



India Environmental and Climate Change Analysis
June, 2008

This Environmental and Climate Change Analysis was carried out as a desk study in March 2008¹. The document aims to summarize the key environmental risks and opportunities India faces, related to poverty reduction and economic development and the Swedish governments' thematic priority Environment and Climate² which includes four focus areas; (i) climate change adaptation, (ii) energy, (iii) environment and security, and (iv) water.

Unfortunately the analysis has not been able to draw upon two critical documents that will be available shortly; National Plan of Action for Climate Change due in June and the 11th Development Plan.

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¹ This Environment and Climate Change Analysis was written at the request of Sida NATUR, Stockholm (att: Jens Berggren) by Olof Drakenberg and Emelie Dahlberg at Sida Helpdesk for Environmental Economics, University of Gothenburg as part of Sida-EEU's institutional collaboration on environmental economics and strategic environmental assessment. Comments are welcome and can be sent to olof.drakenberg@economics.gu.se.

² The Swedish Government has set three thematic priorities for its development cooperation; Democracy and Human rights, Environment and Climate, and Gender equality and the role of women in development.

Summary

India has highly diverse climatic zones and natural resources are unevenly distributed. The economy has long experienced high growth rates and millions have been lifted out of poverty. Today India is both a leading IT nation and home of 30% of the world's poor.

Water availability, increasing pollution and climate change are key environmental challenges for India. Impacts are still dominated by poverty related issues such as lack of sanitation and indoor air pollution causing more than 900 000 deaths every year. Increasingly, however, environmental problems related to industrialization (waste, chemical pollution etc) are expected to dominate. Decreased water availability risks reducing agricultural yields and could increase rural to urban migration. Climate change will add to existing stresses such as water availability, land degradation and exposure to natural disasters (floods, droughts etc). India is one of the most disaster prone countries in the world.

The drivers of environmental degradation are population growth, inappropriate technology and consumption choices, poverty and development activities such as intensive agriculture, polluting industry, and unplanned urbanisation. The underlying causes are lack of clarity or enforcement of rights of access and use of environmental resources, policies which provide disincentives for environmental conservation, market failures and governance constraints.

There is a strong link between today's investments in infrastructure, houses, roads and energy systems and tomorrow's energy needs and health risks. The massive investments taking place also provides business opportunities for clean technologies, development of bio fuels etc.

The current growth path partly building on degradation of ecosystems, depletion of key natural resources and high levels of pollution of land, water, air is probably unsustainable in a long term perspective. Improved management of environment and natural resources is needed to ensure sustainable growth.

The government's capacity to manage challenges related to degraded ecosystems and climate change is mixed. On the one hand a system for environmental management is in place, there is a reasonably well functioning system for disaster management and central planning documents mention the need to plan for climate change and include targets on improved water quality, emission control, energy efficiency etc. On the other hand there is a need to strengthen institutions directly and indirectly involved in environmental management. Urgent areas for improvement include; greater accountability and public participation; stronger monitoring and enforcement; and incentives for integrating sectoral and environmental priorities.

Introduction

India is the world's biggest democracy, the second most populated country and one of the largest countries in the world. The country is both a leading IT nation and home to almost 30 % of the world's poor. The country includes highly diverse climatic zones and natural resources are unevenly distributed. For some parts of India water scarcity is a binding constraint to growth whereas polluted water and air may represent main challenges in other parts of the country. For such a large and highly diverse country it is almost impossible to speak of key national environmental challenges, opportunities, impacts and causes without becoming irrelevant in specific parts of the country. Yet, the focus of the report is on the national level.

For over a decade India has experienced one of the fastest growth rates in the world and is projected to continue on a high level in coming years. The rapid economic growth have lifted millions out of poverty and made the middleclass grow to about 300 million people.

Today's massive investments in infrastructure, roads, energy, housing etc largely determine tomorrow's energy and transportation needs. Efficient city planning, application of clean technologies and appropriate building standards could together with expansion of attractive public transportation cater for lower energy needs, reduce health spending and clean-up costs³. The challenge is to provide the enabling conditions for public and private investments that steer towards sustainability. Strong city planning capacity, efficient institutions (policies and enforcement mechanisms), technology transfer and application of policy instruments that address market failures by putting a price on environmental degradation are necessary. Together with India's highly qualified labour force the most promising sign is perhaps the growing political interest and awareness expressed by the Indian middle class.

The scale of its economic growth makes India a large market for clean technologies. Given high engineering skills it is likely that India will not only benefit from technology transfer from outside but could also expand exports of clean technologies. Furthermore, India also has large potential for production of bio fuels. According to some estimates 12 million jobs could be created if low productive lands were used for bio energy production.⁴ India has also becoming the leading country in terms of attracting investments for Clean Development Mechanism. Thus it is clear that improved environmental management provides opportunities for India.

India has a well elaborated institutional framework for managing the environment and natural resources. The institutions are under great pressure as the demand for infrastructure, energy and industry development continues at high speed. Currently there is a need to strengthen overall planning and the capacity to enforce legislation.

To reach the Millennium Development Goals India needs to expand energy use and plans to increase carbon emissions. Given the size of the economies, India's and China's ecological footprint is generating more and more attention and many argue that continued growth represent a threat to the global ecological system. Others argue that as long as per capita consumption levels (energy, CO₂, food, waste etc) are well below those of OECD countries it is unjust to blame these countries for global environmental problems. The meaning of a shared but differentiated responsibility for addressing climate change is likely to be debated in years to come as dramatic reductions of emission levels from richer countries are unlikely to suffice if temperature rise is to be limited to 2 degrees. What seems to be beyond doubt is that India's capacity to manage its natural resources and environmental challenges will have global impact.

Which are the Key Environmental Problems, Opportunities and their causes?

Key environmental problems and their causes

In rural India, water scarcity and land degradation are the most pressing environmental challenges according to the 10th development plan (2002-2007). For urban areas air and water pollution are seen as pressing issues with large impacts particularly on public health. The World Bank lists water availability, increasing pollution and global climate change as the critical environmental issues⁵. Impacts are still dominated by poverty related issues such as lack of sanitation and indoor air pollution causing more than 900 000 deaths every year. Increasingly, however, environmental problems related to industrialization (waste, chemical pollution etc) are expected to dominate.

³ The cost of environmental degradation in China is estimated to be equivalent to between 3-9% of GDP per year. SEPA and UNDP.

⁴ TIFAC, 2006 Production of biofuels could improve energy security and create rural employment. The impacts of current users of the low productive lands must be assessed to ensure positive outcomes.

