State of the Environment

India

2001

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India : State of the Environment 2001

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Foreword

The Rio Earth Summit in 1992 formulated an action plan, Agenda 21, a multifaceted process to address the full range of development and environmental issues involving participation of governments, international organizations and major groups in the quest for sustainable development.

The publication of the Global Environmental Outlook series, GEO-1, followed by GEO-2000, the Millennium Report on the Environment, involved a participatory assessment process to review the state of the world's environment and to chart a new process for global environmental policy. The diversity and magnitude of environmental problems are outlined, with a call for more complete and precise analyses of the poorly understood linkages between human actions and environmental outcomes. Although the number of policy responses is growing, low priority continues to be afforded to the environment in national and regional planning. GEO-2000 stressed the need for the development of more comprehensive and long-term mechanisms for monitoring and assessing the effects of environmental policies on environmental quality; and for more integrated policy making and action-based programmes to serve the needs of the people.

The United Nations Environment Programme (UNEP) is mandated to produce a Global State of the Environment Report in 2002 (GEO-3) for the 2002 Earth Summit i.e., Rio + 10, and this global assessment will be enriched by producing State of Environment (SoE) reports at the national, subregional and regional levels. In 1998, the UNEP Regional Resource Centre for Asia-Pacific (UNEP RRC.AP) initiated a process on Strengthening National Capabilities on Environment Assessment and Monitoring towards the Preparation of the Global State of the Environment Report 2002, thus linking national to regional and global initiatives.

This National State of the Environment (SoE) Report of India is the one of several national reports from the above process. The Ministry of Environment and Forests (MoEF), Government of India, the national implementing agency in India, has played a very crucial role in carrying out this participatory assessment process in soliciting input from various government sectoral agencies. Around 25 agencies and 60 individuals were involved in the process. With the substantive support from the Tata Energy Research Institute (TERI), the designated national collaborating centre by the Ministry of Environment and Forests of the Government of India, and regular feedback from the South Asia Cooperative Environment Programme (SACEP), this assessment exercise has been successful and instrumental in providing significant input to the ongoing South Asia SoE preparation. It aims at providing guidelines for environmental action planning, policy setting and resource allocation for the coming decades, based on a sound analysis of the state of, and trends in, the nation's environment.

Five priority key issues for the state of environment report for India have been identified by the Government of India and analyzed following the "pressure-state-impact- response" (PSIR) analytical framework. The same process has been followed by the other countries, leading to the identification of their key environmental issues. These can then be addressed subsequently through action-based programmes in the next phase of the planning process.

The five key environmental issues identified for India are (1) land degradation, (2) biodiversity, (3) air pollution with special reference to vehicular pollution in cities, (4) management of fresh water resources, and (5) hazardous waste management with special reference to municipal solid waste management. Land degradation is taking place through natural and man-made process resulting to loss of invaluable nutrients and lower food grain production. Loss of biodiversity is of great concern since many plant and animal species are being threatened. Air pollution in cities is deteriorating due to vehicular growth and trends of air pollution related diseases are increasing. Availability of fresh water, which is going to be one of the critical problems in the coming decades, needs to be addressed on a priority basis. Generation of large quantity of hazardous waste from industries and also the hospital waste has been affecting the public health and environment.

This SoE assessment for India provides a sound basis for the development of action plans, the next stage of the planning process, as we enter the new millenium. The report aims to provide concrete guidance for action planning, policy setting and resource allocation for the coming decades to improve the state of the environment of India and the welfare of her people.

UNEP will continue to provide leadership in the region for the preparation of environmental assessment reports at national, subregional, and regional level and the capacity building necessary to support these assessment activities.

Klaus Töpfer
Under-Secretary General, United Nations and
Executive Director, United Nations Environment Programme
August 2001

Foreword from Government of India

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Executive summary

One of the mandates of the UNEP (United Nations Environment Programme) is to produce a global state of the environment report in 2002. As part of this larger initiative, the UNEP, Bangkok, has undertaken the SEAMCAP (strengthening environmental assessment and monitoring and capabilities for Asia and the Pacific) project to produce the state of the environment reports at the national, sub-regional, and regional levels. The objectives of the report are to increase the awareness and understanding of environmental trends and conditions, to provide a foundation for improved decision-making at all levels, and to facilitate the measurement of progress towards sustainability.

The state of the environment report prepared for India broadly covers the five priority issues pertaining to the environment, identified by the Government of India as per the UNEP guidelines. In addition, other issues addressing economic and social development are also included. The five priority issues are (1) land degradation, (2) biodiversity, (3) air pollution with special reference to vehicular pollution in cities, (4) management of fresh water resources, and (5) hazardous waste management with special reference to municipal solid waste management. The report on priority issues was prepared following the PSIR (pressure-state-impact-response) framework. The various issues are discussed in different chapters of the report.

Land degradation

Land degradation, which occurs through the natural and man-made processes of wind erosion, water erosion, and water-logging, has been identified as one of the priority concerns in India. The result of such a degradation is the loss of invaluable nutrients and lower food grain production. Poor land use practices and management are responsible for the rapid land degradation in India. Various strategies need to be developed by the Government of India including policy intervention, promoting research and stakeholder participation, and technological intervention to check land degradation. The strategies identified are as follows.

- A well-defined integrated land use policy should be developed. Rural fuelwood wood, grazing and fodder policies also need to be developed.
- A national land use commission should be instituted to lay down such policies, implementation strategies and monitoring guidelines.
- A correct assessment of the nature and extent of the existing degraded land needs to be carried out.
- The adoption of land use according to the land capability classes (USDA classification modified to suit Indian conditions) will ensure that land is put to appropriate use.
- A balanced use of organic manures, chemical fertilisers, bio-fertilisers, and other agrochemicals will ensure sustainability

and increased productivity. Hence, research is needed on (1) optimum level of SOM (soil organic matter), (2) the implications for nutrient balance on climate change and a doubling of CO_2, and (3) the relationship between biomass production, organic matter production, and long-term carbon storage.
- Clear property rights or tenure security should be developed with the help of local land users. Community participation is essential for any technology development so that experience or knowledge of local people can be utilized.

Biodiversity

Loss of biodiversity is of great concern to India since many plant and animal species are severely threatened by a destruction of their habitat and an over-exploitation of resources. A large number of species are either endangered or on the verge of extinction, both of which can be attributed to a lack of policy and institutional mechanisms including comprehensive policy guidelines for biodiversity conservation, biodiversity legislation, participation of communities, and a clear perspective on intellectual property rights leading to international patents on Indian biodiversity. Strategies and actions required to protect the India's rich bio-wealth are as follows.
- Most of the legal provisions focus on the use and exploitation of biological resources rather than their conservation. Even the Wild Life Protection Act 1972, focussed on protection and not conservation. Hence a greater thrust should be given to conservation.
- A comprehensive legislation on biodiversity conservation and uses should be promulgated.
- Formulation of policies for the protection of wetlands, grasslands, and sacred groves significant from the point of view of biodiversity.
- A biodiversity bill should be immediately passed but the Biodiversity Act / Bill should not override the provisions of Wildlife Protection act.
- The country needs to urgently finalise a comprehensive biodiversity strategy and action plan that will provide an overall assessment of the current state of India's biodiversity and concrete steps, mechanisms, and guidelines to develop institutional structures for its implementation.
- There should be a continuous monitoring of biodiversity use in order to review the results of the implementation of policies and programmes.
- There is a need to document biodiversity resources.

