Climate Change: India's Options

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Climate change poses particularly difficult challenges for India. On the one hand, India does not want any constraints on its development prospects. On the other, it also wants to be seen as an emerging global power that requires a leadership role on key global issues like climate change. It can either approach climate change as a "stand alone" global negotiation, or, weave these negotiations into a "grand bargain" involving linkages with other international negotiations. In order to understand these issues better, a conference on climate change held in New Delhi in March 2009 focused on the different bargains India might have to strike, both domestically and internationally, to respond to these challenges. The papers presented here highlight some of the key issues raised in the conference and also the analysis and interpretation of the main points of discussion.

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Climate change is emerging as a major global issue and will undoubtedly be a significant preoccupation of India's external negotiations and domestic bargains in the foreseeable future. Given the many complex challenges that climate change poses, responding to it will involve restructuring economies and ways of life, mobilising new technologies, creating innovative systems of finance, and perhaps even new political arrangements and institutions.

In order to understand these issues better, a conference "India's Options in Climate Change Negotiations" was organised in New Delhi. No one conference can cover the multiple dimensions of the enormously complex challenges posed by climate change. The aim of this conference was thus to focus on the different bargains India might have to strike, both domestically and internationally, to respond to these challenges. The emphasis was not merely to collect a list of possible measures that might be necessary to achieve this goal, but rather to examine the ways in which these bargaining options might be embedded in political economy, both domestic and international, and how the frontier of possibilities of this political economy can be shifted to meet these new challenges.

The papers in this EPW symposium were initially presented at this conference. In this paper we highlight some of the key issues raised in the conference as well as our own analysis and interpretation of the main points of discussion. These are not meant to be definitive conclusions, but rather issues that further reflection and debate.

1 State of Play on the Science of Climate Change

The most recent report of the Intergovernmental Panel on Climate Change (IPCC) is unequivocal both about the current warming of the climate system and that the cause of most of the observed increase in global average temperatures is attributable to increase in anthropogenic greenhouse gas (GHG) concentrations (Solomon et al 2007). There is a broad scientific consensus that continued emissions at or above current rates will cause further warming and induce many changes in the climate system during the 21st century that will likely to be larger, with more adverse impacts, than those seen during the 20th century. For instance, a first-time global scale analysis done by the International Union of Forest Research Organisations shows that forests could become carbon sources, not sinks, if temperatures continue to rise. The carbon storing capacity of global forests could be lost entirely if the earth heats up 2.5°C above pre-industrial levels. Under growing emissions scenarios, forests will have difficulty adapting to climate change, and droughts, insect invasions, fires and storms would cause widespread forest destruction – further

exacerbating climate change (Seppala et al 2009). Another example is the decrease in the Arctic sea-ice extent of almost 25% per year from 1979 to 2006. In 2007, this reached its lowest level since satellite observations began and remained low in 2008. New projections show that with medium future GHG emissions, the Arctic Ocean will probably be ice-free before the end of the 21st century (Yin et al 2009; Boe et al 2009).

Recent evidence linking cumulative carbon dioxide (CO_2) emissions with peak warming suggests that in order to avoid dangerous climate impacts, emissions targets must be placed in the context of a cumulative carbon budget (Meinshausen et al 2009; Allen et al 2009). Consequently, a total-carbon-emitted approach that sets this limit on all CO_2 emissions is gaining traction (Allen et al 2009). A cumulative warming commitment is seen as a much more meaningful figure than a stabilisation concentration of CO_2 in the atmosphere. At present, more than 100 countries have adopted a global warming limit of 2°C (relative to pre-industrial levels) to reduce climate change risks, impacts and damages.

At the March 2009 meeting of the International Scientific Conference on Climate Change, climate experts warned that the overall prognosis on climate change is worse than previous estimates have suggested (Heffernan 2009). Immediate and immense emissions reductions will be required to achieve a 2°C warming limit, and even with this, dangerous climate impacts will be hard to avoid (Meinshausen et al 2009: 1117-18, Schmidt and Archer 2009).

2 Impacts on India

Climate change is projected to have severe adverse effects on India's development as it compounds the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic growth. The sectors that have the highest vulnerability to these impacts are water resources, coastal ecosystems, biodiversity, and agricultural productivity. The different areas where climate change will impact India most are given below.[1]

Water: The most serious potential threat arising from climate change in Asia is water scarcity. The gross per capita water availability in India is projected to decline from ~1820 m^3/year (2001) to ~1,140 m^3/year (2050). The per capita availability of freshwater in India is expected to drop from ~1,900 m^3 (2007) to 1,000 m^3 (2025). More intense rain and more frequent flash floods during the monsoon would result in a higher proportion of runoff and a reduction in groundwater recharge.