⁵ World Bank, 2004

The problems listed above are partly but not entirely linked to the degradation of ecosystems and the services they provide (food, fodder, water purification, nutrient recycling, storm protection etc). Large parts of the poor population are directly dependent on the quality of ecosystems (fish stocks, soil quality, grazing land) to earn their livelihoods. Poor women and men are also the most vulnerable to health risks caused by water and air pollution.

The drivers of environmental degradation are population growth, inappropriate technology and consumption choices, poverty and development activities such as intensive agriculture, polluting industry, and unplanned urbanisation. The underlying causes are lack of clarity or enforcement of rights of access and use of environmental resources, policies which provide disincentives for environmental conservation, market failures and governance constraints.⁶

Below we provide a short description of water resources, air pollution, land degradation and climate change.

Air pollution (outdoor and indoor) Emissions to air have increased with economic growth and emission levels are largely above national standards. Pollution is particularly bad in urban areas with the exception of some of the largest cities in the country where concerted action has led to reduced emission levels.⁷ The main causes of outdoor air pollution are rapid industrialization, energy production and consumption, urbanisation, commercialization and transportation. Estimates show that 70% of all industrial pollution (air, water, land) comes from small and medium enterprises (SMEs). Pollution from small scale industries is generally higher per unit of production than large scale industries due to use of obsolete technology and no or primitive pollution control methods⁸. Outdoor air pollution in rural areas is a serious and largely neglected issue. Combustion of bio fuel, used widely for cooking, is the largest source of “soot” or black carbon in the atmosphere.⁹ Underlying causes for air pollution include inefficient pricing of fossil fuel based energy¹⁰, incomplete combustion of bio fuels, weak monitoring and enforcement.

Indoor particulate concentrations measured in Indian solid-fuel using households are well above the dirtiest of cities¹¹. Use of biomass and coal for cooking and/or space heating (often used in unventilated areas) results in high concentration of particulates and pose serious threat to women and children under five. Subsidies to chemical fertilizers contribute to increased use of manure as fuel thus increasing indoor air pollution.

Water resources: The quantity and quality aspects of water resources are of outmost importance for poverty reduction in India. In terms of quantity water resources are unevenly distributed. The North-Western and Southern parts of the country are facing particularly severe water shortages due to overexploitation of groundwater (see Annex 1). This is partly caused by extensive and inefficient use of water for irrigation. Economic growth and high population growth together with the large agricultural sector and industrial growth create a high demand for water. Projections of future water needs highlight the need for improved management of water resources and to improve the capacity for storage.

⁶ GoI, 2006

⁷ Between 1993 and 2002 urban air pollution (with focus on particulate air pollution) decreased in Delhi, Kolkata, Mumbai, Hyderabad and Chennai. The decline led to nearly 13 000 fewer cases of premature death. Three key reasons for the improved air quality were identified as: cleaner fuel, improved technology and stronger and better enforced regulatory. (World Bank, 2005)

⁸ World Bank, 2007a

⁹ Venkataraman, C et al, 2005 Black carbon is a form of carbon produced by incomplete combustion of fossil fuel and wood (forming soot) or biomass (forming charcoals).

¹⁰ MOEF, 2006 (NEP p37)

¹¹ Smith, 2006

Table 1.2: Water Requirement for Various Sectors

Sector	Water Demand in km ³ (or BCM)					
	Standing Sub-Committee of MoWR			NCIWRD		
Year	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	813	1093	1447	710	843	1180

Source: Ministry of Water Resources 2006

Climate change is expected to have multiple impacts on water resources with different consequences in different parts. See more under separate heading.

In terms of water quality Water pollution levels are persistently in excess of national standards.¹² The treatment capacity of wastewater in urban areas is only 27% meaning that 73% is untreated. Estimates show that between 1978-79 and 2003-04 wastewater generation and investments in treatment capacity increased drastically but the gap between treated and untreated wastewater widened.¹³ The main causes of water pollution are discharge of untreated sewage. Industrial effluents, agricultural run-off (pesticides, fertilizers) and insufficient waste management (including hazardous waste, waste dumps) are other important pollution sources. Even groundwater has been contaminated which has long term implications. Underlying causes include rural to urban migration, insufficient sanitation, weak enforcement in cases with non-compliance. The 10th Development plan set out to clean all major rivers by 2007 as one of the top priority objectives.

Land degradation: 64% of the population, notably the poor, derive their livelihood from agriculture. About 60 % of the total area under cultivation is substantially degraded mainly due to soil erosion¹⁴ and this proportion is growing¹⁵. Poor land use practices and management e.g. deforestation, improper use of fertilisers and pesticides, overgrazing, and poor use and maintenance of canal irrigation, are responsible for the rapid land degradation. The underlying causes include: insecure property rights, insufficient empowering of local institutions, lack of alternative livelihoods, land scarcity and population pressure. Conversion of forest lands into agricultural lands has previously contributed significantly to land degradation. However the area under forest cover is now reported to increase. The 10th Development plan set out to increase forest cover to 25 % by 2007 and 33 % by 2012. In Dec 2006 the MOEF expected that the target for 2007 would be achieved. Despite increase in forest cover biodiversity is being lost as the ecosystem services provided by new forests are less than those that are lost.

Climate change: Climate change will add to existing stresses in India including the above mentioned issues particularly disaster risks, water scarcity, land degradation (increased erosion from heavy rains, increased risks from overgrazing due to drought etc) but also poverty, health and food production. Climate projections, adaptation and mitigation challenges are described under a separate heading later in the document.

¹² World Bank, 2007a

¹³ MOUD, 2007

¹⁴ MOEF, 2004

¹⁵ GoI, 2002. The 10th plan use the data 45 % of the country's geographical area is affected by soil erosion and the proportion is increasing year by year.

Opportunities

Benefits of a well managed environment and natural resources include improved agricultural yields and tourism incomes; reduced health costs associated with air and water pollution and increased resilience to natural disasters. The global attention to climate change also creates markets for business (clean technologies, bio energy etc) from which India is well placed to benefit. See also, Economic development and environment. Mobility demand and traffic volume is rapidly increasing. Traffic congestion is becoming a problem. Investments to increase capacity but also improved use of transport capacity such as public transportation and congestion charges could contribute to congestion relief and environmental preservation¹⁶.