Air pollution with specific reference to vehicular pollution

Air pollution in India can broadly be attributed to rapid industrialisation, energy production, urbanisation, commercialisation, and an increase in the number of motorised vehicles. Vehicles are a major source of pollutants in cities and towns. Apart from the sheer numbers, other factors contributing to the increasing vehicular pollution in urban areas include the types of engines used, age of vehicles, density of traffic, road conditions, and the status of automotive technologies and traffic management systems. Some of the recommendations made to reduce air pollution are as follows:
- Vehicular pollution control in metropolitan cities and other cities deserves top priority. Strategies which need to be adopted include the promotion of public transport and mass rapid transport systems together with traffic planning and management. In addition, taxes on fuels and vehicles, stringent emission norms and fuel quality specifications, promotion of

cleaner fuels such as CNG, replacement of two-stroke engines, and a strengthening of the inspection and maintenance (I & M) system.

- Measures to be taken to control industrial air pollution including promotion of cleaner technologies, strengthening of emission standards, introducing economic incentives, and strengthening of the monitoring and reporting system. Emphasise should be given to waste minimisation and utilisation. Appropriate siting of industries will help to minimise the impacts of activities on ecosystems and human health.
- A comprehensive urban air quality management strategy should be formulated using information related to urban planning, ambient air quality, an emission inventory, and air quality dispersion models. Strengthening the monitoring network and institutional capabilities would facilitate an improvement in the enforcement mechanism.
- Use of cleaner fuels such as LPG in households would reduce indoor air pollution.
- Epidemiological studies should be undertaken to develop dose-response relationships, which will help in developing appropriate air quality standards.
- Economic instruments need to be put in place to encourage industries to adopt cleaner technologies and other conservation practices and to discourage the over-utilisation of natural resources.

Fresh water management

The availability of fresh water is going to be the most pressing problem in India over the coming decades. The stress on water resources is a result of multiple factors namely urban growth, increased industrial activities, intensive farming, and the overuse of fertilisers and other chemicals in agricultural production. Untreated water from urban settlements and industrial activities, and run-off from agricultural land carrying chemicals, are primarily responsible for the deterioration of water quality and the contamination of lakes, rivers, and groundwater aquifers.

The Government of India formulated the National Water Policy in 1987 to provide top priority to drinking water supply and undertook the National River Action Plan to clean up polluted river stretches. An action plan consisting of the following measures to increase the availability of fresh water in India, is needed.

- Emphasis should be given to adopting a river basin approach or sub-basin-based approach, which integrates all aspects of water management namely water allocation, pollution control, protection of water resources, and mobilisation of financial resources.
- Each state should prepare water policies. The National Water Policy of 1987 also needs to be revised urgently. Groundwater legislation needs to be promulgated in all states to promote sustainable water uses and development. Incentives under the Water Cess Act have to be made more attractive.
- Emphasis should be given to rainwater harvesting to increasing water resource availability. Watershed development must be adopted more rigorously. People's participation is the essential prerequisite for water shed development and to this end, public education and training to local people is to be provided.
- An appropriate tariff structure for water services will have to be evolved to encourage wise usage. There is also a need to develop and implement cost-effective water appliances such as low-flow cisterns and faucets.
- Technological intervention is required to enhance effective treatment of wastewater. Adoption of cleaner technologies by the industry would help to safeguard surface water bodies.

- Data on water supply and sanitation for both urban and rural areas need to be collected to formulate strategies and prioritise the action plan. Similarly, information on water consumption and effluent discharge patterns for industries would help to benchmark resource consumption and increase the productivity levels per unit of water consumed.
- The availability of utilisable water resources, demand levels and consumption patterns needs to be analysed for different basins. Such an analysis would help in developing a Water Zoning Atlas to guide decisions related to the siting of industries and other economic activities.

Hazardous waste management

There has been a significant increase in the quantities of municipal solid wastes and hazardous waste generated in India over the last few decades. The largest quantities of hazardous waste are generated by the following industries: petrochemicals, pharmaceuticals, pesticides, paints and dyes, petroleum, fertilisers, asbestos, caustic soda, inorganic chemicals, and general engineering. The rate of generation of solid waste in urban centres has outpaced population growth in recent years with the wastes normally disposed in low-lying areas of the city's outskirts.

The Government has promulgated various rules and guidelines on the management and handling of hazardous waste. These rules are implemented through the State Pollution Control Boards (SPCBs) and Pollution Control Committees in states and the union territories. The following strategies are recommended for improving the management of hazardous and solid waste.

- Ensure the scientific management of hazardous waste including its generation, segregation, transportation, treatment and disposal. The strategy should also target waste minimisation/reduction as its primary focus.
- More efforts towards quantifying and characterising the volume of waste generated by industries. Training and building the capacity of SPCB officials are required to prepare such an inventory of waste.
- Comprehensive environmental and social assessments of hazardous waste management operations are needed to minimise the impacts of waste on human health and the ecosystem.
- Develop an adequate infrastructure for the proper treatment and disposal of hazardous waste. Opportunities for setting up such facilities at the state level, addressing the willingness-to-pay issues by the participating industries, type of ownership, financial mechanisms to finance such ventures, and the extent of private sector participation need to be addressed to ensure that such facilities come into existence.
- Give urgent attention to reducing the generation of solid waste at source through mandatory standards and regulation, fee and tax incentives, and education and voluntary compliance.
- Develop technologies for waste collection, treatment, and disposal in order to ensure proper solid waste management. Community waste bins must be provided at convenient places to systematise the collection process. Private enterprises and NGOs should be actively involved in waste collection and its recycling.
- Governmental standards must be set up not only for disposal of waste on land but also for cleaning up contaminated soils and groundwater.

Part II

Overview

India has witnessed remarkable progress in human and economic development since it gained independence in 1947. In the overview section, issues pertaining to human and economic development are discussed. Population growth, employment, income, education, literacy, health and mortality, and population policy are included to address the human development. Economic development covers energy sector, industrial development, agricultural sector, and tourism. In addition, natural disasters and institutional mechanism and environmental policy of India are also included.

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1 Human development

Introduction

With a population of 1 billion people, India supports 16% of the world's population on 2.4% of its land. The density of population (persons per square kilometre) in India was 313. The corresponding density for arable land was as high as 559.

The National Population Policy, 2000, warns, "India's current annual increase in population of 15.5 million is large enough to neutralise efforts to conserve the resource endowment and environment" (DoFW 2000). While it may be a bit pessimistic to think that all efforts would be neutralised, there is little doubt that the huge population puts immense pressure on the country's resources. Increasing population has resulted in a decline of the per capita availability of land and fresh water. The annual per capita availability of renewable fresh water fell from 5277 cubic metres in 1955 to 2464 cubic metres in 1990 (Engelman and Roy 1993). The estimated per capita water availability in 1947 was 6008 cubic metres and in 1997 it shrunk to 2266 cubic metres (Pachauri and Sridharan 1998).

