Chapter 31

India

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India is an important actor in the climate change debate for several reasons. First, India's monsoonal climate, long coastline, and large rural population with substantial poverty make it highly vulnerable to climate change impacts. Second, the Indian economy, because of its size and recent rapid growth, is becoming a significant contributor to greenhouse gas (GHG) emissions. Third, Indian analysts have played important roles in framing the climate debate, and India and China will play important roles in climate negotiations as leaders of the developing world.

Background

India is a large and complex country: the world's most populous democracy, perhaps the most eco-socially diverse region of the world, a complex mixture of the traditional and the modern, and a rapidly changing economy. India's population crossed the 1 billion mark in 2000, and the growth rate, although slowing down, is still just below 2 percent. About two-thirds of this population still depends on agriculture, forests, and fisheries for its livelihood.[1] Politically, India has been a relatively stable multi-party democracy with a multi-tiered system of governance.

Since independence in 1947, India has made impressive progress on many economic and social indicators, including achieving self-sufficiency in food production and substantially reducing poverty, illiteracy, and fertility. It has established a diverse and strong industrial base, and the Indian economy has grown rapidly (at more than 6 percent annually) since 1994.

The fruits of this rapid economic growth, however, are unevenly shared within Indian society. The top 10 percent of India's population accounts for 34 percent of the GDP, while the bottom 10 percent accounts for about 3 percent, and at least 26 percent of the population lives below the poverty line.[2] In 2008, UNDP ranked India 132nd on the Human Development Index.[3] But economic growth continues to be the main focus of the political and economic leadership in the country today, with poverty reduction believed to be achievable through trickle-down and environmental concerns largely receiving lip service.

GHG Emissions from India

The choice of measure used to characterize a country's contribution—current absolute emissions, aggregate historical emissions, current per capita emissions, and so on—is inextricably linked with one's value position about how responsibility for the climate change problem and its mitigation should be assigned. We provide estimates and projections in different terms and discuss their implications.

Current Situation

In absolute terms, India's annual GHG emissions were 1,228 million tonnes of CO_2 equivalent (tCO_2e) in 1994 and are estimated to have reached about 1,750 million tCO_2e by 2005.[4] This amounts to only about 4 percent to 5 percent of the global GHG emissions rate in this period.[5] In per capita terms, India's GHG emissions were 1.3 tCO_2e in 1994, rising to 1.9 tCO_2e in 2004 (still using 1994 population), and so India is ranked 146th among all countries. In contrast, per capita emissions of the United States were around 23 tCO_2e in 2004.[6]

CO_2 of course constitutes the major share of GHGs emitted from India (65 percent in 1994), but methane (primarily from the livestock and agricultural sector) contributes significantly also (31 percent in 1994).[7] Methane emissions are, however, relatively stagnant, whereas CO_2 emissions are rapidly increasing.[8] The main sectors that accounted for CO_2 emissions from fuel combustion in 1994 were energy transformation including power generation (52 percent), industry (22 percent), and transport (12 percent). Coal, of which India has large stocks, is the main source of energy for power generation and meeting industrial energy requirements, accounting for nearly two-thirds of India's CO_2 emissions. The industrial sector accounts for around 50 percent of total commercial energy consumption, with fertilizers, iron and steel, aluminum, cement, and paper and pulp industries collectively accounting for about two-thirds of total industrial energy consumption. Not much information is available on variations in emissions by region or class.