What are the Effects of the Environmental Problems and Opportunities

Poverty, Health and Environment

Of the 260 million people living below poverty line in India, 193 million lives in rural areas and 67 million in urban areas. The Central and Northern parts of the country have the highest percentage of poor. India's urban areas hold less than 30 per cent of the total population. This is expected to rise to 40.7 per cent by 2030.¹⁷

Safe drinking water and sanitation is vital for health. Population with access to improved drinking water in urban and rural areas is 95% respectively 83%. Population with sustainable access to improved sanitation in urban and rural areas is 59% respectively 22% (WHO). In rural areas water borne diseases are most common. In urban environment nearly two-third of all diseases are caused by problems relating to lack of clean air or poor access to basic infrastructure and services e.g. water supply, sanitation, drainage and waste management. According to WHO estimates more than 900 000 annual deaths due to diarrhoea caused by polluted water/bad hygiene (44%)¹⁸, indoor air pollution (44%) and outdoor air pollution (12%), see table below.¹⁹ Health impacts related to water and indoor air pollution are much larger in India than China whereas the problem of outdoor air pollution is bigger in China.

¹⁶ Singh S.K. 2006

¹⁷ UNFPA, 2007

¹⁸ This figure only includes diarrhoeal diseases. Other water related diseases e.g. arsenicosis and river blindness are not included in the estimates. Hence, the total number of deaths related to hygiene, water and sanitation is higher.

¹⁹ In a separate study, Smith, 2006 has estimated that 400,000-500,000 premature deaths are caused by indoor air pollution exposures to children under five and adult women.

WHO estimates	Water Sanitation & Hygiene		Indoor air pollution		Outdoor air pollution		
	Country	Diarrhoea deaths/year	Diarrhoea DALYs/1000 capita per year	Deaths/year	DALYs/1000 capita per year	Deaths/year	DALYs/1000 capita per year
	Bangladesh	60 300	14	46 000	9,2	8 200	0,7
	China	95 600	3	380 700	2,5	275 600	1,4
	India	402 200	13	407 100	10	120 600	1,1
	Vietnam	9 400	4	10 600	2,0	6 300	0,5

Source: WHO

Degradation of natural resources particularly affects rural women as they are directly responsible for collection and use of these resources. The commitment of time and effort in collection of these resources has a direct impact on the capacity of rural women to devote time to raising and educating children, enhancing their earning skills, or participating in gainful livelihoods.²⁰

Environment and security

Conflicts over natural resources in India can be found on transboundary lever, regional and local level. Major rivers such as Brahmaputra, Ganges and Indus are shared with neighbouring countries (Nepal, China, Bangladesh and Pakistan) and their regulation for hydropower and irrigation affect already relations between the parties. Examples include the reduced dry season river flow in Bangladesh due to the Farraka Dam that regulates the Ganges and the Chinese hydropower expansion along Brahmaputra expected to affect downstream Indians. Climate change may raise the tension between the parties and is expected to increase the number of environmental refugees. During floods in the Bay of Bengal Bangladeshis have crossed the Indian borders to seek refugee causing conflicts with residents.

Internal conflicts over resources include resource use in protected areas²¹, displacement of population for infrastructure development or mineral exploitation²² and conflicts related to water distraction. The total number of ousters/displaced persons during the period from 1951 to 1990 due to various mining, industrial, hydropower, and other development projects is about 21.3 million people. It is projected that the average number is likely to increase. Unplanned redistribution of population on the scale indicated could add to urbanization problems.²³

Weak property rights and lack of voice puts the poor at disadvantage. The government is criticised for inadequate impact assessments for development projects and for neglecting the rights of communities.²⁴

²⁰ MOEF, 2006

²¹ An estimated four million people live in India's national parks and sanctuaries alone. Many more, some say up to 50 million people, inhabit the reserved and protected forests. (IPS news)

²² A large proportion of the mineral wealth is found in forest rich states such as Orissa, Chhattisgarh and Jharkhand with high poverty rates, large proportion of marginalized indigenous groups and where livelihoods are dependent on the wellbeing of ecosystem services provided by forests (food, timber, building material, medicines etc). (Center for Science and environment, 2008.)

²³ Pachauri et al, 2000.

²⁴ Visvanathan, 2002.

Economic Development and Environment

India has a large service sector representing about 50% of GDP. Manufacturing and Agriculture, forestry, fishing and mining activities both contribute with contribute to about 25 %. Despite a continuous decline in agricultural GDP nearly 64 per cent of the population, notably the rural poor, depend on agriculture and rain fed agriculture alone accounts for 6% of GDP. Crop production takes place in almost all land class types and will continue to be important in India's economy in the years to come as it helps to feed a growing population, employs a large labour force, and provides raw material to agro-based industries.²⁵ There is high dependence in rural areas on forests and land for livelihood. Population pressure puts severe strains on the fragile ecosystems of dry zones, aggravates land degradation, and reduces the natural resource base that supports the livelihood in dry zones. This results in reduction in productivity. Growth rate in agriculture, forestry and fishing is expected to decrease during the period 2007-2008 compared to previous years. The projected overall GDP growth rate of 9 per cent and agricultural growth rate of 4.1 per cent during the 11th Plan cannot be achieved with the ongoing shrinking and degradation of the country's natural resources.²⁶ Global food prices are on the rise and competition for land between food and energy is likely to increase. The urban poor are the most vulnerable to rising food prices.

Growth of India's economy has led to high performance in the industrial sector. Growth in industry is causing "modern environmental problems" e.g. increase in industrial waste and chemical pollution. High growth in manufacturing (e.g. electronics and information technology, textiles, pharmaceuticals, basic chemicals) has severe environmental consequences in terms of water and air pollution and hazardous waste. Pollution generated by small scale industries is generally higher per unit of production than of the corresponding large units. Fuel subsidies stimulate the rapidly growing use of diesel, kerosene etc and is estimated to cost as much as 2-3% of GDP.²⁷

Another effect of the growth of India is the rapid urbanization. During the time period 2007-2012 approximately 37 million people are expected to be added to the country's total urban population which today is 330 million people (representing 30% of India's total population)²⁸. Cities in India consume large quantities of energy and water and produce equally large quantities of liquid and solid wastes. The rate of generation of solid waste has outpaced population growth. Urban environment management has not been prioritized in the previous five year plans. It is indeed one of the most neglected areas in planning future urban growth and development. Traffic congestion constrains economic activity and increase air pollution. In Delhi, average vehicular speed has dropped from 20-27 km per hour in 1997 to 15 km per hour in 2002. In Kolkata, the average speed ranges between 15-20 km per hour and falls to 7 km per hour.

It is also important to stress that economic growth also brings in resources, technologies, policies, capacity and public demand for improved environmental performance and quality. The Indian market for cleantech was about 5-6 billion USD in 2006 and is growing with 15% per year.²⁹

India is today a world leader in attracting CDM projects (Clean Development Mechanism). The majority of registered projects are renewable energy projects focusing on hydropower and wind energy. Other projects include industrial process projects, forestry projects etc. These experiences could open for more massive investments when the market matures. In 2007 the value of the Indian CDM projects had risen to about 16 MUSD.