While technology has made India self-sufficient in food grains, it has come at the huge price of land degradation and a depleting water table. 90% of the increased demand for food comes from population increase and only 10% from an increase in income (Cassen 2000).

Population growth

Over the past five decades, India's population has grown nearly three-fold to one billion, from 361 million in 1951. Figure 1.1[1] shows the population growth curve. While the annual rate of growth of population over the fifty-year period, 1901-51 was only 0.83%, over 1951-71 it increased to 2.09, over 1971-91 to 2.17% and finally between 1991-96 it fell to 1.98%. The annual growth rate for 1996-2006 is expected to be 1.57% and over 2006-2016 it is expected to be 1.44%.

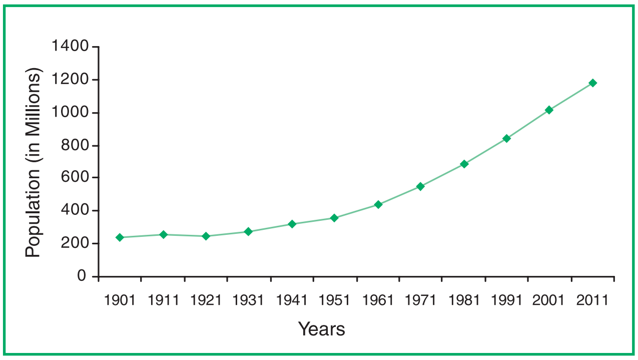

Figure 1.1 Population of India: 1901–2011
Source Census of India 1991

The decline in the growth rate, however, conceals a population momentum hidden in the age structure of the population of our country. Table 1.1 shows the age distribution for the year 1991. The percentage of persons in the reproductive age group, 15-49 years is about 50%. Thus, the population momentum

[1] As the 1981 census was not conducted in Assam, the 1981 population figures for India include interpolated figures for Assam; The 1991 census was not held in J and K. The 1991 population figures for India include projected figures for Jammu and Kashmir as per the Standing Committee of Experts on Population Projections (Oct. 1981); Figures for 2001 and 2011 are projections

is likely to continue for some years. In fact, an addition of 417 million persons is expected purely on account of this momentum between 1991 and 2016 even if there are substantial reductions in family sizes in several states (DoFW 2000, Srinivasan and Shariff 1997, and Registrar General of India 1991).

Table 1.1 Percentage age distribution of the population for 1991

	Percentage distribution		
Age group	*Males*	*Females*	*Total*
All ages	100.00	100.00	100.00
0-4	12.58	13.03	12.80
5-9	13.20	13.28	13.24
10-14	11.95	11.48	11.73
15-19	9.90	9.51	9.71
20-24	8.60	8.98	8.78
25-29	7.79	8.45	8.11
30-34	6.96	7.20	7.08
35-39	6.19	6.01	6.10
40-44	5.25	4.97	5.12
45-49	4.43	4.19	4.32
50-54	3.63	3.42	3.53
55-59	2.85	2.80	2.83
60-64	2.39	2.41	2.40
65-69	1.75	1.76	1.76
70-74	1.28	1.24	1.26
75-79	0.48	0.50	0.49
80+	0.77	0.75	0.76

Source Census of India 1991; Registrar General of India 1996

Poverty and human development

Employment and income

The average annual labour force growth rate over 1980-95 was 1.9% and over 1995-2010 it is expected to be 1.7%. While there has been an increase in the rate of growth of the labour force, the employment intensity of the growth process has shown a decline.

The average annual growth rate of employment[2] in both the organised and unorganised sectors declined continuously over 1972-78 and 1987-94 from 2.75% to 1.77% (MoF 2000). There has been an evident shift in the workforce from the agriculture or primary sector towards the manufacturing and tertiary sectors (Table 1.2).

Table 1.2 Changes in sector-wise workforce (distribution of male workers / 1000)

	Primary	*Secondary*	*Tertiary*
1977/78	806	88	105
1994/95	756	103	141

Source NSSO 1998

The unemployment rate in 1994-95 (NSS 51st round) by usual status was 1.2% for males 0.5% for females in rural areas and 3.7% for males and 4.1% for females in urban areas. The corresponding rates for 1987-88 were 6.1 % for males in urban areas, 2.8 % in the rural sector, and 8.5 and 3.5% for females in urban and rural areas, respectively.

In an agricultural economy like India, there is much underemployment, especially in the rural areas. There is a strong possibility of under utilisation of labour time or incidence of underemployment. This is because agriculture and related activities can absorb a large number of persons at very low productivity with marginal engagement (NSSO 1997).

The incidence of unemployment is higher among the educated, those with secondary and

[2] Employment rate is defined as the number of persons employed per thousand persons in the labour force. In this report employment is expressed as a percentage (i.e. per 100 persons). Labour force in turn is defined as the total of employed and unemployed. Workers or employed are "persons who are engaged in any economic activity or who despite their attachment to economic activity have abstained for reason of illness, injury, or other physical disability, bad weather, festivals, social or religious functions or other contingencies necessitating temporary absence from work. Unpaid helpers who assist in the operation of an economic activity in the household farm or non-farm activities are also considered as workers."

higher education levels because of limited labour market options for them.

Latest estimates of the incidence of poverty, expressed as a percentage of people below the poverty line, available from the NSS for 1993-94, show a decline in the proportion of people in poverty from 54.9% in 1973-74 to 36% in 1993-94. However, the number of poor remained at 320 million due to the rise in population (MoF 2000).

Education, literacy, and awareness

Apart from income, another important factor in human development is education. The Indian system of elementary education is the second largest in the world with 151 million children in the age group 6-14 years enrolled, covering 91% of the children in that group. Despite this, only 52% of Indians, seven years or older, are literate.

Table 1.3 India's human development performance vis-a-vis some other countries

Country	*Life expectancy at birth*	*Adult literacy rate*	*Gross enrolment ratio*	*GDP per capita (PPP$)*	*HDI*	*HDI rank*
India	62.9	55.7	54	2077	0.563	128
China	70.1	82.8	72	3105	0.706	99
Brazil	67.0	84.5	84	6625	0.747	74
Sri Lanka	73.3	91.1	66	2979	0.733	84
Vietnam	67.8	92.9	63	1689	0.671	109

Source UNDP 1999

Note The Human Development Index includes three indicators (essential but not exhaustive):
- life expectancy at birth - to measure health status and longevity
- educational attainment - to represent the level of knowledge and skills
- an appropriately adjusted real GDP per capita (in purchasing power parity dollars) - to serve as a surrogate for command over resources (UN 1997)

Over 70% of India's population is rural and in 1993-94, more than half the rural population was below the poverty line, measured by the head count ratios for five states: Bihar, Orissa, Assam, West Bengal, and Maharashtra (Chelliah and Sudarshan 1999).

Income is only one aspect of development. Other factors such as education and health have a distinct influence in promoting or constraining people's ability to make use of economic opportunities. Ranked 128th in terms of human development, India is far behind other developing countries including Vietnam, Brazil and Sri Lanka (Tables 1.3 and 1.4).

Table 1.4 Selected human development indicators: India and all developing countries

	India	*All developing countries (1994)*
Infant mortality rate (per thousand live births)	78 (1992)	64.0
Life expectancy at birth (years)	59.3 (1989-93)	61.8
Adult literacy rate (percent)	48.7 (1991)	69.7

Source Srinivasan and Shariff 1997, UNDP 1999

The problem of low average literacy is exacerbated by huge inequalities between men and women, between different states and between urban and rural areas. Only 40% of women are literate compared to 67% of men.