Glacier melt in the Himalayas is projected to increase flooding and affect water resources within the next two to three decades. The implications of melting Himalayan glaciers and sharing of scarcer river-basin water resources will pose a formidable challenge,[2] and lead to acute shortages of water for drinking and farming. If current warming rates are maintained, Himalayan glaciers could decay at extremely rapid rates, shrinking from the present 5,00,000 km^2 to 1,00,000 km^2 by the 2030s. This will also be reason for concern when considering Himalayan hydropower as a partial solution to India's energy needs, as climate change will sharply reduce the effectiveness of the planned mammoth investments. River flow data is critical when planning hydropower projects. However, historical river flows will no longer be a good measure for future flows not only due to glacier melts, but also due to the changing patterns, duration and intensity of rainfall and the seasonal distribution of river flows.

Coastal Areas: Coastal ecosystems will be affected by sea-level rise and temperature increases. Heavily populated mega-delta regions, in particular, will be at greatest risk due to increased flooding. The changes in the Godavari, Indus, Mahanadi and Krishna coastal deltas will potentially displace millions of people. Projected sea-level rise could damage aquaculture industries, and exacerbate already declining fish productivity. There will also be higher risks of increased frequency and intensity of coastal surges and cyclones.[3]

Agriculture: India's agriculture has been predicted to suffer more than any other country's as a result of climate impacts.[4] Projected surface warming and shifts in rainfall could decrease crop yields by 30% by the mid-21st century. There will also be reductions in arable land with resulting pressures on agricultural output.

Precipitation: Climate change can lead to an increase in precipitation intensity and variability, and India will potentially experience a decline in summer rainfall by the 2050s (crucial to Indian agriculture). Semi-arid regions of western India are expected to receive higher than average rainfall, while central India will experience a decrease of 10-20% in winter rainfall by the 2050s (CSE 2002). Changes to the monsoon are expected to result in severe droughts and intense flooding in parts of India.

Biodiversity: Climate change is expected to exacerbate threats to biodiversity resulting from land use/cover change and population pressure. Along the coastline, marine wetlands, tropical ecosystems and species such as mangroves and coral reefs are threatened by changes in temperature, rising sea levels and increased concentrations of CO_2 in the atmosphere.[5]

Health: Increasing temperatures and projected changes in the hydrological cycle will lead to an increase in temperature-related illnesses, vector-borne diseases, health impacts related to extreme weather events (particularly, floods and droughts), and health effects due to food insecurity. Increase in coastal water temperatures would exacerbate the abundance and/or toxicity of cholera.

Increased Temperatures and Extreme Events: Climate change impacts will lead to an increased frequency of hot days, heat waves, droughts (declining water tables, crop failures, etc) and natural disasters resulting from cyclones.

3 International Climate Negotiations: Do Things Stand?

In the lead up to the international climate negotiations to be held in Copenhagen, a large number of international conferences have been held. In the first of three preparatory meetings (Bonn, March 2009) that will culminate in the Copenhagen climate change summit in December (formally the first meeting of the Fifth Session of the ad hoc working group on long-term cooperative

action under the UNFCCC), the key differences centred on two issues (Schiermeier 2009a, b):

(1) Determining Emissions Targets and Timelines: While the US commitment to reducing emissions was welcomed, there was little clarity on the setting up of medium- and long-term emission reduction targets. Developing countries (including South Africa, India and China) maintained their stand of having rich nations commit to a 25-40% cut by 2020 – a target developed nations will not be able to reach easily.

(2) Defining the Scale and Processes of Financial and Technological Transfers: There was a lack of consensus in determining how much, and how, the funding needed to support adaptation programmes in poor nations will be organised. Developing countries favoured majority of the funding to come from public funds, while developed nations preferred private sector sources.

However, the earlier sharp North-South dividing line is blurring somewhat as some middle-income developing countries such as Mexico, Argentina and South Africa have indicated their willingness to shoulder more responsibilities. Perhaps most importantly China appears to have shifted its position and is now agreeable to engaging in a global deal on climate change (Watts 2009). While the Chinese official negotiating position is unchanged, the government is understood to be preparing a set of targets up to and beyond 2020 to lower the country's carbon intensity. This change is said to be catalysed by the US pledge to reduce its emissions to 1990 levels by 2020; the increasing number of observed adverse climate impacts; and the growing business opportunities that a move towards a low carbon economy presents. While specific targets have not been set, the change in China's tenor sends an important message to the rest of the world – and to India.