²⁵ MOEF, 2004

²⁶ GoI, 2007.

²⁷ The Economist, May 28th 2008, Crude measures – not everybody is paying higher prices for oil. According to and IMF study, fuel subsidies, particularly for petrol and diesel have proven to disproportionately benefit richer segments of society.

²⁸ MOUD, 2007.

²⁹ Cleantech Forum 2006 Theme paper

Bio-energy is an opportunity for alternative source of energy. The plant *Jatropha Curcas* (used for bio-diesel) can easily grow in degraded lands with adverse agro-climatic conditions. India, with its huge waste/non-fertile lands, is leading in *jatropha* cultivation. Bio fuel for India has special significance due to energy security, contribution to rural economy and employment generation. Use of 11 million ha of “wastelands” can lead to a minimum of 12 million jobs.³⁰ Lands referred to as “wastelands” are typically areas with ill defined property rights that are used by poor men and women to collect fuel wood, fodder etc that are important for their livelihoods. To protect these vulnerable groups both social and environmental impacts of bio energy production must be analysed.

Climate change and India

Overview

Under this heading we will give a brief overview of both climate change impacts on India, adaptation and current and projected levels of emissions. India hosted the UNFCCC COP 8 conference in 2002 which generated higher political awareness on climate change in India. The issues have matured further and now there appears to be general political awareness of the issues (mitigation and adaptation) which can be seen in various inputs into the 11th plan including disaster risk management, agricultural risks, water resources, energy and infrastructure. In negotiations on climate change the Indian government advocates focus on per capita emissions, inclusion of historical emissions and the UNFCCC principle of common but differentiated responsibility in order to avoid constraints for developing nations. India declares itself prepared to commit that future per capita emissions will not exceed the average of per capita emissions of developed industrial countries. A National plan of action on Climate Change is to be presented in June³¹ and work is ongoing on a second National Communication to the UNFCCC.

Expected impacts of Climate Change

According to IPCC³², climate change is expected (high certainty) to bring higher temperatures, more extreme weather (storm surges, drought, flooding), negatively affect health³³ and cause losses of coastal ecosystems such as mangroves and productive lands due to sea level rise and salt water intrusion. Furthermore infrastructure in megacities in flood deltas is particularly threatened. Accelerated glacier melt is likely to cause increase in the number and severity of floods, slope destabilisation and a decrease in river flows. Gangotri, the longest Indian glacier, is currently retreating at a rate of 20 m per year, compared to 16 m per year in the past. Projections of future rainfall (number of rain days, volume etc) are less certain but could have dramatic and diverse impacts in different parts of India. Most models project increased precipitation during the monsoon season, particularly over the northwestern parts of the country.³⁴ However, studies of river basins show that river flow may be reduced despite increased precipitation mainly due to increased evaporation.³⁵ India is expected to reach a state of water stress before 2025 as average water availability per capita falls below 1000 m³ per capita. Economic impact assessments include loss in net agricultural revenues in India by 12 % (temperature rise of 2 degrees and 7% increase in precipitation).³⁶ Reduction in crops is expected to be highest for farmers, mostly poor, relying on rainfed agriculture.

³⁰ Tifac, 2006

³¹ Prime Minister Dr Manmohan Singh, 2008 , Delhi Sustainable Development Summit February 2008

³² Cruz, R.V et al, 2007

³³ Projection for 2050 indicate a shift of malaria from central Indian region to the south western coastal states of Maharashtra, Karnataka and Kerala. Also the northern states, including Himachal Pradesh may become malaria prone in the future climate change regime. The duration of the transmission windows is likely to widen in northern and western states and shorten in the southern states.

³⁴ Kumar et al, 2006,

³⁵ Gosain et al, 2006

³⁶ Teri, 2006. Other studies indicate small increase in rice yields. (MOEF, 2004)

India is one of the most vulnerable nations to natural disasters like floods, cyclones and droughts, and earthquakes. Every year 7% of the population are victims of natural disasters³⁷ and about 85 % of the country's total area is vulnerable to one or more disasters and the frequency of the number of natural disaster has increased³⁸. Global warming is expected to increase the frequency and magnitude of climatic disasters.

Climate induced shocks such as floods and drought risk create large rural to urban migration. The current migration pattern with growing coastal urban areas has increased the number vulnerable to floods. Impacts on sectors such as infrastructure and industry include higher maintenance costs and increased costs for cooling.

The government estimate that climate change currently is costing India the equivalent of 2 % of GDP annually. Ultimately, the costs of climate change to India will heavily depend on the success of global mitigation and the country's adaptive capacity. According to the Stern review a temperature rise of 5-6 % would result in costs of 5-10% of global GDP and for poor countries costs in excess of 10%. If mitigation efforts can reduce global warming to 2 degrees at 2050 costs would be substantially lower.

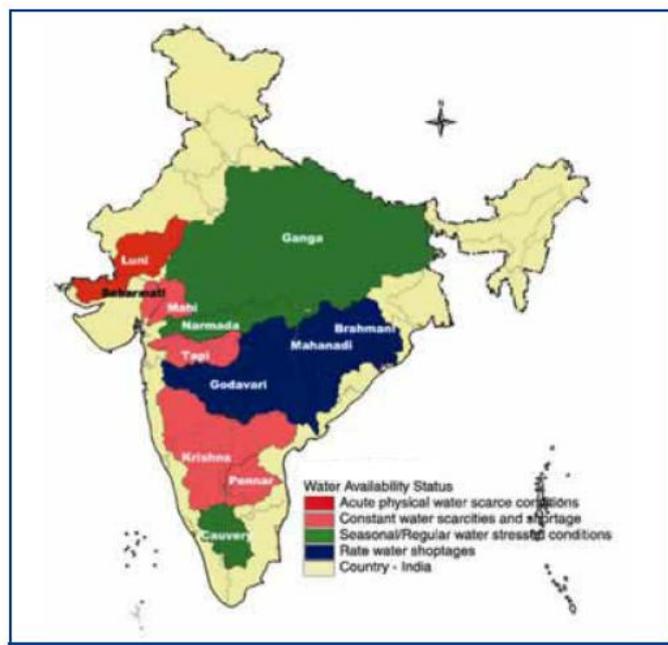
Adaptation to climate change

Vulnerability is a reflection of human capacity to cope with risks or shocks. The Indian population has always been exposed to climate variability and extreme weather events and a range individual and societal coping mechanisms have evolved. Wealth, access to technology and societal organisation are important determinants of a county's adaptive capacity. Key adaptation priorities listed in the UNFCCC National Communication include; i) overarching issues like; economic growth/poverty reduction, institutional strengthening and education; ii) continued focus on programs such as integrated water resources management, soil conservation, flood warning systems, crop diversification and crop insurance; and iii) climate specific measures like climate research, plantation of mangroves for storm protection and improved building standards. Poverty reduction is seen as the single most important measure to reduce vulnerability.

