and thus cover more than half the commercial energy consumed in India.[34]

The provision of adequate and affordable energy to all citizens is a very high priority in India, where per capita electricity consumption is far below the world average. India hopes to enhance the share of renewable energy in electricity generation from 6 per cent to 15 per cent of its energy mix by 2022. India's renewable energy strategy is driven by the objectives of enhancing energy access and security for all, reducing the carbon footprint of national energy systems via technologies that contribute to better air quality, reducing reliance on fossil fuels, curbing global warming, and protecting water and habitat quality. India will scale up the share of non-fossil fuel based energy resources in its total electricity mix, including wind power, solar power,

hydropower, biomass, waste to energy, and nuclear power. India's renewable energy capacity target has been raised from 35 GW up to March 2015 to 175 GW by 2022.[35] Within this, solar power capacity in India is to be rapidly enhanced to 100 GW by 2022, and scaled up even further thereafter. The development of twenty five solar parks, ultra-mega solar power projects, canal top solar projects, and the provision of one hundred thousand solar pumps for farmers is underway. Under Prime Minister Narendra Modi's leadership, India has also actively pursued an important initiative to host a global solar alliance - the International Agency for Solar Policy & Application (INSPA) - bringing together 121 countries located between the Tropic of Cancer and the Tropic of Capricorn.[36]

India has set up two dedicated funds for mobilizing domestic financing for mitigation and adaptation.[37] It recently doubled its domestic market clean energy cess on coal to Rs 400 per metric tonne, the proceeds of which go to the National Clean Energy Fund to be used for financing research and innovative projects in clean energy technologies, thereby reducing GHG emissions. India has also established a National Adaptation Fund, with an initial allocation of INR 3,500 million (US$ 55.6 million). Moreover, under the "Zero Defect Zero Effect" Scheme,[38] over a million small and medium Indian enterprises are improving their quality, energy efficiency, pollution control, and waste management, and are also shifting to renewable energy. The energy efficiency of thermal power plants will also be mandatorily improved.

India's urban transport policy will encourage moving people rather than vehicles, with a major focus on Mass Rapid Transit Systems. Major metro projects are planned for cities like Ahmedabad, Pune and Lucknow. Switching from Bharat Stage IV to Bharat Stage VI to improve fuel standards across India is also envisaged, and the dates for doing so have been advanced.

Turning to forestry, India's long term aim is to increase its forest cover via initiatives like the Green India Mission, financial incentives for forests, green highways policy, Reduced Emissions from Deforestation and Forest Degradation (REDD+) programme, etc. The devolution of federal funds to Indian States will be based on a formula that attaches 7.5 per cent weight to forest area and incentivises a greener distribution of resources.[39] It will condition about US$ 6.9 billion of transfers to Indian States based on their forest cover, increasing to US$ 12 billion by 2019-20.[40]

India was not a major GHG emitter when the UNFCCC was agreed to in 1992; but it has come into the spotlight now for its rising GHG emissions. Yet, India's per capita GHG emissions remain a fraction of all major emitters.

In volume terms, India is now the third-largest GHG emitter, after China and the USA; but its historic and current levels of GHG emissions per capita remain the lowest amongst all the G20 countries, Moreover, India has one of the lowest rates of energy intensity of GDP growth.

Against this backdrop, on October 2, 2015, India announced its 'Intended Nationally Determined Contribution – Towards Climate Justice' (INDC)[41] as a progressive and ambitious contribution to international efforts to rein in climate change. It envisages, *inter alia*, (a) reduction in the emissions intensity of its GDP by 33–35 per cent by 2030 from its 2005 level; (b) changing India's share of non-fossil fuel in its total installed capacity from 30 per cent in 2015 to about 40 per cent by 2030, and (c) creating an additional carbon sink of 2.5 to 3 billion tonnes of carbon dioxide equivalent through additional forest and tree cover by 2030.[42]

As per preliminary estimates, over US$ 2.5 trillion would be required between 2015 and 2030 to implement India's climate-related plans.[43] Scaling up these plans would require even greater resources. Developing countries like India are resource constrained, and implementing climate change mitigation/adaptation actions would require additional domestic and new funds from developed countries to cover the resource gap. Enhanced action on technology development and transfer will be central to the implementation of India's INDC. Developed countries should help in the transfer of environmentally sound technologies, in providing climate finance, capacity building, as well as creating a framework for R&D on clean coal technologies. India has projected an illustrative list of clean coal, nuclear power and renewable energy technologies that it would like to see shared.[44]

India believes that it can achieve a similar level of well-being as the developed world without going down the path of reckless and wasteful consumption. It has, in the past, indicated that its per capita emissions would never exceed those of the developed countries, including their historical emissions. It is also prepared to share its technologies with others, as seen from its readiness to develop a satellite specifically for South Asia by 2016, and its offer of free-of-cost remote sensing satellite data to other SAARC countries.[45]