4 International Negotiations: India's Options

India's current official stance is that no negotiations are possible without addressing the egregious equity issues due to the historical burden placed on poor countries by industrialised countries, who have not only been the main contributors to the existing stock of anthropogenic GHGs, but continue to emit at per capita rates that are manifold that of a poor country like India. In addition, India's official position highlights the lack of commitment by the Annex 1 (or developed) countries so far,[6] the extremely low per capita emissions of Indians, and steps already taken domestically by the government. Indian government representatives are vehement that the official position is not a negative attitude. Rather it is the North which has yet to demonstrate that it is serious about climate change by making tangible cuts in its emissions – only then might India consider joining a treaty. In any case, India will not pay for adaptation and mitigation and this will have to be made viable through (entitled) resource and technology transfers.

India's official position is based on the principle that long-term convergence of per capita emissions is "the only equitable basis for a global compact on climate change". India's prime minister gave a declaration that despite India's "developmental imperatives, our per capita GHG emissions will not exceed the per capita GHG emissions of the developed industrialised countries".[7]

Very recently, Indian negotiators submitted a detailed recommendation on the architecture for transfer and diffusion of technologies under the United Nations Framework Convention on Climate Change (UNFCCC) from developed countries to the developing world for the first time (Sethi 2009). The recommendations were part of India's formal submissions to the ongoing negotiations and will be deliberated between countries at the next UNFCCC meeting in Bonn, in June. In the plan, India's demands from the climate talks include: full costs of procuring technology; guarantee on foreign direct investment (FDI) for technologies; global public investment to leverage a market for new technologies; costs of compulsory licensing and other intellectual property rights (IPR) costs to be taken care of; and all funding and technology issues to be handled through the UN treaty and not through the World Bank or other agencies. India has also asked rich countries to contribute 0.5% of their gross domestic product (GDP) towards an adaptation fund for poor countries. The official position is both a principled position and is a strong articulation of India's national interests. However, there is a risk in that India appears to be taking a reactive position, rather than approaching the problem through a different framework of co-benefit-based policies and diplomatic leadership that can simultaneously secure its long-term national energy needs, meet the global challenge of climate change and importantly, meet its own national challenge of climate change. Given that large income redistribution or North-South transfers are not in the ball park of realism with the current global economic crisis, what alternatives can India put on the negotiating table?

Joshi and Patel propose a framework based on zero net welfare costs for India, while Subramanian proposes shifting from overall emissions to using metrics of production and consumption emission efficiency. There was also a broad consensus amongst all authors that while a carbon tax might be the most efficient solution based on first principles, a carbon cap-and-trade (C&T) system is more politically feasible and can better serve India's interests. The C&T is more likely to fulfil the equity objective, allow transfers without government involvement, and disguise the costs incurrent in industrialised countries. While these proposals will generate considerable debate, they have two advantages. They offer suggestions beyond the current deadlock that is based in equity being defined in per capita emissions. At the same time they preserve the core moral claim behind India's position that any international outcomes should not jeopardise its development prospects.

Importantly, the discussions made very clear that climate change negotiations pose a strategic problem unlike any other set of negotiations. First, there is the complex issue of strategy. India obviously wants to minimise the costs imposed upon it by any international obligations it may be required to undertake. One way of securing this is asking for compensation even for those actions that a country thinks are desirable for independent reasons. On the other hand, developed countries play up the fear factor – that the most adverse effects of climate change will be on developing countries and, therefore, it is in the interest of developing countries to negotiate some kind of deal on climate change since it is their future that is most at risk. The assumption is made that this will put pressure on developing countries to blink. How will

this strategic stalemate be broken? Can this negotiation lead to a successful outcome if it is done under the standard framework of maximising national interests?

Second, unlike most issues, climate change action will require a large number of cross-sectoral linkages, which, in turn, makes thinking about the different tradeoffs analytically and intellectually more difficult. One of the virtues of these papers is that they at least open up the question of how to think of these linkages.

Third, climate change also has the potential of redefining the whole concept of development. Even amongst those who fully agree on the need for strong climate change action, there is disagreement over what this will entail. Many believe that the solutions will be largely technological: the world can have similar patterns of consumption, only with less carbon emissions. Others believe that climate change actions will require more than simply technology fixes; it will require a significant redefinition of lifestyles, aspirations, and, indeed, the very goals of development. There is still no clear empirical resolution of the question: what exactly is the horizon of technological possibilities? Fourth, climate change actions potentially involve, not just a narrow set of specialists, but virtually all of society. In short, reaching a consensus will require also thinking of complex participatory frameworks, not just technocratic fixes. It involves, what Navroz Dubhash, in a resonant phrase, calls a "problem of multi-level governance". Just this complexity introduces a kind of vertigo, where lots of different elements have to be thought of simultaneously.