Future Scenarios

Predictions of future emissions from India based on coarse-scale models of economic growth and sector-wise intensities all suggest substantial increases in CO_2 emissions regardless of the policy scenario, but there are significant differences in the estimated values and scope for mitigation. Shukla and colleagues developed four scenarios for India's development trajectory from 2000 to 2030, ranging from "high economic growth" to "self-reliance."[9] Per these scenarios, energy consumption grows from about 500 million tonnes of oil equivalent (mtoe) to values ranging from 800 mtoe (self-reliance) to 1,300 (high growth) by the year 2030. Coal continues to dominate the energy mix in all these scenarios. Natural gas shows tremendous growth in all scenarios from its relatively low base in 2000. Renewable electric capacity increases by a factor between ten and fifteen, but its absolute contribution remains small. CO_2 emissions increase from about 990 million tonnes to values ranging from 2,020 to 3,120 million tonnes, and per capita emissions grow from about 0.99 tonne to values ranging from 1.47 to 2.38 tCO_2. TERI's more recent predictions suggest much higher emissions in 2031 (around 5 tCO_2 per capita) under business-as-usual, but much greater scope for reductions (down to 1.2 tCO_2/capita) with an ambitious mitigation policy requiring 41 percent of commercial needs to be met by renewables.[10]

In summary, India has so far contributed little in absolute terms and much less in per capita terms to GHG emissions. Its absolute contribution will definitely rise rapidly over the next three decades, but per capita emissions will continue to be below even the current global average and far below the current western per capita emissions. On the other hand, depending upon what is considered to be a global per capita sustainable emissions level for 2030, India may come close to or even cross that level if it continues business as usual.

Climate Change Impacts on India

It is becoming clearer in the Indian subcontinent that significant climate changes are imminent. Global climate models (GCMs) now predict a 3- to 6-degree-Celsius increase in temperature and 15 to 40 percent increase in rainfall by end of this century, and higher variability in temperature and rainfall extremes.[11] All GCMs predict more pronounced warming during winter and in the post-monsoon season—a feature conspicuously observed in current Indian temperature trends. Even if average temperature rise is modest, extreme events will increase significantly. In particular, since the monsoon is a critical phenomenon in the Indian climate system, increased variability of the monsoon is likely to be the major form in which climate change affects India.[12] Similarly, sea-level rise is likely to be less than a meter during this century, but the intensity of tropical cyclones and high surges is already increasing

and will increase further.[13] Alth
models continue to have limit
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coincided to make even polic
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seriously.

Given that the majority of th
lation still depends upon agric
and fisheries for their livelihoc
impacts of such physical cha
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We try to summarize below wha
unknown about the different i
mate change on India.

Water Resources

Effects of climate change on
likely to vary across the region
rivers the retreat of glaciers is
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flooding and later on it may i
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duced buffering. Some model
reduced summer flows in suc
purely rainfed areas, changes in
could be either positive or nega
20 percent in magnitude—but
analyses are based on scant da
quate or unsatisfactory models.[1
that is not only facing increa
scarcity of water but also a crisis
of water resources and poor syst
logical monitoring, climate ch
floods and droughts are both bc
vate the situation.

Agriculture

Studies that are largely based
mate models (increased tem

increased precipitation) seem to agree that there will generally be a decline in physical and economic productivity of Indian agriculture of 5 percent to 20 percent even after CO_2 fertilization effects and farmer adaptation are factored in.[16] Other predictions differ in magnitude but not in direction. Increased variability of the monsoon, possibly more important than changes in mean precipitation, will also adversely affect agricultural production. Obviously, food security will be threatened. Since rainfed cultivation is 65 percent of the total, much of it for subsistence, the bigger problem is that the impacts will be disproportionately felt by the poorer farmers.

Natural Hazards

Fast glacier melting causes unexpected or sudden glacial lake outbursts, an increasing threat in the upper Himalayas.[17] Increased frequency of cyclonic storms could cause severe loss not just to coastal agriculture and business but also to human life, habitation, and settlements, given the high density of the coastal population.