While the urban literacy rate is over 73%, it is 33% in the villages. Literacy rates also vary from state to state - from over 90% in Kerala to 21% in Rajasthan. Literacy aggregates also conceal distressing micro level information. For instance female literacy is only 8% in the district of Barmer (Rajasthan), 10% in Kishanganj (Bihar) and 11% in Bahraich (Uttar Pradesh). These figures are close to what is seen in sub-Saharan Africa (Burkina Faso, Sierra Leone, and Benin) (Dreze J 1995).

Equally disconcerting is the fact that in Indian villages, over half the girls and a quarter of the boys in the age group of 12-14 years never enrolled for education (Dreze J and Sen A 1996). The figures in urban areas are better: 19% for girls and 11% for boys.

Given that about 60 million children were never enrolled in schools, there is no doubt that the Indian educational system has performed quite dismally. Estimates suggest that more than 70 000 primary schools (14%) and 17 000 upper primary schools (4%) were run in open spaces, in tents or in thatched huts. Another 14% of the primary schools and 8% of the upper primary schools were run in *kutcha* buildings. At the time of the 6th All India Educational Survey conducted in 1993, 20% of all primary schools were single-teacher schools and about 0.77% did not have any teacher at all. The problem of no teachers or a single teacher is severe in rural areas (NCERT 1999). The quality of education and infrastructure is found to be an important reason for students dropping out.

Only two-thirds of the children who enrol in grade I, reach grade V; about half reach grade VIII; and just a third reach grade X (Ministry of Human Resource Development data - cited in Tilak 1996). Over a quarter of the primary schools are single-teacher schools.

Table 1.5 Education and literacy: indicators for selected Indian states (1992)

State	*Literacy rate (%)*	*Infant mortality rate (per thousand)*	*Total fertility rate*
Uttar Pradesh	33.2	71	5.2
Bihar	30.6	98	4.5
Kerala	78	15	1.7

Research indicates that education has a negative association with fertility. Table 1.5 which has figures for selected Indian states demonstrates this.

Health and mortality

Apart from education, "one of the most important factors in fertility decline is mortality itself. It is not babies that parents want, so the argument runs, but surviving offspring". This fact too, is demonstrated in Table 1.5 above.

Infant mortality and child mortality rates (IMR and CMR) have a high negative correlation with fertility. Parents are interested in a certain number of surviving children and with a high IMR or CMR, parents are unlikely to adopt family planning. In general, it is the poor who have high IMR and CMR because of improper access to basic health services, among the poor too, it is those who live in rural areas, who are more susceptible.

In India, 2.2 million infants die every year and most of these deaths are avoidable. The country's average infant mortality rate is 80 per 1000 live births. Also 53% of children under age four - 60 million - are undernourished / underweight.

There is only one primary health centre for every 30 000 people and 15% of India's population does not have any access to health services. Poor health conditions leading to morbidity and under-nourishment can be serious barriers to productive work and economic performance.

Policy

That the Government of India seeks to address concerns about the level of human development in the country can be gauged by the increase in percentage expenditure on the social sector – education, health and family welfare, water supply, sanitation, housing, rural development, social welfare, nutrition, and minimum basic services.

The central governments Plan and Non-plan expenditure on these social sectors as a fraction of total expenditure rose from 9.4% in 1993-94 to 11.4% in 1999-2000. As a fraction of GDP at current market prices the expenditure increased from 1.5% in 1993-94 to 1.7% in 1999-2000. The Central Plan outlay on major schemes of social sectors as a percentage of the GDP at current market prices increased from 1.09% in 1993-94 to 1.12% in 1999-2000. The Central outlay increased by 29.6% in family welfare in 1999-2000 over that in 1998-99, in health by 24.3 %, welfare of weaker sections by 22.1% and women and child development by 16.4% (MoF 2000).

The anti-poverty programmes designed for the generation of self-employment and wage employment in rural areas have been redesigned and restructured to improve their efficacy. The Integrated Rural Development Programme and allied programmes such as Training of Rural Youth for Self-Employment (TRYSEM), Development of Women and Children in Rural Areas and Million Wells Scheme were restructured into a single self-employment programme called the Swarnajayanti Gram Swarozgar Yojana from April 1999. This restructuring was done with the objective of promoting a focussed approach to poverty alleviation, capitalising advantages of group lending, and overcoming the problems associated with multiple programmes.

Among the wage employment programmes, the Jawahar Rozgar Yojana has been restructured and is now called (from April 1999) the Jawahar Gram Samridhi Yojana. The primary objective is to create a demand-driven village infrastructure including durable assets at the village level enabling the rural poor to increase the opportunities for sustained employment.

Population policy

Towards addressing specific concerns relating to population growth and its linkages with human development, the government laid down the National Population Policy, 2000. While the long -term objective of this policy is population stabilisation, the immediate objective is to fulfill the unmet contraceptive needs of the people and in the medium term to bring the total fertility rate to the replacement level. To achieve these objectives, the Government of India has set up national socio-demographic goals, which include compulsory and free education up to 14 years of age, reducing the IMR and the maternal mortality ratio, and controlling infectious diseases. The implementation of the programme involves an emphasis on decentralisation, where the Panchayat has a significant role. The policy document has also emphasised the delivery of integrated essential services at the village and household level (DoFW 2000).

The population policy has clearly, come a long way from the 1970s when it was target-oriented and did not even integrate population and health policies. The paradigm shift in the policy occurred in the 1990s and the emphasis on delivery of essential services is, in fact, moving beyond mere family planning.

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2 An overview of the energy sector

Introduction

The energy sector plays a pivotal role in the overall development of the economy. Planning for the energy sector has therefore held considerable importance since the inception of the economic planning process in 1951. This is reflected in the rising share of planned outlays for the sector which has increased from 19.7% of the total expenditure in the First Five-Year Plan (1951-56) to about 27% in the Eighth (1992-97). Coal, oil, gas and hydro constitute the main sources of energy sources in the country. The share of various energy sources in the commercial consumption of energy is shown in Figure 2.1, below. Apart from commercial energy, a large amount of traditional energy sources in the form of fuelwood, agricultural waste and animal residue are used in the country. Traditional energy sources account for nearly 40% of the total energy consumption in the country.

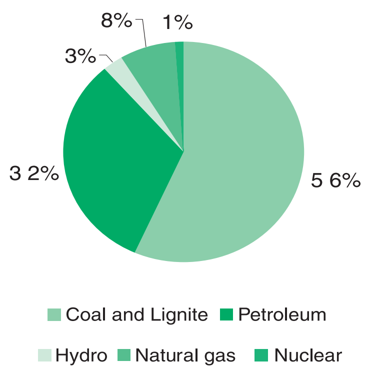

Figure 2.1 Share of energy sources in commercial energy consumption (1997/98)
Source CMIE 2000

Final commercial energy consumption has grown from 130.7 MTOE (million tonnes of oil equivalent) in 1991/92 to 176.08 MTOE in 1997/98 and the per capita energy consumption has grown from 152.7 TOE to 184.7 TOE in the same period. The main drivers of this increase are the accompanying structural changes of economic growth and a rise in population together with rapid urbanisation. However, the per capita commercial energy consumption in India is still low when compared to other countries, being less than 4% that of a developed country such as the USA. Inspite of a relatively low energy consumption, the country is grappling with issues of energy security, growing imports and sustainability of balance of payments. India continues to be a net importer of energy—almost 22% of the total energy supply in 1997/98 was through imports in the form of coking coal, crude oil, and petroleum products. Self-sufficiency in petroleum products has declined from 60% in 1985/86 to 34% during 1997/98.