Delineating India's stance at the United Nations in September 2015, Prime Minister Narendra Modi stated:

> We should forge a global public partnership to harness technology, innovation and finance to put affordable clean and renewable energy within the reach of all. Equally, we must look for changes in our lifestyles that

would make us less dependent on energy and more sustainable in our consumption. It is equally critical to launch a global education programme that prepares our next generation to protect and conserve Nature. I hope that the Developed World will fulfil its financing commitments for development and climate change, without in any way putting both under the same head![46]

The Paris Agreement and Beyond

On December 12, 2015 in Paris, the 21st Conference of Parties of UNFCCC (COP21) adopted a new Climate Change Agreement for a post-2020 arrangement. While the Paris Agreement[47] is contoured like a legally binding instrument, many of its most important provisions are actually voluntary and non-binding. It retains references to the principle of CBDR&RC, while reinterpreting and largely paying lip service to it. It specifies that the Agreement will be implemented to reflect equity and the CBDR&RC principle, in 'the light of different national circumstances'. Unlike the UNFCCC, it avoids mentioning historical GHG emissions and side-steps the requirement that the developed countries take the lead in combating climate change and its adverse effects. Instead, the Paris Agreement replaces the Annex-based approach to differentiation in responsibilities that is incorporated in the UNFCCC and its Kyoto Protocol, by a methodology that permits self-differentiation. It also takes into account changes in a country's circumstances and capacity. It also substitutes the "top-down" approach of the Kyoto Protocol by a "bottoms-up" one, based on voluntary, nationally determined pledges to be made by all States Parties. In a preambular reference, it notes that 'climate justice' is 'important to some'. The significance of sustainable lifestyles as well as sustainable patterns of consumption and production in addressing climate change is also acknowledged in the preambular part of the Agreement. It establishes an inbuilt process by which States Parties will take stock of their collective progress every five years, and put forward progressively more ambitious GHG emission reduction plans for every subsequent five-year period. It uses a transparency and accountability framework to incentivise all States Parties to deliver on their non-legally binding NDCs or else, face public criticism and peer pressure.

Under the Paris Agreement, each State Party has pledged via its INDC to contribute what it can to tackle global warming. As on February 5, 2016, 188 countries had put forward their INDC's, representing 97.1 per cent of total global emissions.[48] However, the INDCs of many developed countries -

comprising their mitigation targets, the provision of finance, technology transfer, and capacity-building support to developing countries - could have been more ambitious. The EU has targeted a modest 40 per cent GHG reduction by 2030, compared to 1990, besides increasing energy efficiency by 27 per cent, and the share of renewable energy by 27 per cent.[49] USA has offered a 26–28 per cent GHG reduction by 2025, but from a 2005 baseline.[50] While admittedly these pledges constitute a first step, our developed country partners must do more to curtail their GHG emissions, and assist developing countries meet climate disruption challenges. It is also noteworthy that China's INDC target has 2030 as an approximate peaking date for its carbon emissions, by when China's per capita emissions would be comparable to current EU emissions.[51] This too is an unambitious and conservative pledge, particularly since most Chinese experts believe its GHG emissions are set to peak earlier, perhaps by 2025.

On April 22, 2016, 174 countries and the European Union signed the Paris Agreement, which comes into effect a month after it is ratified/acceded to by 55 States representing at least 55 per cent of GHG emissions[52]. India was amongst those signatories, and is committed to ratifying it, hopefully before end 2016.

As per 'Climate Action Tracker' - an independent science-based assessment that tracks the emission commitments of countries - the aggregate impact of the climate pledges contained in the INDCs put forward by countries in connection with COP21 will, if fully implemented by all, at best limit temperature increase to +2.7°C by the year 2100, compared to the warming of +3.6°C by 2100 projected to result from current policies.[53] Pledges made so far are inadequate and Nationally Determined Contributions would need to be substantially enhanced in any future stocktaking reviews if global warming is to be capped at +2°C, let alone +1.5°C above pre-industrial levels, as envisaged under the Paris Agreement.

Meanwhile, it is worrisome that contributions to the Green Climate Fund (GCF), set up as a key institution for global climate finance with a target of US$100 billion annually by the year 2020, have barely crossed US$10 billion so far. Entering into force of the Paris Agreement is not in doubt. However, unless the climate finance scenario radically improves, and enhanced financial and technological cooperation is extended by the developed world, the prospects of our effectively tackling climate change at the global level will remain bleak. In such an eventuality, we may need to explore other ways of securing a minimum, assured financial flow into the GCF. Finally, it is sobering to remember that even if international action curbs temperature rise in line with

the Paris Agreement, global climate benefits will only emerge in the latter half of the 21st Century.

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