Biodiversity

Indian forests and other habitats were originally very rich in biodiversity but are currently greatly fragmented and under serious multiple pressures. There has not been much progress in our ability to predict the impact of climate change on forest vegetation, so the predictions of changes in productivity and shifts in species composition must be treated cautiously, given that forests react much more slowly to any environmental changes than annual crops.[18]

Human Health

Most of the attention has been focused on possible increases in malaria. Any predictions about the behavior of this disease are fraught with uncertainty, given the complex interaction between climatic factors, poverty, irrigation practices, waste management, and other socioeconomic factors. But there is room to believe that areas not previously infested may now face outbreaks due to favorable climatic conditions.[19]

On the whole, there are clear signs of multi-dimensional and adverse impacts of unpredictable magnitude already taking place and becoming more severe in the long run. Within India, the impacts vary significantly in space and tend to be disproportionately felt by the poorer economic classes.

Indian Society's Response to Climate Change

There is broad agreement among Indian analysts on four points. First, India and developing countries in general are not historically responsible for the problem of climate change. Most of the historical increase in CO_2 in the atmosphere has come from the developed countries.[20] Second, given that India is just beginning to make the transition (in average terms) from a poor to a middle-income country, India's capacity to make significant contributions to absolute reductions is small, compared to the total reductions required to contain climate change under 2 degrees Celsius. Third, a broadly equal per capita allocation of emissions rights, even if it is in terms of "frozen" 1990 population levels and even giving some margin to historical and geographical variations, is the only morally acceptable approach.[21] Fourth, much of the human cost of climate change will be borne by developing countries due to their higher vulnerability, sensitive location, and limited adaptive capacities. There is, however, considerable debate regarding how to translate these into international negotiating positions and domestic policies.

Responding Internationally

India and other developing countries have forged and stuck to the principle of "common but differentiated responsibility" based upon: (1) considerations outlined above, (2) the argument that poverty eradication and meeting minimum development needs cannot be compromised, and (3) developed countries needing to provide substantial additional assistance to help contain future emissions.[22]

Post-Kyoto, the major internal debate was on whether India should sign on to the clean development mechanism (CDM). Critics of CDM noted that selling certified emissions reductions (CERs) to developed countries permits them to meet their small Kyoto commitments cheaply and to postpone or not address the major changes required in their domestic economies and lifestyles. Second, selling off the cheapest GHG reduction options now to the industrial countries amounts to giving them the low-hanging-fruit, whereas when the time inevitably came for India to accept some reductions in its own GHG emissions, India would have to undertake the remaining (more expensive) options to meet its own obligations.[23] Third, CDM-related payments will end up replacing, not supplementing, untied development aid. Supporters of CDM have provided arguments of realpolitik, namely, that developed countries would not have accepted even the mil under Kyoto if CDM had n that CDM is essentially free ing funds for efficiency imp one might have made anywa scope for such improveme that participating in CDM p significantly reduce the pote savings.

After intense lobbying I States, the Indian governmen CDM approach in 2001.[24] I CDM Authority came into ex In 2005 and 2006, India was veloping country in terms of n projects in the pipeline and However, the results are clim tive; 80 percent of the CERs destruction of HFC-23, a by manufacture of HCFC-22, phased out anyway under the l col.[25] The companies involve much more lucrative to destro to actually produce HCFC-2 of the distortions that can e CDM projects.[26] Many other renewable energy sector seem would have been profitable an achievements under CDM t truly contributing to climate tion (see chapters 27 and 2 CDM).

The inclusion of land-u forestry in CDM starting in Jul as providing another avenue f for countries like India that h historical deforestation. Seven claimed that the 50 to 70 mill wastelands in India can be us tion programs involving local thereby simultaneously provi enhancement, local environm

and climate change mitigation.[27] However, this approach is fraught with pitfalls. The wastelands are actually significant sources of firewood, grazing material, and other subsistence products gathered by the rural poor. The major cause of wasteland degradation is not the absence of adequate economic incentives, but the absence of adequate, secure, and enforceable property rights for local users over these lands. Providing payments for carbon sequestration without, among other things, resolving forest rights issues will lead to plantation forestry that will benefit the village elite (who already have non-forest sources of income) and/or the state agencies who control common lands, at the cost of the needs of poorer or forest-dependent households.[28] This has often happened under donor-funded joint forest management (JFM) programs.[29] On the other hand, India does not stand to benefit from the new Reducing Emissions from Deforestation and Degradation (REDD) and so has opposed it, although the problems with REDD may not be fundamentally different from those with CDM-afforestation.