There is no clear mapping of the most vulnerable groups to climate change. However poor farmers depending on rainfed agriculture, and rural and urban poor in flood prone areas are said to be particularly exposed to climate hazards. The map below focus on projected water scarcity.

³⁷ Per capita India is one of the 10 most affected countries in the world. The IPCC finds a reduction of the number of cyclones in the Bay of Bengal but an increased intensity thus causing overall larger damage. (Guha-Sapir et al,2004)

³⁸ MOEF, 2004



Broad variation in vulnerability of different regions to projected climate change
Source: National Communication, 2004

Energy and CO2 emissions

Estimates show that 64% of the country's installed energy capacity is thermal (53% coal, 10% gas and 1% oil), hydro contributes to 25.5%, nuclear 3% and renewable energy 7.5%. Over 600 million in India have no access to electricity. Energy, industry and agriculture (including livestock)³⁹ are the main green house gas emission sources in India and their relative share has changed in recent years, see table 1 below.

	1994	2000
Energy incl transport	60%	65%
Industrial processes	8%	11%
Agriculture, incl livestock	28%	22%
Land use, land use change and forestry	1%	0%
Waste management	2%	2%

Per capita emissions are low in international context, a projection for growth in emissions under a high growth scenario shows that emissions would level off at 3,8 tonnes per capita in 2100 see figure 1 .

In World Energy Outlook 2007⁴⁰ energy need in the world would in 2030 be 50% higher than today (in a high growth scenario without policy changes). India and China together account for 45% of this increase in demand. Coal will remain India's most important fuel and its use will nearly triple between 2005 and 2030. Much of India's energy needs to 2030 will have to be imported. Hard coal import will rise almost seven fold by 2030. Net oil imports will also grow and before 2025 India will be the third largest net importer of oil (after United States and China). Power-generation capacity, most of it coal-fired, will more than triple between 2005 and 2030. The number of Indians relying on biomass for cooking and heating will drop from 668 million people to 470 million and the share of population with access to electricity will rise from 62% to 96% during the same time span. Transport energy demand see the fastest rate of growth as the vehicle stock expands rapidly with rising economic activity and household incomes. Stronger policies that the Indian government is now considering could yield

³⁹ India is the global leader in milk production.

⁴⁰ IEA, 2007

energy savings that are 17% lower than the high growth scenario (policies for energy efficiency, energy security and the environment).

It should be noted that India is estimated to be 1.5 times more efficient than the US in terms of emissions calculated in purchasing power parity (PPP) terms. (World Bank, 2007b). Over 4630 MW of grid interactive renewable power capacity was added during the first four years of the 10th Plan against an aim of 3075 MW for the Plan period. Of this, 3684 MW has come from wind power, 387.83 MW from small hydropower, 581 MW from bio-energy and 25.15 MW from waste to energy.

Actions taken to reduce carbon emissions include investments in renewable energy (India is fifth largest nation in terms of installed wind energy, ethanol is blended in petrol, hydropower expansion etc).⁴¹ As stated above India has a large potential for production of biofuels and the country has been early to benefit from the market for carbon credits, clean development mechanisms.

What are Key Actors doing to manage the Environmental Problems and Opportunities?

Government and planning

The central government planning instrument is the five years plan. The 11th five year development plan (2007-2012) is ready for approval.⁴² Rapid growth is an essential part of the eleventh five year plan for India and it is to be achieved through an improved business environment, higher agricultural productivity and broad investments in infrastructure, education, health, water, sanitation.

Environmental concern and climate change appears to be integrated in the prepared draft and sector documents (water, agriculture, energy, natural disaster, urban development etc) for the eleventh five year plan and is noted as one of key challenges for the plan. However it is difficult to judge the extent to which the concerns expressed will get budget priority.

Environmental degradation could constrain the goal of 4% agricultural growth which is double the rate compared to the 10th plan period. Soil conservation and access to water through irrigation is vital to increase production. Poor environmental management also risk raising spending on health and natural disasters. There may be a trade off between creating an enabling business environment and safeguarding long term sustainability for instance related to impact assessments and permits for industrial development.

National plans for water management (e.g. for rivers, groundwater, irrigation) in urban and rural areas are currently being undertaken. Under the National River Action Plan India is taking action to reduce pollution in its 7 major rivers.

Governance of urban areas is both fragmented and uncoordinated.⁴³ To address the issue of rapidly growing urban areas the Indian government has created a number of initiatives to stimulate urbanization infrastructure where the JNNURM (Jawaharala Nehru National Urban Renewal Mission) is such an initiative. Few urban local bodies have prepared long term action plans for effective Solid Waste Management (SWM). The Government of India emphasise the need for waste recycle, reuse, and resource recovery for reduction in waste and more advanced technology measures for effective and economical disposal of municipal solid waste.

The government of India highlights the importance of continued development in the power sector through energy efficiency and environmental consideration in coal-based generation and increase of

⁴¹ MOEF 2004

⁴² The 11th plan has not been publicly available during our analysis. We have had access to the document Approach of the 11th plan and numerous sectoral documents feeding in to the 11th plan.

⁴³ MOUD, 2007

capacity for renewable energy e.g. wind, hydro and solar energy. India has distinguished record of promoting renewable energy, particularly wind. However, there is a need to create a stable regulatory for renewable energy. Recovery of energy from urban waste and industrial waste is being implemented and continued technological support to this sector is needed.

Environmental institutions

India has an extensive environmental management system with a comprehensive set of environmental laws, specific statutory mandates, regulatory instruments, and institutional framework to implement and enforce environmental policy objectives. Environmental regulatory is in India represented at the central level by the Ministry of Environment and Forests (MoEF) and the Central Pollution Board Control (CPCB), and at the state level by State departments of environment and forests, and State Pollution Control Boards (SPCBs).

The main environmental management instruments include: (i) an *Environmental Impact Assessment* (EIA) system to regulate the siting and approval of large projects; (ii) *Forestry Clearances* that require the project proponent to deposit the compensatory afforestation payment and (iii) the *Consent to Establish* (CTE) and *Consent to Operate* (CTO) that regulate the establishment and operation of facilities at the State level.

Other instruments include taxes, fees, zoning, information disclosure and polluter liability.

The legal system is seen a key actor for environmental enforcement. The introduction of Public Interest Litigation (PIL) has empowered individuals and community groups and the courts have become important players in environmental protection.⁴⁴

India is party to all eight of the environmental conventions, with prime relevance for poverty alleviation, that are given specific attention in Sweden's development cooperation.