But climate change negotiations, more than any others, will also require India to think of the appropriate conceptual framework within which to conduct negotiations. Historically, India has been more comfortable with negotiations where it is defending its moral entitlements. And in these negotiations, it has often stood its ground well. But one of the consequences of India's traditional negotiating position is that it has seldom been strong at *bargaining*.[8] A moral entitlement approach to negotiation and a bargaining approach to negotiation require two very different sensibilities. The former requires sticking to a principle, even if the outcome is a deadlock or isolation. The latter requires cutting deals, even if they are not based on the most equitable moral principle. India's position so far has been largely articulated in the language of entitlements. But, if world opinion shifts, and particularly if China and the US cut some kind of deal on climate, then India will be confronted with the question: what kind of bargain will it settle for? The answer to this question must be posed against a counterfactual – namely, staying away from any deal. This, in turn, has its own risks, not just about India's position in the world, but the reality that the costs of joining international agreements in usually less at the time of inception than later.

India also needs to think more carefully about its domestic political economy in its international negotiations. Indian diplomats, in the past, have vigorously defended the country's interests in multilateral conferences. However, the lesson of the Multi-Fibre Arrangement (MFA), where India negotiated hard for opening up western textile markets in the Uruguay round, is instructive. More than a decade later, the benefits of all this hard work appear to have accrued more to Chinese and Bangladeshi textile exporters than their Indian counterparts, mainly because the domestic changes to take advantage of this opening up did not occur. A country's international political capital is limited and a country's political leadership should make sure that it can deliver on the internal domestic bargains corresponding to its international negotiating position.

Are there any second-best positions, any tradeoffs that India is comfortable with that can protect its core interests? How much should it sacrifice on its position to get a workable deal? It is also important to understand India's best alternative to any negotiated agreements. While it may be premature to pose these questions at this stage, they cannot be postponed forever. Many of the papers in this symposium offer suggestions about possible bargains.[9]

The Domestic Challenge

No matter what happens in international negotiations, India will have to address the growing challenges arising out of a changing climate. It is well known that Indians are amongst the lowest per capita emitters of GHGs in the world. A new "green index" on environmentally sustainable behaviour (based on a survey conducted by the National Geographic Society and GlobeScan), rates Indian consumers the most environmental-friendly among the larger countries.[10] However, this appears to be more the result of compulsion than conviction, and is unlikely to be sustained as India grows rapidly. According to this survey, Indian consumers have conflicting views on the environment. As a group, they have concerns about the environment and say they are trying hard to reduce their own negative impact on the environmental. At the same time, many feel that environmental problems are exaggerated and that the Green movement is a fad.

There is a broad consensus in India that the country should focus on adaptation, preferably with money and technologies from the west, whose emissions are the root cause of the problem. Nonetheless, it is an open question whether the country can avoid making any attempt at addressing mitigation. As India continues to engage in multiple bargains on the issues related to climate change, it is important to have a comprehensive view of the domestic trade-offs posed by each mitigation strategy. In Table 1 (p 38), we use official government of India (GOI) inventory of the GHG emissions from India (submitted to the UNFCCC), and suggest the sort of criteria that need careful investigation to prioritise mitigation strategies for these sources.[11] Our judgments are not meant to be authoritative – rather they are meant to stimulate debate about the areas where co-benefits are high and costs (relatively) low. The intuition behind this reasoning is that there are certain areas, for example, having efficient cooking-stoves in rural areas, where the social welfare benefits for the country are high in any case given the adverse health effects of indoor air pollution as well as fuelwood conservation, quite apart from anything related to climate change. If they also happen to help boost India's mitigation credentials, then it could be a key part of India's bargaining arsenal.

For each strategy, four main issues need to be addressed. These include:

(1) Mitigation Potential: Indicates whether the particular strategy has a high or low emission reduction potential. This metric

Table 1: Potential Adaptation and Mitigation Strategies and Their Associated Trade-Offs