At Bali and afterward, even as the developed world's actions reflect a greater urgency, India and the developing countries in general have come under greater pressure to take on some commitments. While China and some others have shown willingness to consider sustainable development policies and measures (SD-PAMs), India has stuck to its hard line of no commitments. Ironically, this position may have inadvertently aligned India with the United States as the spoilers at Bali.[30] There is room to believe that Indian actions before and at Bali were driven more by geopolitics rather than high principles.

For instance, after ratifying Kyoto, India joined the Asia-Pacific Partnership, an alliance floated by the United States in 2005 as an alternative to Kyoto that allows member countries to set individual reduction targets with no enforcement mechanism. India also has negotiated technology deals or partnerships related to nuclear energy and clean coal technology with the United States. Indian climate negotiators have sought to (mis-)characterize the Indo-U.S. nuclear deal as solving all mitigation concerns.

Addressing Mitigation Nationally

Should India have a proactive emissions reduction policy at home? The economic growth lobby would rather not see reduction measures, except if they come in the form of the free money from CDM. Others, including the government, seem to subscribe to a "development first with climate-co-benefits" approach, whereby emission reductions will happen as a by-product of sound development policies, including local-level pollution control.[31] The 2005 Integrated Energy Policy document of the Planning Commission seemed to reflect such thinking.[32] The focus was entirely on ensuring energy security given the anticipated manyfold increases in energy demand. Climate change was (literally) at the bottom of the agenda. With growth equated to development, almost all expert discussions in India focus on supply-side solutions (e.g., nuclear energy), efficiency improvements, and perhaps slowing population growth.[33]

Not surprisingly, the National Action Plan for Climate Change released in mid-2008 drew attention to the seriousness of impending climate change impacts on India, but has set no concrete targets even for a few sectors. It lays out an ambitious plan for energy efficiency improvements in building, but otherwise reiterates strategies that have already proven to be problematic, such as the use of JFM for greening India or reform of electricity subsidies to farmers, and has no vision in terms of mass transit or other shifts.[34]

But it may be necessary to go beyond "development first" for several reasons. First, to be consistent, the principle of equity espoused internationally has to be applied in the internal allocation of emission rights and of compensation funds received, if any. Already the top 10 percent of the population in India today is probably consuming five times the national average, or as much per capita as the average person of a mid-level developed country.[35] If everyone else in India also aspires to that lifestyle, efficiency improvements alone will not be enough. And long before even milder aspirations are met, the climate space available to the Indian poor will have been usurped by the Indian rich. Second, if some reduction obligations are inevitable in the long run, then major long-term decisions being made currently in the energy infrastructure (such as more coal-fired plants), transportation infrastructure (such as more highways), and industries (more steel, cement, and bauxite plants) need to be reconsidered before they lock the country into a high-emission trajectory for several decades. It may also be argued that Indian business can leapfrog and specialize in low-carbon technologies and processes.[36] Third, even if developmental problems are a high priority, they are likely to be dramatically exacerbated by impending climate change. It may therefore be in India's narrow self-interest to negotiate more flexibly if that can lead to early mitigation actions by developed countries. Embracing the concept of SD-PAMs aggressively might shift the focus back toward the deep emissions reductions required of the developed countries.

Adapting to Climate Ch

The second dimension of
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it is argued, are required to bui
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tal required to face up to po
water scarcity, the costs of oce
extreme storm events, increas
den, and so on. The measure
in this approach are more i
structure to protect against dr
frastructure to protect agains
clones, more investment in
systems and in breeding drougl
pest-resistant crops, and so on.