Civil society and NGOs

The number of NGOs in India is estimated at between 50,000 and 100,000. Environmental NGO are active in areas ranging from policy analysis to school programs; from participatory natural resources management to activism. In January 2008 a gathering of 600 of India's most important environmental NGOs met with other civil society stakeholders such as the corporate community, the judiciary, international agencies⁴⁵. (We have not found any assessments of the NGO community)

How and to what extent are the Responses to Environmental Problems and Opportunities implemented and followed-up?⁴⁶

Despite a strong policy and institutional framework environmental degradation continues in many areas and public dissatisfaction with the situation is growing. The World Bank in collaboration with MoEF⁴⁷ judged that the following improvements were particularly important:

- promote greater accountability, transparency and public participation in environmental management
- strengthening monitoring and enforcement of policies and regulations
- addressing capacity needs of environmental institutions
- improving institutional incentives for integrating sectoral and environmental priorities

⁴⁴ Rajamani, 2007

⁴⁵ Sangam 2008: The All-India NGO Summit for Protection of Environment and Access to Social Justice is an initiative that attempts to bring together multi-sectoral NGOs from across the country on one common platform to develop practical solutions for India's most pressing environmental concerns. Speakers included Nobel Laureate Dr. R.K. Pachauri, Chairman of the Intergovernmental Panel on Climate Change and Dr. Vandana Shiva, Director of the Research Foundation for Science, Technology and Natural Resource Policy.

⁴⁶ If not otherwise stated this section builds on the institutional Country Environmental Analysis

⁴⁷ World Bank, 2007a, The areas selected were chosen after broad consultations among different stakeholders and after taken into account other ongoing processes to improve efficiency.

Promote greater accountability transparency and public participation in environmental management:

Good governance and transparency should be ensured in the implementation of public programmes and also in government's interaction with the ordinary citizens. India scores 3.5 on the 2007 Corruption Perception Index and is together with China ranked 72 in the world.⁴⁸ Better design of projects, implementation mechanisms, and procedures can reduce the scope for corruption. Much more needs to be done by both the Centre and the states to lessen the discretionary power of government, ensure greater transparency and accountability, and create awareness among citizens. The Right to Information (RTI) Act empowers people to demand improved governance. Citizen monitoring can be an effective mechanism to support implementation of an agency's environmental management responsibilities.

Strengthening monitoring and enforcement of policies and regulations: There is a large unfinished agenda to strengthen the regulatory, enforcement and incentive mechanisms available with environmental agencies. The current application of environmental regulation does not match the scale, diversity and trends of India's economy. There is a need for different regulatory programs and approaches e.g. monitoring a large number of SMEs using the same method as for large industry units is inefficient. Environmental Impact Assessment (EIA) is one of the important management tools for incorporating environmental concerns in the development projects at the planning stage. Improve use of EIA should be emphasised. Linking industrial promotion incentives (such as tax holidays and soft loans) to environmental risks and performance is also proposed.

Addressing capacity needs of environmental institutions: Overall there is a need for better access to training, knowledge and capacity enhancement. Institutional changes and improvements will require long-term program of action. This will require environmental agencies, sectoral institutions and the general public work together to make progress. Improved access to environmental information by researchers and the public is needed. There are many areas where action is rendered infeasible by lack of data or lack of data in the public domain.⁴⁹

Improving institutional incentives for integrating sectoral and environmental priorities: There is a need to improve cross-sectoral coordination, particularly involving environmental authorities in the early planning and design stages of large infrastructure and industrial development programs. Empowering local government to oversee regional environmental programs and foster cross sectoral coordination are clearly needed.

Critics argue that Ministry of Environment and Forests recently has downgraded environmental and social safeguards in order to facilitate economic growth and foreign investment thus increasing the risk for biodiversity losses degrading ecosystems.⁵⁰

What are the implications for Sida?

Sida's development cooperation with India is based on actor-driven cooperation. The point of departure is to facilitate partnerships and cooperation between Swedish actors (businesses, authorities, institutions, municipalities, civil society etc) and Indian counterparts/actors in ways that contribute to poverty reduction. It has been proposed that the selective development cooperation should be

⁴⁸ Score under 5 indicates that the country face serious perceived levels of domestic corruption. (Transparency International, 2007)

⁴⁹ One interesting initiative in this regard that has the support of the National Knowledge Commission set up by the Prime Minister is the proposal to build an India Biodiversity Portal (IBP) that will be an open-source wiki website that will aggregate information. The IBP is being planned by the Ashoka Trust for Research in Ecology and Environment (<http://www.atree.org/>) and may be expanded to an environmental information system.

⁵⁰ Winrock International India/IIED, 2006

concentrated to the two main areas/themes; environment/climate change and human rights and democracy.

We find the transformation of current forms of development cooperation to an actor driven approach very challenging. The suggestions below aim at contributing to a discussion and identification of Swedish priorities and should not be seen as prescriptive or all inclusive. Suggestions complement the Indo- Swedish Environmental Facility, Demo-Miljö, the Environment-Energy office at the Embassy and export promotion activities. It should be noted that we have not had access to an analysis of the comparative strength of the Swedish resource base with the specific conditions of an actor driven approach in mind (clean technologies, services, institutions etc). We suggest that such a study is undertaken to inform all strategies of this kind and bearing in mind the challenges of exporting/sharing a “Swedish” approach in different social and institutional contexts.

In an international comparison, Sweden has been successful in reducing emissions to water, soil and air and in putting in place measures for protecting ecosystems. Important factors for successful environmental management include strong environmental institutions, high levels of environmental awareness among the public, significant use of economic policy instruments for environmental management, strong research capacity within businesses and academia, clean technologies and strong integrated planning capacity. Strong environmental policies have also created incentives for innovation of clean technologies and services.

Areas where Swedish competence is well positioned in an urban Indian context include waste management, waste incineration, waste water treatment, district cooling, monitoring, transportation and mobility management. The holistic approach of integrated planning and thinking with collaboration between public and private sector is also a key Swedish competence; see for instance the recently launched Swedish CleanWater Partnership and SymbioCity⁵¹ India expressed particular urban interest in the areas of energy efficient housing, solar energy, public transportation systems, waste water management and reuse.⁵²

The Swedish competence base could offer many opportunities for fruitful partnerships. Whereas business and to some extent academia has clear incentives for engaging in partnerships the incentives for actors like municipalities, public agencies and government bodies to engage are often inadequate or even hindered by legal barriers.⁵³ Yet the public sector, including municipal owned businesses, may have a lot to offer. This problem is not specific for the Indian context but merits further attention by Sida.