The energy policy of the government aims to ensure adequate energy supplies at minimum possible costs, achieving self-sufficiency in energy supplies and protecting the environment from adverse impact due to utilisation of energy resources. The liberalised policies of the government have paved the way for the entry of private investors, including foreign owned companies in upstream and downstream energy sectors. Government subsidies to energy consumption remain substantial being inextricably related to issues of budget deficits, energy demand, and associated environmental hazards. The evolution of the government's energy policy is presented in Table 2.4.

In what follows, an overview of the energy sector is presented and broad trends in the production and consumption of energy are outlined[1].

Energy reserves

Table 2.1 shows the reserves position of the major fuels. The country is relatively well endowed with both renewable and exhaustible energy sources. Coal, oil and natural gas are the primary commercial sources of energy. Coal is the major exhaustible energy resource in the country with an R/P ratio of over 200 years. Although reserves are substantial, Indian coal is primarily non-coking coal of a poor quality with a high ash content (40%–50%) and low calorific value (1300-4200 kcal/kg). India also has substantial reserves of nuclear fuels—the world's largest deposits of thorium, about 363 thousand tonnes, and about 34 thousand tonnes of the uranium ore, (though only 44% of it is economically exploitable). Renewable sources are also expected to play an important role in solving the energy problems in decentralised locations and in some remote inaccessible areas where the extension of the grid system may be uneconomical.

Production

Coal

India ranks third amongst the coal producing countries of the world. Coal production has grown significantly from 100 MT (million tonnes) in 1975/76 to 306 MT in 1998/99 (Table 2.2). Only about 15% of the coal produced domestically has coking properties and is used in the iron and steel industry. The bulk of the coal produced is inferior grade non-coking coal used to meet the demands of the power sector (Photo 2.1).

Table 2.1 Proven reserves of fossil fuels and reserve-production ratios

	End 1991				*End 1998*			
	Reserves		*R/P*		*Reserves*		*R/P*	
Fuel	*India*	*World*	*India*	*World*	*India*	*World*	*India*	*World*
Coal (billion tonnes)	62.54	1040.52	195.00	239.00	74.73	984.21	233	218
Crude Oil (billion tonnes)	0.80	135.40	25.60	43.40	0.5	143.4	14.5	41.0
Natural Gas (trillion cubic metres)	0.70	124.00	48.80	58.70	0.54	146.39	22.9	63.4

Sources BPC 1999; TERI 1999

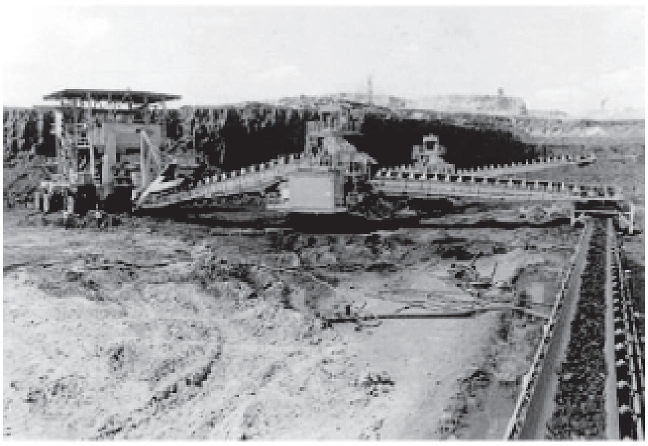

Photo 2.1 Coal production from mines

[1] Unless otherwise stated, data used for this chapter have been drawn from TERI 1999

Table 2.2 Production trends in coal, oil, gas, and petroleum products

	Production				*Net imports*
1975/76	*1985/86*	*1995/96*	*1998/99*	*1998/99*	
Coal (million tonnes)*	99.7	154.3	273.4	296.5	14.8
Crude Oil (million tonnes)	8.4	30.2	35.1	32.7	39.8
Petroleum Products (million tonnes)	20.8	39.8	55.1	64.5	17.4
Natural Gas (billion cubic metres)	2.4	8.1	22.6	27.4	-

Sources *CMIE 2000; Indian Petroleum and Natural Gas Statistics, (various years), Ministry of Petroleum and Natural Gas, Government of India

Oil and Natural Gas

India is one of the least explored regions with a well density of 20 per 10,000 sq km as against a world average of 100. Of the 26 sedimentary basins, only 6 have been explored so far, accounting for 30% of the country's prognosticated reserves. Table 2.2 shows the trends in the production of crude oil, natural gas and petroleum products. Inspite of a significant growth, domestic production has not matched demand, leading to a constant growth in net imports, which were estimated at 39.81 MT of crude oil and 17.4 MT of petroleum products in 1998-99. Major products imported in 1998/99 were high speed diesel oil (10.5 MT), kerosene (5.8 MT) and liquefied petroleum gas (1.5 MT). The country's self-reliance in petroleum products has declined from 56% in 1990-91 to about 34% in 1998-99 (MoPNG 2000) (Photo 2.2).

Photo 2.2 Oil and natural gas production

Power

The generating capacity in India comprises a mix of hydro, coal-based thermal, oil-fired thermal, gas and nuclear. Lately non-conventional energy sources particularly wind energy, have also become important. In 1996/97, about 396 TWh of electricity was generated in the country (in 1998/99, power generation by utilities stood at 448 TWh). Figure 2.2 shows, about 72% of power generation is thermal-based, using predominantly coal (Photo 2.3). While the share of gas-based thermal has also gone up, that of nuclear has declined, in spite of a high degree of self-reliance in nuclear technology. Financial constraints as also long term waste management and eventual decommissioning of plants remain issues of concern in this sector. The share of hydro in

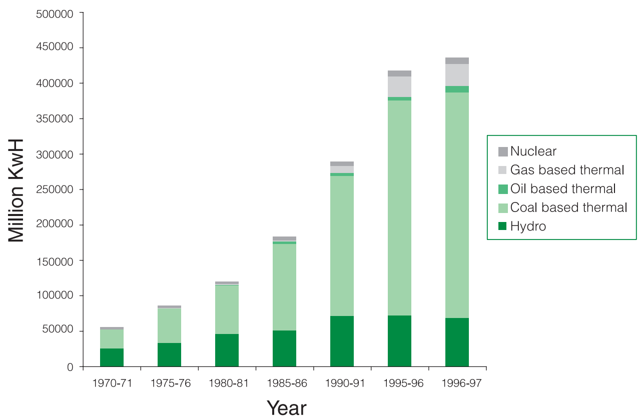

Figure 2.2 Gross generation (utilities and non-utilities)
Source TERI 1999

Photo 2.3 Thermal power generation

the hydro-thermal capacity mix has changed significantly since the early 70s – it was 43% in 1970-71, which has now come down to about 24% (Photo 2.4). Despite a substantial increase in electricity generation, energy shortages affect all sectors of the Indian economy. In 1997/98, the country faced a shortfall of 11.3% in peak and 8.1% in meeting energy requirements (Planning Commission, GoI 1999). The extent of transmission and distribution losses—consistently over 20% of gross generation—remains an issue of serious concern. The prime reasons for high non-technical losses include pilferage of electricity, and faulty meters.