An alternative developmen
might suggest that many of the
which conventional economic
is achieved, such as increased
tion or mono-cropping in ag
those that reduce the capacity
catastrophic events, especially
Given that the natural resour
poor are also the most vulnera
vulnerability may require a
people-centric dimension that
decentralized, democratic, and
friendly system of governance ca

Conclusion

The response of Indian society (a
of the Indian government) to the
mate change will depend on its

the immediacy and seriousness of impacts from climate change, and the larger question of the extent to which Indian society and decision makers weigh concerns for environmental sustainability and social justice in their development thinking. Currently, public awareness of the risks to India from climate change is relatively low. Unless there is an overall shift from a simplistic focus on growth (and implicit trickle-down) to an explicit focus on basic needs, sustainable lifestyles, and environmental justice as an integral part of the development process, climate change will not be taken seriously. Such a focus will then call for not just efficiency-improvement programs but also for more attention to renewables and (more important) for major changes in the way the energy sector is governed, and indeed in the mapping of the development trajectory itself, an approach in which climate change–sensitive and climate change–agnostic policies may converge.[37]

Notes

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1. GoI, 2003. Agricultural statistics at a glance. Ministry of Agriculture and Cooperation, Government of India, New Delhi.

2. GoI, 2006. Economic survey 2005–2006. Ministry of Finance, Government of India, http://indiabudget.nic.in/es2005-06/general.htm.

3. See http://hdr.undp.org/en/statistics/ visited on January 29, 2009.

4. Throughout this chapter, "tonne" denotes a metric ton, i.e., 1,000 kg, not the U.S. ton that equals 2,000 pounds. MoEF, 2004. India's initial national communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Forests, Government of India, New Delhi. Garg, A., P. R. Shukla, and M. Kapshe, 2006. The sectoral trends of multigas emissions inventory of India. *Atmospheric Environment* 40(24): 4608–20.

5. EIA, 2006. International energy annual 2004. Energy Information Administration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, www.eia.doe.gov/emeu/iea/carbon.html.

6. Anonymous, 2007. List of countries by greenhouse gas emissions per capita. Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/List_of_countries_by_greenhouse_gas_emissions_per_capita.

7. MoEF, 2004 op. cit.

8. Garg, Shukla, and Kapshe, 2006 op. cit.

9. Shukla, P. R., R. Nair, M. Kapshe, A. Garg, S. Balasubramaniam, D. Menon, and K. K. Sharma, 2003. Development and climate: An assessment for India. Draft Report, Indian Institute of Management, Ahmedabad.

10. TERI, 2008. Mitigation options for India: The role of the international community, The Energy and Resources Institute, Delhi. Note that the per capita values mentioned in this paragraph are based on predicted populations of 2030/31 under different scenarios, and hence the per capita figure in terms of 1990 reference population will be higher by up to 30%.

11. Kumar, K. R., A. K. Sahai, K. Krishna Kumar, S. K. Patwardhan, P. K. Mishra, J. V. Revadekar, K. Kamala, and G. B. Pant, 2006. High-resolution climate change scenarios for India for the 21st century. *Current Science* 90(3): 334–45.

12. Sulochana Gadgil, Centre for Atmospheric and Oceanic Sciences, Indian Institute of Science, Bangalore, personal communication.

13. Unnikrishnan, A. S., K. R. Kumar, S. E. Fernandes, G. S. Michael, and S. K. Patwardhan, 2006. Sea-level changes along the Indian coast: Observations and projections. *Current Science* 90(3): 362–68.

14. Singh, P., and L. Bengtsson, 2004. Hydrological sensitivity of a large Himalayan basin to climate change. *Hydrological Processes* 18: 2363–85.

15. Gosain, A. K., S. Rao, and D. Basuray, 2006. Climate change impact assessment on hydrology of Indian river basins. *Current Science* 90(3): 346–53.

16. Kumar, K. S. K., and J. Parikh, 2001. Indian agriculture and climate sensitivity. *Global Environmental Change* 11(2): 147–54.