Respond to needs of institutional strengthening

Swedish institutions and agencies should primarily address the institutional needs identified by the Country Environmental Analysis and consider risks for diverting institutional attention from pressing recurrent activities⁵⁴ Identified needs are:

- Promote greater accountability, transparency and public participation in environmental management
- Strengthening monitoring and enforcement of policies and regulations
- Addressing capacity needs of environmental institutions

⁵¹ Speech by Andreas Carlgren on the 4th of February, 2008 at the Ministry for Urban Development and Poverty Alleviation. http://www.swentec.se/templates/page_4746.aspx?epslanguage=SV, www.symbiocity.org

⁵² Ministry of Environment, 2008-03-07, -PM Report from Andreas Carlgrens visit in India 4-8 February,

⁵³ On the one hand the Policy For Global Development promotes efforts in this area but on the other hand kommunallagen prohibits broader engagement.

⁵⁴ According to a recent study by ODI Environmental institutions are often deeply involved in project and programme support directly funded by donors. As a consequence these institutions often fail to undertake their primary tasks including enforcement and monitoring. A key recommendation for donors is to be careful in the use of project finance to environmental institutions. Bird, 2008, Government institutions, public expenditure and the role of development partners: meeting the new challenges of the environmental sector, ODI

-Improving institutional incentives for integrating sectoral and environmental priorities

As an example Swedish institutions should seek to strengthen their Indian counterparts in the area of right to information. This could include; i) improving access to environmental information by civil society, community interest groups, and research community etc and ii) improved public participation/consultation in Environmental Impact Assessments/Strategic Environmental Assessments etc.

Strengthen civil society to take on the challenge of climate change

Indian civil society has played an important role in improving environmental management partly with Swedish support. Continued support to civil society organisation with or without partnerships with Swedish civil society should be promoted as a mean to strengthen implementation, accountability and transparency of environmental policy. A strong civil society will also be critical for promoting a demand for better policies not least for addressing the challenges of climate change including both low carbon growth and adaptive capacity. Civil society can play an important role in climate change adaptation and enhance involvement of vulnerable groups including the rural poor.

Use economic instruments for energy efficiency and climate change mitigation

Like Sweden, India has large experience of using different policy instruments for environmental management. Extensive use of economic instruments has been important for environmental management in Sweden. Addressing the problems with fuel subsidies is an area of particular interest. Opportunities for exchange with Swedish institutions and academia could be explored in areas including climate change adaptation, energy, bioenergy, waste, transportation etc.

Improve the urban environment

Investments in the urban environment are needed and better planning capacity is critical for successful environmental outcomes. Promoting inclusion of environmental and climate change aspects in spatial planning is therefore important and could be considered by Sida. The holistic approach, Swedish CleanWater Partnership, Symbio City, that integrates planning and implementation and collaboration across both administrative levels and public private sectors, could be promoted. This could include study tours, international training courses and work shops that can stimulate partnerships and create business opportunities in various fields including water, waste, energy and mobility management. . Improved spatial planning can both reduce future emissions and reduce vulnerability to climate change.

Improve water resources management

Improved water resources management including water efficiency and water demand management is key to climate change adaptation in drier parts of India, and can be more cost effective than new supply-side investments. Opportunities for working through the Swedish CleanWater Partnership could be considered.

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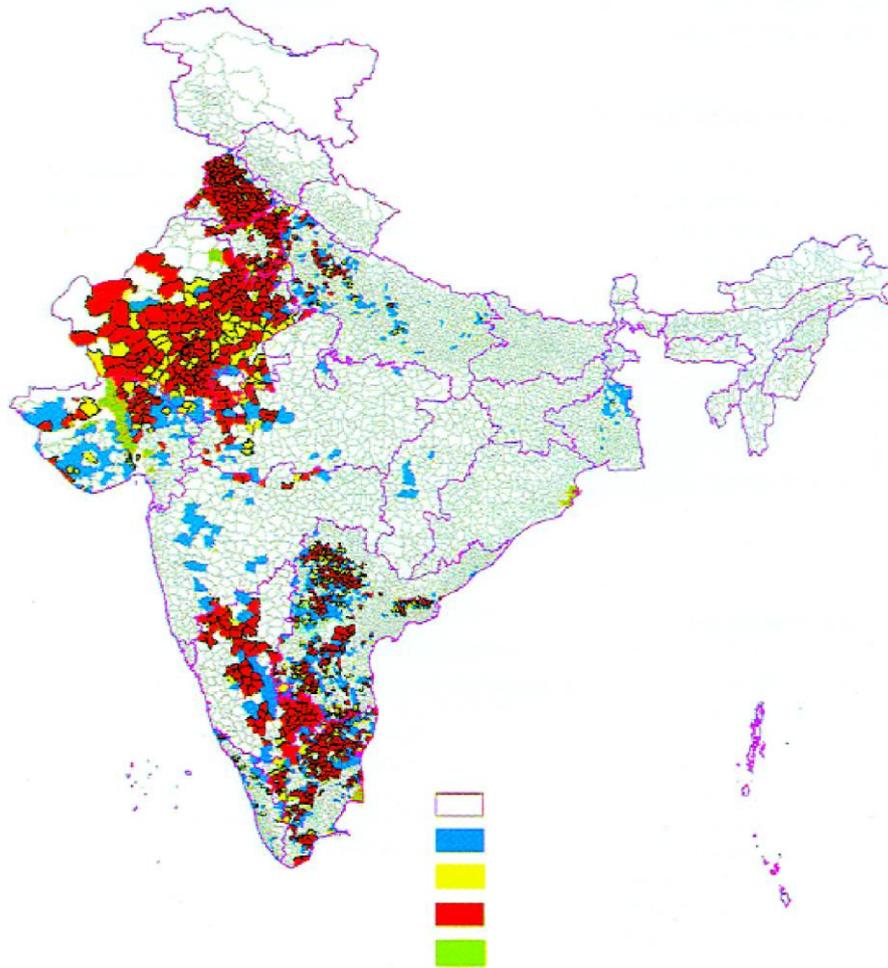
Personal communication:

Berit Gullbransson, director Swentec, 10th of June 2008

Göran Värmbö, project manager, Business Region Göteborg, 29th of May 2008

ANNEX I

Ground water



White – Safe
Blue – Semi-critical
Yellow – Critical
Red – Over Exploited
Green - Saline