Photo 2.4 Hydro power generation

Renewable energy

The potential of renewable energy in the country is estimated at 100 000 MW. There has been a steady increase in power generation based on renewable sources and as of December 1999, 1600 MW, representing a little over 1.5% of the total grid capacity was based on renewable sources. Solar, wind biomass, and small hydro are the main sources of renewable energy used for power generation (Photo 2.5 and 2.6).

Photo 2.5 Solar power generation

Photo 2.6 Wind power generation

Biomass includes large quantities of cattle dung and human excreta, agricultural residues, bagasse and other by-products of agro-based industries such as paper mills, etc. Of the 1600 MW of installed generating capacity contributed by renewable sources so far, energy from waste accounts for 0.9%, solar photovoltaic 2.6%, small hydro 13.1%, biomass 16%, and wind power 67.4%. India has the fifth largest wind power capacity in the world.

Apart from supplementing power generation from conventional fossil fuels and providing electricity to rural and remote areas, substantial progress has also been achieved in providing energy for a variety of applications in villages such as pumping water for irrigation, drying farm produce and providing improved cook-stoves and biogas plants, which would reduce the drudgery of rural women and minimise the health hazards they would otherwise face (Photo 2.7).

Photo 2.7 Biogas plant

Consumption

Figure 2.3 shows the sectoral shares of final commercial energy consumption in the country in 1996/97. The industrial sector is the largest consumer of commercial energy, while the transport sector is the main consumer of petroleum products. Commercial energy consumption in the agricultural and residential sectors, too, has increased significantly over time though the latter continues to depend heavily on traditional fuels. The sectoral details are examined below.

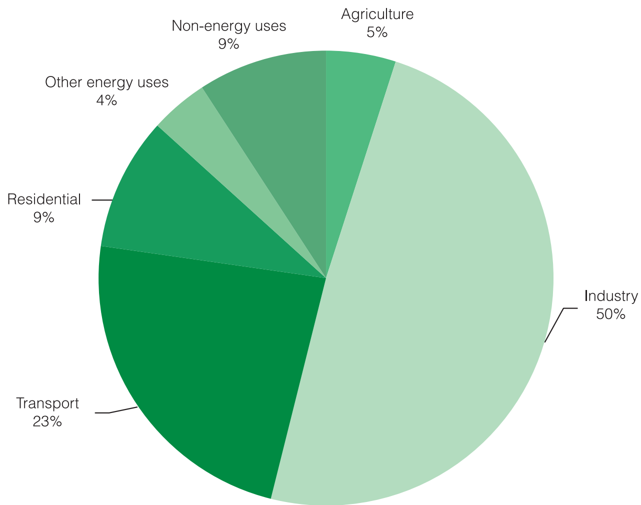

Figure 2.3 Sectoral shares of final commercial energy consumption-1996/97
Source TERI 1999

Industrial sector

The sector is the largest consumer of energy consuming about 50% of the total commercial energy produced in the country (Figure 2.3), followed by the transport sector.

Of the commercial sources of energy used in the industrial sector, coal and lignite contribute about 57%, oil and gas around 33%, hydroelectric power 3%, and nuclear power 0.2%. The sector is the largest consumer of electricity in the country. During 1996/97, it consumed 104 billion kWh from the utilities and 34 billion from its captive plants (CMIE 2000). Among the most energy intensive industries which together account for nearly 80% of the total industrial energy consumption are the fertiliser, aluminium, textile, cement, iron and steel, pulp and paper and chlor-alkali.

Transport sector

This sector is the largest consumer of petroleum products – mainly in the form of high-speed diesel (HSD) and gasoline and accounts for nearly 50% of the total consumption. Consumption of HSD in the sector, increased from about 9 million tonnes in 1980/81 to 30 million tonnes in 1996/97 (CMIE 2000). Commercial energy consumption in this sector grew at the rate of 3.1% annually between 1970/71 and 1980/81 and at much faster rates of 4.9% a year between 1980/81 and 1990/91 and 5.6% a year during 1990/91 and 1997/98.

The higher rates of growth in energy consumption in the latter period are primarily due to increases in the share of road transport vis-à-vis rail for both passenger and freight movements and a phenomenal increase in the number of personalised vis-à-vis public vehicles. This has severe implications for health and the environment in urban areas.

Agricultural sector

With increased mechanisation and modernisation of agricultural activities, the sector's consumption of commercial energy has grown significantly. The relative share of electricity and diesel power as against human and animal labour has increased significantly from 5.37% in 1950-51 to almost 50% of the total farm power consumed for irrigation in 1995-96. Consequently, the share of the farm sector in electrical energy consumption has increased from a mere 3.9% in 1950-51 to about 32.5% in 1996/97. In absolute terms, electricity consumption by agriculture has grown from 8.7 billion kWh in 1975/76 to 23.4 billion kWh in 85/86 further to 84 billion kWh in 1996/97.

Domestic sector

The domestic sector accounts for 40% to 50% of the total energy consumption in the country. The consumption of biomass energy is very high around 78% of rural and 30% of urban households depend on firewood and wood-chips. However the mix of traditional fuels in the national energy mix is decreasing as more efficient commercial fuels are increasingly substituting these. In particular, between 1970/71 and 1994/95, the annual consumption of electricity per household went up from 7kWh to 53kWh; of kerosene from 6.6 kg to 9.9 kg and of cooking gas from 0.33 kg to 3.8 kg. There is however a marked disparity in the level of energy and type of fuel consumed in rural and urban areas (Table 2.3).

Table 2.3 Monthly per capita consumption of selected fuels in rural and urban areas

	Rural		*Urban*	
All India	*1987/88*	*1993/94*	*1987/88*	*1993/94*
Firewood and chips (kg)	16.24	17.27	7.40	6.09
Electricity (kWh)	1.30	2.27	7.18	9.67
Kerosene (litre)	0.57	0.68	1.29	1.42
LPG (kg)	0.01	0.04	0.39	0.88

Source NSSO 1997

Environmental concerns

The environmental effects of the use of various fuels are of growing concern owing to increasing consumption levels. Pollutants associated with the combustion of fossil fuels SPM, SO_2, NO_x, and CO either in transformation activities (to oil products or power and heat combustion) or in end uses pose a major threat to environmental quality and human health. A TERI study (Pachauri and Sridharan 1998), noted that in the majority of Indian cities, WHO air quality standards with respect to SPM are violated. The problem is compounded due to the poor quality of Indian coal, the predominant source of energy in the country[2]. In addition to emissions, land requirements for the disposal of fly ash generated in thermal power plants is a major concern. Electric power generation is also the largest source of greenhouse gases and accounts for 48% of carbon emitted (MNES 2000).