GHG Source Categories	% of CO_2 eq Emissions	Growth (Last 10 Years)	Mitigation Strategy	Mitigation Potential	Co-benefits	Cost	Technology Available	Action Points
All energy	61							
Energy and transformation industries: Power generation and petroleum refining industries	29	High	Ultra- and super- critical steam cycle plants	High	High	High	Readily available	– Implement super critical boilers instead of sub-critical boilers
			Carbon Capture and Storage (CCS)	High	Low	High	Initial stages	
			Nuclear energy	High	Low	High	Readily available	
			Renewable energy: wind; solar; small hydro; biomass	High	High	High	Readily available	– Alter the taxation structure to incentivise renewable energy use (e g, remove kerosene subsidy; no tax on solar energy products)
			Integrated Gasification Combined Cycle (IGCC) technology for coal	High	Low	High	Initial stages	
			IGCC based on refinery residue	High	Low	High	Readily available	
			Increased efficiency reforms for power plants	High	High	Low	Readily available	– Raise efficiency standards for new and existing power generators – Establish independent coal mine regulator – Mandatory washing of coal used 700 km away from mine mouth
			Electricity sector reforms	High	High	High	Readily available	– Transmission and distribution efficiency – Demand-side management programmes – Reduce auxiliary consumption – Apply current reforms nationwide
			Electricity sector investment	High	High	High	Readily available	– Use advanced technologies for power delivery and metering (combined with commercial incentives to power distributors to cut distribution losses)
Industry: paper, sugar, cement, iron and steel, textile, bricks, fertiliser, chemical, aluminium, ferroalloys, non-ferrous, food and beverages, leather and tannery, jute, plastic, mining and quarrying, rubber, and all other industries.	12	High	Waste heat recovery	Low	Low	Low	Readily available	
			Industrial cogeneration	High	Low	Low	Readily available	
			Increased energy efficiency	High	High	High	Readily available	– Increase efficiency, shift fuels, shift to low carbon alternatives when building new infrastructure
Transport sector	7	High	Regulatory reforms in the transport sector	High	High	Low	Readily available	– Implement higher fuel efficiency standards (diesel, gasoline) – Stricter vehicle emission norms – Provide transit use incentives – Modify current policies/vehicle taxations that disincentivise public transport use
			Increased efficiency of vehicles	High	High	Low	Readily available	– Target large vehicles in particular
			Transport sector investment	High	High	High	Readily available	– More investment in public transport systems (high-speed rail) – Encourage urban development focused on public transit, walking, reduced vehicle use
Biomass burning	3	Medium	Efficient biomass-based cook stoves	High	High	Low	Initial stages	–Design programme for efficient and cheap cook stoves that can be sold and distributed nationwide
Commercial/residential Sector	5	High	End-use energy reforms	High	High	Low	Readily available	– Enforce standards, labelling, and schemes – Using central incentives to improve state implementation of efficiency standards – Incentives for the growth of energy service companies (ESCOs)
			End-use energy efficiency	High	High	Low	Readily available	– Efficient appliance use, lighting, heating and cooling devices – Replace street bulbs with LED lighting – Increase efficiency of income generating products used by the poor (e g, sewing machines)

(Continued)

Table 1: Potential Adaptation and Mitigation Strategies and Their Associated Trade-Offs *(Continued)*

GHG Source Categories	% of CO_2 eq Emissions	Growth (Last 10 Years)	Mitigation Strategy	Mitigation Potential	Co-benefits	Cost	Technology Available	Action Points
			Retrofit buildings	High	High	High	Readily available	– Retrofit commercial, industrial and residential buildings
			Building sector reforms	High	High	Low	Readily available	– Update and make the Energy Conservation Building Code mandatory for new buildings – Establish new mandatory guidelines for renovations, including water management (rain water harvesting)
			Smart buildings	High	High	High	Requires demonstration	– Integrate design of commercial buildings with smart technologies (e g, intelligent meters that provide feedback and control) – Integrate solar PV in buildings.
Agriculture	28							
Emission from soils	4	High	Efficient synthetic fertiliser use	Low	High	Low	Readily available	– Improve nitrogen fertiliser application techniques to reduce N_2O emissions
			Non-selective catalytic reduction use	High	Low	Low	Readily available	
			Increase efficiency of agricultural processes	Low	High	Low	Initial stages	– Address post harvest losses through post-harvest innovation programmes – Address livestock and animal disease issues – Increase research for improved crops yields – Increasing efficient use of input resources (has been promoted by GoI)
Enteric fermentation	15	Medium	Improve livestock and manure management	High	High	Low	Readily available	
			Improved livestock feed	High	Low	Low	Readily available	– Strategic supplementation of feed through molasses urea, multi-nutrient blocks and low bypass protein for improving low digestibility of animal feed
Paddy cultivation	7	Low	Improve rice cultivation techniques	High	High	Low	Readily available	– Improved fertiliser application – Improved water management (mid season drainage) – Increase productive cultivars
			Alternate paddy varieties	High	Low	Low	Initial stages varieties	– Develop less methane-intensive paddy – Change the crop mix where possible to reduce paddy cultivation
Agricultural crop residue	0.4	Low	Reduce open burning of crop residue	Low	High	Low	Initial stages	– Improve/modify harvesters/seed drills to reduce open burning of crop residue
Industrial processes	8							
Cement production	2	High	Waste heat recovery	Low	Low	High	Readily available	
			Substitute clinker by mineral components	High	High	Low	Readily available	– Clinker substitution by fly ash
			Increase share of alternative fuels in fuel mix	High	Low	Low	Readily available	– Substitute conventional fossil fuels by alternative fuels (municipal/industrial waste and biomass) in the cement kiln
			Efficiency improvement in clinker kilns through clinker-asset renewal	High	High	High	Readily available	– All new capacity additions should use cleaner technology/efficiency improvements
Iron and steel production	3	High	Energy efficiency measures	High	High	High	Readily available	– Continuous improvement measures – Preventive and better planned maintenance – Insulation of furnaces – Improved process flows – Sinter plant heat recovery – Coal-moisture control – Pulverised coal injection
			Fuel shift	Low	Low	Low	Readily available	– Substituting coke used in furnaces with fuel based on biomass (charcoal)
Waste	2							
Municipal solid waste disposal	1	High	Direct use of landfill gas	Low	Low	Low	Requires demonstration	
			Waste management regulations	Low	High	Low	Readily available	– Financial incentives for improved waste and wastewater management