17. Leber, D., 2007. Cli... sk

response strategies in Himalayan countries (Bhutan, India, Nepal). Discussion Paper, Institute of Geology, University of Vienna, Vienna.

18. Such as Ravindranath, N. H., N. V. Joshi, R. Sukumar, and A. Saxena, 2006. Impact of climate change on forests in India. *Current Science* 90(3): 354–61.

19. Bhattacharya, S., C. Sharma, R. C. Dhiman, and A. P. Mitra, 2006. Climate change and malaria in India. *Current Science* 90(3): 369–75.

20. According to Loske, R., 1996. *Scope of the Report: Setting the Stage: Climate Change and Sustainable Development*. Third Assessment Report of Working Group III, Intergovernmental Panel on Climate Change, Geneva. About 83 percent of the cumulative rise in fossil-fuel–related CO_2 from 1800 onward came from developed countries.

21. As suggested by Byrne, J., Y.-D. Wong, H. Lee, and J.-D. Kim, 1998. An equity- and sustainability-based policy response to global climate change. *Energy Policy* 26(4): 335–43.

22. Soz, S., 1997. Address to the UN Convention on Climate Change by the Union Minister of Environment and Forests, at the 3rd Session of the Conference of the Parties to the Framework Convention on Climate Change at Kyoto, Japan, on December 8, 1997, www.indianembassy.org/policy/Environment/soz.htm.

23. Agarwal, A., S. Narain, and A. Sharma, 1999. *Green Politics* (Centre for Science and Environment, New Delhi). Agarwal, A., 2001. Climate change: A challenge to India's economy. Briefing Paper for Members of Parliament, Centre for Science and Environment, New Delhi.

24. Agarwal, 2001 op. cit. Hausker, K., and K. McGinty, 2001. India's reappraisal of the clean development mechanism. Feature, *Resources For the Future*, Washington, DC.

25. Kumar, V., 2006. CDMs: Destination India. The Energy Research Institute, http://static.teriin.org/teritimes/issue8/news4.html.

26. Balaji, N., 2006. CDM in India and its contribution to compensation for ecosystem services, paper presented at South Asia Regional Workshop on Compensation for Ecosystem Services, organized by World Agroforestry Centre and Institute for Social and Economic Change at Bangalore during May 8–10.

27. Satyanarayana, M., 2004. How forest producers and rural farmers can benefit from the Clean Development Mechanism, Appanah, and Y. C. Youn, eds., *P Workshop on Forests for Poverty Re tunities with Clean Development vironmental Services and Biodiversi Korea on 27–29 August* 2003, Food Organization of the United Natio fice for Asia and the Pacific, Ba J. A., and N. H. Ravindranath, change mitigation in the energy an of developing countries. *Annual R and Environment* 23: 387–437.

28. Gundimeda, H., 2005. C ate carbon credits without hurtin *nomic and Political Weekly* 40(10

29. Lélé, S., A. K. K. Kum ashankar, 2005. Joint forest plann ment in the Eastern Plains Regio rapid assessment. CISED Techn tre for Interdisciplinary Studies and Development, Bangalore.

30. Dubash, N., 2007. Inc produce hard realities: Notes fro *and Political Weekly* 42(52): 31–

31. See, for example, Shukl cit..

32. Anonymous, 2005. Draft pert Committee on Integrated E ning Commission, Governmer Delhi.

33. Shukla et al., 2003 op. 2006. Climate change dialogue: sentation. United Nations Frame on Climate Change, Presentat .int/files/meetings/dialogue/ap powerpoint/20060516_india_p Srinivasan, J., 2006,. Hottest dec or false alarm? *Current Science* 9

34. Anonymous, 2008. Cli vision, not plan. *Economic an* 43(28): 5–6.

35. Ananthapadmanabhan, and V. Gopal, 2007. Hiding beh port by Greenpeace on climate peace India Society, Bangalore.

36. Dubash, 2007 op. cit.

37. Narasimha, D., 2006. I ahead. *Infochange Agenda*, June