The nuclear option comes with its own set of problems. Uncertainties surrounding the safety and economics of radioactive waste disposal and decommissioning remain. The recent mishap at Tokaimura, Japan (30 September 1999) shows that the danger of a nuclear accident is still very real.

Large hydro projects in turn, may entail severe and often irreparable social and environmental costs including the dislocation of people, submergence of valuable resources including forests and wildlife habitats, destruction of estuaries and adverse impacts on downstream hydrology.

The final use of energy also imposes severe environmental costs. Industrial and vehicular emissions have assumed serious proportions in urban areas. Petrol-driven vehicles are the major source of CO emissions contributing over 85% of them, while diesel-driven vehicles are the major source of NO_x, contributing over 90% an injudicious use of energy in the agricultural sector has resulted in the depletion of groundwater in several parts of the country. Indoor air pollution due to the domestic consumption of both traditional and commercial fuels is significant. In fact, the total human exposure to many important pollutants may be much more substantial in the homes of the poor in developing countries such as India than in the outdoor air of cities in the developed world, due to high concentrations and the large population involved.

Energy consumption will increase several fold in the future. In order that future growth is sustainable, it needs to be resource-efficient and environmentally accountable. The challenge is to thus use conventional energy resources with the least cost to the environment while at the same time, tapping renewable energy resources, which are environmentally sustainable.

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[2] In view of the threatening level of emissions from thermal power plants, the Ministry of Environment and Forests has mandated the use of maximum 34% ash content coal in all power plants located beyond 1000 km from coal fields and to locations in critically polluted and sensitive urban areas with effect from June 2001.

Annexure I

Table 2.4 Evolution of energy policy and planning

Five year plans	*Focus*
1951-56	Priority to agricultural development, including irrigation and power.
1957-61	Long-term investment plans for sectors like power and transport.
1962-66	Comprehensive review of extent and quality of the information available with respect to the country's natural resources. A unit for natural resources was set up under the Planning Commission to study problems related to assessment and development of natural resources. Broad study of trends in energy demand and supply in the country was undertaken in 1963-65 by the Energy Survey of India Committee.
1974-79	Time bound programme of action in order to achieve self-reliance in food and energy. Fuel Policy Committee was set up in 1974 to explore availability of indigenous fuel resources, especially oil and gas, to overcome steep price rise in 1973. Working Group on Energy Policy was set up in 1979 to suggest long-term views and action plans to optimise energy use. The Group suggested R & D in various sectors to solve problems of energy sector relating to availability and efficient use.
1980-85	For the first time a comprehensive and integrated energy strategy for the country was envisaged. The plan recommended – accelerated exploitation of domestic energy resources, management of oil demand, energy conservation, exploitation of renewable sources of energy and R&D in emerging energy technologies. Inter-ministerial working group and advisory board on energy was constituted to formulate subsidy and cross subsidy for different fuels and biomass based technologies.
1986-91	Major objective of this plan was to increase use of indigenous coal and increase the share of electricity in rail transport in order to reduce dependence on oil. The plan also stressed on the need to develop and accelerate utilisation of renewable energy sources wherever these were feasible. The stress was also on design and implementation of area based rural energy programmes. The seventh plan for the first time addressed environmental degradation resulting from deforestation. Energy sector reforms initiated in 1991 vide Industrial Policy Resolution to promote private sector participation in energy sector programmes.
1992-97	Reducing energy intensity in different sectors through changes in technology and processes, optimisation of inter- and intra-fuel substitution, maximising use of renewable sources of energy at affordable cost to low income groups in rural and urban areas, better demand management and development of hydel power. Minimise adverse environmental impacts associated with coal mining and associated processes. Better environmental monitoring of coal mining area and development of environmental preservation schemes.
1997-2002	Rationalising the tariff structure for energy products. Dismantling administrative pricing mechanism (ADM). Improving energy efficiency according to socio-economic and environmental priorities. Promoting renewable and environmentally sound energy systems. Promoting energy efficiency and emission standards to reduce adverse environmental impacts.

Source Unpublished TERI Report

3 Industry

Introduction

The Government of India has given major thrusts to industrial development for rapid economic growth since it gained independence in 1947. India is one of the ten most industrialised nations of the world. The industrial policy resolution of 1956 entrusted the public sector with a major role in India's economic development. Targets were fixed for industrial investments in Five Year Plans which were the backbone of India's planned development. The contribution of industry to the GDP has increased from 22% in 1970-71 to 30% in 1996-97. The economic reforms initiated by the Government of India in 1991 have led to a critical phase of transition and restructuring of the Indian industry. The New Industrial Policy (NIP) was introduced in 1991 with an emphasis on deregulation. The basic objectives of the NIP were to promote growth, to increase efficiency and to enhance international competitiveness. Salient features of the NIP are given below.

- Substantial reduction in the scope of industrial licensing
- Simplification of procedures, rules, and regulations
- Reforms in the MRTP (Monopolies and Restrictive Trade Practices) Act
- Reduction of areas reserved exclusively for the public sector
- Disinvestment of selected public sector enterprises
- Enhancing limits for foreign equity participation in domestic industrial undertakings
- Liberalisation of trade and exchange rate policies
- Rationalisation and reduction of customs and excise duties; and
- Extension of the scope of MODVAT (modified value-added tax), etc.

Industrial growth

The general IIP (index of industrial production) recorded a growth rate of 6.6% in 1997/98 (at 1993/94 prices), aided by a growth rate of 5.9% in mining and quarrying, 6.6% in manufacturing, and 6.6% in electricity generation. However, the modest growth rate of 6.6% is much lower than the 12.8% growth achieved in 1995/96. The yearly growth rates for the mining, manufacturing, and electricity

Table 3.1 Annual growth rates in major sectors of industry **(in percent)**

Period	*Mining*	*Manufacturing*	*Electricity*	*General*
(Base: 1981-82 = 100)				
Weights	11.46	77.11	11.43	100
1985-96	4.1	9.7	8.5	8.7
1986-87	6.2	9.3	10.3	9.1
1987-88	3.8	7.9	7.7	7.3
1988-89	7.9	8.7	9.5	8.7
1989-90	6.3	8.6	10.8	8.6
1990-91	4.5	9	7.8	8.2
1991-92	0.6	-0.8	8.5	0.6
1992-93	0.5	2.2	5	2.3
1993-94	3.5	6.1	7.4	6
(Base: 1993-94 = 100)				
Weights	10.47	79.36	10.17	100
1994-95	7.6	8.5	8.5	8.4
1995-96	9.6	13.8	8.1	12.8
1996-97	-2	6.7	4	5.6
1997-98	5.9	6.7	6.6	6.6
1998-99	-1.7	4.3	6.5	4

Photo 3.1 Mining industry

sectors since 1985 is given in Table 3.1 (Photos 3.1 and 3.2).