(Continued)

Table 1: Potential Adaptation and Mitigation Strategies and Their Associated Trade-Offs *(Continued)*

GHG Source Categories	% of CO_2 eq Emissions	Growth (Last 10 Years)	Mitigation Strategy	Mitigation Potential	Co-benefits	Cost	Technology Available	Action Points
			Waste recycling	Low	High	Low	Readily available	– Sort solid waste for the recycling of glass, paper, plastic, metal waste and the composting of organic waste
Land use change and forestry	1*							
Forest and grassland conversion	2	Medium	Improve forest management	Low	High	Low	Readily available	– Financial incentives to increase forest area; reduce deforestation; maintain and manage forests
			Avoid deforestation	High	High	Low	Readily available	
			Afforestation	Low	High	High	Readily available	– Promote afforestation of marginal croplands/pasturelands
			Reforestation of degraded lands	Low	High	Low	Readily available	
Emissions and removals from soils	2	Medium	Improve land management	Low	High	Low	Readily available	– Conservation tillage on all cropland – Improved crop and grazing land management to increase soil carbon storage – Financial incentives and regulations for improved land management, maintaining soil carbon content, efficient use of fertilisers and irrigation

* The cumulative total is lower than the subtotals due to the positive impact of removal of GHGvia sinks.
Sources: Chandler et al 2002, Garg et al 2006, 2004, MoEF 2004, Rai and Victor 2009, McKinsey & Company (2009): "Pathways to a Low-Carbon Economy. Version 2 of the Global Greenhouse Gas Abatement Cost Curve" and the Energy and Resource Institute: "National Energy Map for India; Technology Vision 2030, Summary for Policymakers".

is a qualitative indicator that takes into account the size of the existing source emissions, and allows us to compare the reduction potential of each source to the share of total potential reductions of emissions from the country.

(2) Co-benefits: Does a particular strategy provide high (or low) parallel benefits, in addition to the benefits it provides by reducing emissions? These range from significant health improvements, better air quality, reduced dependence on foreign energy imports, financial benefits due to high rate of return on investments, accessibility to new decentralised energy sources, etc.

(3) Cost: How expensive will it be to implement a particular strategy effectively? Low cost strategies typically represent mass scale with little capital or R&D expenditures.

(4) Technology Availability: An indication of the state of the technology required for the particular strategy, i e, whether the technology is in its initial stages, is operational but requires demonstration, or if it is readily available.

In addition, the growth rate (over the last decade) of the GHG emissions from each sector are identified as high, medium, or low – serving as an indicator of whether the emissions from that source are likely to increase or not. Action points that provide more specific details on the implementation of each strategy are also included.

Such a schema is illustrative of the sorts of detailed analysis of the costs and benefits of different mitigation programmes to prioritise among them. Table 1 gives a very rough sense of areas with high mitigation potential (relatively) low costs, readily available technologies and significant co-benefits – thus pointing to steps that India might undertake irrespective of the threat of climate change, and therefore *also* useful as a bargaining tool in international negotiations. The information presented here allows policymakers to better understand the nuance between what measures India takes purely for itself and what it needs to commit to gain leverage in international negotiations.

To summarise, this table provides a non-exhaustive list of mitigation options, with qualitative assessments using "high/low" metrics for the key issues for each strategy. It serves as a starting point to understand the kinds of trade-offs that are required when tackling climate change impacts, along with highlighting opportunities with high co-benefits that India could negotiate with.