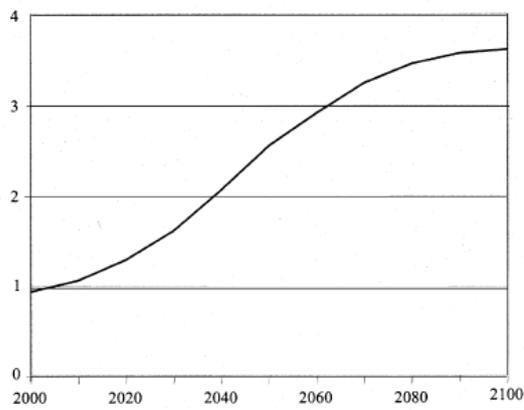
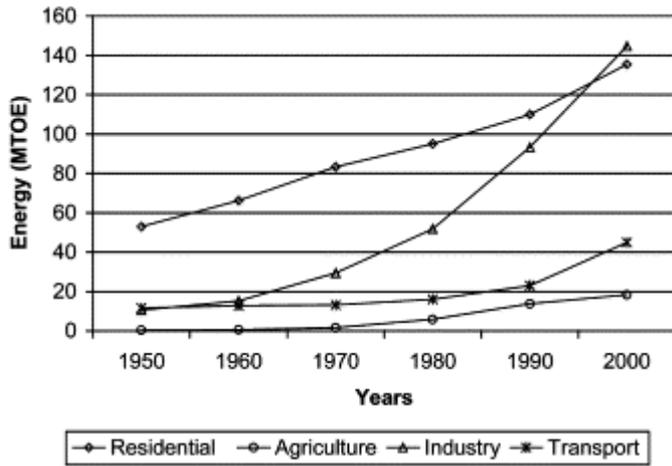
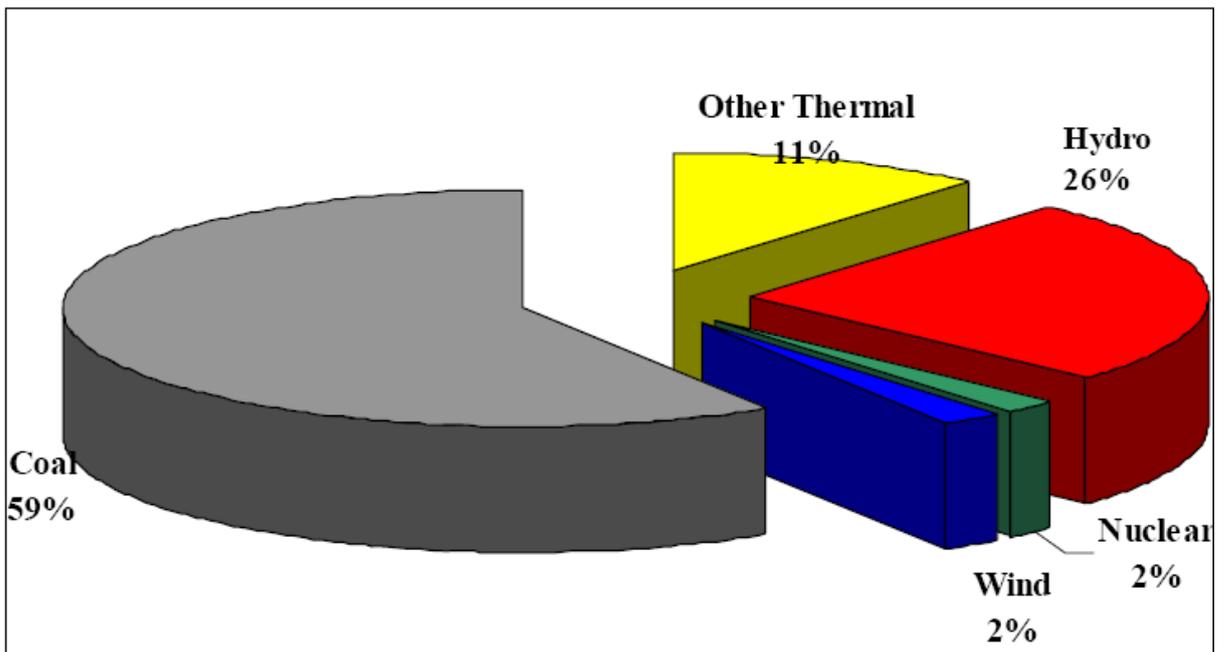


Figure 9. Per capita CO₂ emissions in IA2 scenario (tonne of CO₂/ person/year).

Source: Shukla, 2006

Figure 4.1: Installed Capacity of Power Generation by Source (percentage), 2005



Source: MoP (2005)

BOX 1.1

MONITORABLE TARGETS FOR THE TENTH PLAN AND BEYOND

- Reduction of poverty ratio by 5 percentage points by 2007 and by 15 percentage points by 2012;
- Providing gainful and high-quality employment at least to addition to the labour force over the Tenth Plan period;
- All children in school by 2003; all children to complete 5 years of schooling by 2007;
- Reduction in gender gaps in literacy and wage rates by at least 50 per cent by 2007;
- Reduction in the decadal rate of population growth between 2001 and 2011 to 16.2 per cent;
- Increase in Literacy rates to 75 per cent within the Plan period;
- Reduction of Infant mortality rate (IMR) to 45 per 1000 live births by 2007 and to 28 by 2012;
- Reduction of Maternal mortality ratio (MMR) to 2 per 1000 live births by 2007 and to 1 by 2012;
- Increase in forest and tree cover to 25 per cent by 2007 and 33 per cent by 2012;
- All villages to have sustained access to potable drinking water within the Plan period;
- Cleaning of all major polluted rivers by 2007 and other notified stretches by 2012.

ET = evapotranspiration

Table 4. Per capita CO₂ equivalent emissions in 2000

Country	Per capita CO ₂ equivalent emission in 2000 (tonnes/capita)	Ratio of per capita emissions wrt Indian emissions	Percentage of Indian emissions
USA ²²	23	15.3	6.5
Germany ²³	12	8.0	12.5
United Kingdom ²⁴	11	7.3	13.6
Japan ²⁵	10	6.7	15.0
India ¹¹	1.5	1.0	100.0
Brazil ²⁶	1.9	1.3	78.9
China ²⁷	3.3	2.2	45.5
Global ²⁶	3.9	2.6	38.5

Table 2. Trends of GHG emission in India

Greenhouse gas sources and sinks (G g)	1990 ⁷ (CO ₂ eq. mt)	1994 ¹¹ (CO ₂ eq. mt)	2000* (CO ₂ eq. mt)
All energy	622,587	743,820	959,527
Industrial processes	24,510	102,710	168,378
Agriculture	325,188	344,485	328,080
Land use, land use change and forestry	1467	14,291	–
Waste management	14,133	23,233	28,637
Total emissions (Gg)	987,885	1,228,539	1,484,622
Population (million)	853	914	1000
Per capita emissions (tonnes/capita)	1.2	1.3	1.5

Preliminary estimates made by the authors.