What is clear, however, is that for the country to be able to reap the large co-benefits even in areas with considerable mitigation potential, politically contentious domestic reforms will be essential. The electricity sector exemplifies the issue as Rai and Victor argue in their paper. Quite apart from anything to do with climate change, for decades India has been struggling to improve the weak performance of its electricity sector. A host of commissions and reports have argued for nationwide reforms to address energy and peak demand deficits by improving transmission and distribution efficiency, demand-side management programmes, reducing auxiliary consumption at power stations and establishing an independent regulator for coal mines to reduce the current inefficiency in the coal mining sector. To be sure in some cases such as increased efficiency of coal-based power plants, setting up ultra and super critical plants and a programme to improve the efficiency of existing plants, some investments will not be justified on pure cost and efficiency criteria unless subsidised by additional external resources. But in other cases such as more efficient cook stoves for rural households – which India has been struggling to deliver to its rural population – there is little excuse as to why it cannot design and implement an effective programme for more efficient cooking stoves to reduce local emissions with its associated health benefits at the household level and reduced soot emissions at the national

level.[12] The problem with the current programme is the ineffective (standardised, non-tailored) stove design produced by the government. Rhetoric notwithstanding the reality is that the needs of a rural housewife have little claim on the resources of the state.

Another key area is India's urban policies, given rapid urbanisation trends. Mukhopadhaya and Revi argue that a paradigm shift in urban policies will be required. Preferences and social values will needs to be redefined, for instance, to wean the middle-class towards an effective public transport system. Urban design and construction will have to shift from the blind imitation of the west to Indian conditions. However, urban land has emerged as a major source of rents and created powerful constituencies that will not be easy to overcome.

A third example is water. If India is to reduce its vulnerabilities to increasing water stress resulting from climate change, it will have to move to reduce the large inefficiencies in water use in agriculture which are partly the result of poor technologies and partly the result of populist water pricing. India is even more profligate than the US, where water is more abundant (Table 2). Land use patterns (such as growing rice in Rajasthan and Punjab) will have to change – and this again requires a major political consensus.

Table 2: Water Use Inefficiency in Indian Agriculture

	Average Amount of Water[a] (in cubic metres per tonne) Needed to Grow Crops in:			
Crops and Crop Products[b]	Brazil	India	China	US
Maize (corn) nes*	1180	1937	801	489
Soya beans	1076	4124	2617	1869
Wheat nes and meslin	1616	1654	690	849
Rice, semi-milled or wholly milled, whether or not polished or glazed	4447	4113	1906	1840

* "nes" is a short form of Not Elsewhere Specified or Indicated (NESOI).
(a) Virtual water content of different crops for the period (1997-2001) are from Appendix XVI of Hoekstra and Chapagain (2008).
(b) The codes, value and quantity produced for crops and crop products are from Appendix XIV of Hoekstra and Chapagain (2008).
Source: Hoekstra and Chapagain (2008).

More broadly, a serious rethink of regulatory policies ranging from policy instruments to both mandate and provide incentives for increased energy efficiency, pollution control, water use efficiency and recycling, renewable energy use, public transport use, etc, will be required. These changes should focus on improving the country's adaptation capabilities. For instance, public programmes (e g, National Rural Employment Guarantee Act (NREGA), Bharat Nirman) should be redesigned to be built to hazard resistant standards to provide an adaptation advantage.[13] The platform created by the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) should be used to undertake urban renewal and create long-term urban-rural balance by linking the poverty, development and risk mitigation agendas in cities.

A very different issue that is likely to emerge is the intra-country variability in GHG emissions and the consequent equity issues. In 2000 the ratio of the per capita GHG (CO_2, methane, nitrous oxide) emissions of the US compared to India was 14.9, while that of per capita CO_2 emissions in 2000 was 20.4.[14] By comparison the ratio of the highest to the lowest per capita CO_2 emissions across Indian states (Madhya Pradesh/Assam) was 16.5.[15] This large intra-country variability in emissions in India is further illustrated with regional and sectoral assessment of GHG emissions (Garg et al 2001). For instance,

– Eighty per cent of Indian districts covering almost three-fourth of the total Indian population as per Census of India 1992 emitted less than 2.5 teragram (tg) of annual CO_2 equivalent GHG emissions in 1990. The all-India CO_2 equivalent GHG emissions in that year were 1016.3 tg. These districts have low absolute emission levels and low emission growth trajectories.

– In contrast the largest 25-emitter districts, individually for each gas (CO_2, CH_4, N_2O), show high growth rates (1990-95) and account for more than 37% of all-India CO_2 equivalent GHG emissions (in 1995) – exhibiting a strong regional variability.[16] This majority was dominated by emissions from the 40 largest coal-based thermal plants, five largest steel plants and 15 largest cement plants in the country.

– Ten per cent of total Indian districts contributed 67% of India's total CO_2 emissions in 1995 indicating a high concentration of emissions.[17]

– CO_2 emission from the largest 10% emitter districts increased by 8.1% in 1995 with respect to 1990 and emissions from rest of the districts decreased over the same period – indicating a skewed primary energy consumption pattern for the country.

While the large intra-country variance is perhaps not surprising, it does point to the need to think about policies such as fiscal transfer mechanisms (perhaps, through the finance commission awards) to address the issue.

Conclusions

Climate change poses particularly difficult challenges for India. On the one hand, India does not want any constraints on its development prospects. On the other, it also wants to be seen as an emerging global power. While the former may be best served by its current position, the latter will, however, require it to take a leadership role on key global issues – climate change being a critical one. And it can either approach climate change as a "stand alone" global negotiation, or weave these negotiations into a "grand bargain" involving linkages with other international negotiations that also involve key Indian interests, be it reforms of the Security Council, World Trade Organisation negotiations, the financial architecture, etc.

The question, however, remains: what if countries are unwilling or unable to make these steep emission cuts in GHGs that seem essential to slow and reverse adverse climate change impacts? Should the global community have a Plan B, in case this reality comes to pass? And what would that entail? The most seductive (and in the opinion of some, dangerous) idea is geo-engineering, from genetically engineered plants, depositing sulphur dioxide into the stratosphere, to devices that can mop CO_2 out of the air (Jones 2009). While these technologies are still at the fringes, the larger point is whether India should support global geo-engineering projects as an insurance policy or might this simply encourage industrialised countries to do little by way of abatement with uncertain and potentially dangerous consequences?

While differences on specific positions are bound to be contentious, on two issues there is little disagreement. First, India needs to sharply deploy resources to augment domestic research

capacity. Currently, there is little definitive research on what the impacts of climate change will be on different sectors of the Indian economy and people. A technically robust analysis is required to understand the feasibility and opportunities of low and continued high carbon growth paths, and the effects of mitigation mechanisms. Moreover, we need to put resources in universities in the physical, biological and social sciences, for climate-related research. This is key to promoting greater awareness, involvement, constructing behavioural preferences and ultimately to the interest in building institutions of advanced climate research.

Second, given its wide ramifications, debates need to be more inclusive than the narrow confines of Delhi. A more participatory debate involving political representatives, civil society actors and the bureaucracy, both at the national and sub-national level is needed to build a national consensus. The seriousness of climate change impacts, necessity, and options for adaptation and mitigation policies need to be discussed with all stakeholders.

A better knowledge base and a more inclusive debate will allow India to take a more informed view on climate change both domestically and internationally and build broader support for implementing what are bound to be difficult options. It also presents an opportunity for India for rethinking its development strategy, one which is more inclusive and less resource-intensive.

Current debates on climate change mark (to paraphrase Churchill) not the end nor even the beginning of the end, but at best the end of the beginning in what will be a long and arduous road over the next few decades.

NOTES

1 All impacts (unless otherwise stated) are sourced from the IPCC Working Group II Report "Impacts, Adaptation and Vulnerability" (2007), Cambridge University Press.

2 For an excellent analysis on how this challenge may be addressed see Ben Crow and Nirvikar Singh (2009) (forthcoming).

3 Department for Environment, Food and Rural Affairs (2005): "Investigating the Impacts of Climate Change in India".

4 "Melting Asia", *The Economist*, 5 June 2008. (Available at: http://www.economist.com/opinion/displaystory.cfm?story_id=11488548)

5 Refer to endnote 14, CSE (2002).

6 Developed countries have postponed meeting their Kyoto targets by 10-15 years without penalty, and this lag will worsen the climate impacts and pressures on developing countries.

7 PM's speech on release of Climate Change Action Plan, 30 June 2008, New Delhi: http://pmindia.nic.in/speech/content.asp?id=690

8 A rare exception was the recently concluded nuclear deal with the US.

9 For a brief but accessible account see Lavanya Rajamani "India's Climate Change Position: Legitimate But Not Sagacious". Available at: http://cprindia.org/policyupload/1215098988-Rajamani_PolicyBrief.pdf

10 Greendex (2009): "Consumer Choice and the Environment – A Worldwide Tracking Survey", available at: http://www.nationalgeographic.com/greendex/assets/GS_NGS_Full_Report_May09.pdf

11 The base year chosen for information on India's GHG emissions by sources and sinks is 1994.

12 Improving efficiency instead of switching fuels is the target here, because of the cultural preferences of cooking with biomass.

13 Adverse climate effects will largely be *more* frequent and *more* intense series of natural hazard shocks that most regions cope with on an annual basis. If convergence, targeting and implementation issues are addressed the incremental adaptation resources may be lower than imagined.

14 Data used from the World Resources Institute's Climate Analysis Indicators Tool (http://cait.wri.org/).

15 T Ghoshal and R Bhattacharyya (2007): "State Level Carbon Dioxide Emissions of India: 1980-2000", available at SSRN: http://ssrn.com/abstract=999353.

16 Refer to Table 14 of Garg et al (2001).

17 Refer to Table 4 of Garg et al (2001).

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