Figure 3.1 shows the growth rate over different years. Table 3.2 gives the annual production figures for some industries from 1950-51 to 1998-99, and it shows the significant increase total production of all the sectors. The Indian industry is currently going through a difficult phase (MoF 1999). Industrial growth, which was at a peak of 12.8% in 1995-96, decelerated to 5.6% in 1996-97 and further declined to 4% in 1998-99. The de-

Photo 3.2 Ramagundam super thermal power project
Source Ministry of Power, Annual report 1999-2000

Table 3.2 Progress of industrial production (selected industries)

Industry type	*50-51*	*60-61*	*70-71*	*80-81*	*90-91*	*97-98*	*98-99**
Coal (incl. Lignite) (million tonnes)	32.3	55.2	76.3	119.0	225.5	319.0	315.7
Hot metal (incl. Pig iron) (million tonnes)	1.7	4.3	7.0	9.6	12.2	19.2	18.2
Finished steel (million tonnes) (incl. secondary producers)	1.0	2.4	4.6	6.8	13.5	23.4	23.8
Aluminium (thousand tonnes)	4.0	18.5	168.8	199.0	451.1	550.0	536.8
Blister copper (thousand tonnes)	7.1	9.0	9.3	25.3	40.6	43.7	37.7
Nitrogenous fertiliser-N (thousand tonnes)	9	99	830	2164	6993	10538	10675
Phosphatic fertiliser-P^2O^2 (thousand tonnes)	9	54	229	842	2052	3191	3222
Caustic soda (thousand tonnes)	12	99	371	578	992	1445	1429
Paper & paper board (thousand tonnes)	116	349	755	1149	2088	2922	3117
Cement (million tonnes)	2.7	8.0	14.3	18.6	48.8	82.1	88.0
Petroleum refinery products (million tonnes)	0.2	5.7	17.1	24.1	48.0	60.7	63.7

* Provisional
Source MoF 2000

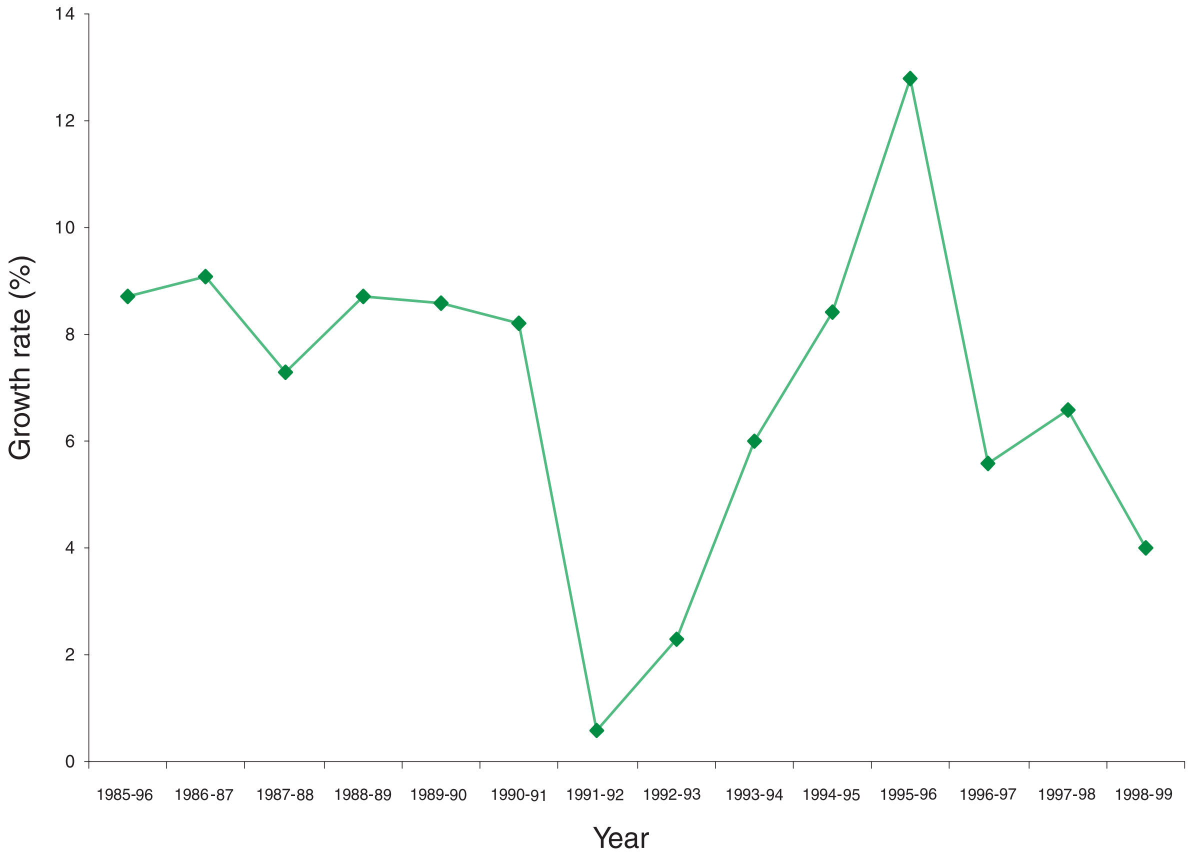

Figure 3.1 Annual industrial growth rate
Source MoF 1997-98, 1999-2000

mining and manufacturing sectors. Small-scale industries play an important role in the growth of the economy in India (Photos 3.3 and 3.4).

The total number of small-scale units in the country in 1998-99 was 31.21 lakh, compared to 20.82 lakh in 1991-92. The volume of employment has gone up from 129.80 lakh in 91-92 to 171.58 lakh in 1998-99. The output from small-scale industries (at current price) has gone up from 178 699 crore in 1991-92 to 527 515 crore in 1998-99.

Environmental concerns

In the process of rapid industrial development, a huge amount of residuals has been generated, which have an undesirable impact on air, water and the land environment. Table 3.3 presents the contribution of industries to pollution by subsector. For instance, the iron and steel

Photo 3.3 Brick industry

Photo 3.4 Glass industry

and steel contribute about 70% of the toxic release (e.g. heavy metals, cyanides and pesticides) but produce only about 20% of the industrial output.

Some of the highly air polluting industries as per the Central Pollution Board (CPCB) are integrated iron and steel,thermal power plants, copper/zinc/aluminum smelters, cement, oil refineries, petrochemicals, pesticides, and fertilisers. Many small-scale industries are also highly polluting to air and water and are located within or in close proximity to cities and towns. Major hazardous waste generating industries include petro-

Table 3.3 Industrial contribution (%) to pollution by subsector

Sector	*Share of industrial output*	*Share of total industrial pollution (%)*				
		Toxic	*BOD*	*Particulate*	*Sulphur*	*Nitrogen*
Iron and steel	12.5	23	0	23	2	5
Industrial chemicals	7.5	44	29	8	11	15
Non-ferrous metals	2.1	6	10	3	1	0
Other chemicals	6.8	6	1	1	0	1
Food products	15.3	1	38	11	4	8
Paper and pulp	2.0	2	19	4	15	11
Non metallic mineral products	3.4	1	0	32	3	10
Petroleum refineries	6.8	6	2	6	31	21
Textiles	11.1	3	1	6	30	23
Total	67.5	92	100	94	97	94

Source World Bank 1996

cline in industrial growth rate can be attributed to the poor performance of the industry and non-metallic mineral products contribute 16% of the total industrial output, but share 55% of the particulate matter load. Similarly, food products share 15% of the total industrial output, but 38% of the total industrial BOD. Industrial chemicals, food products and paper and pulp together account for about 25% of the industrial output but are responsible for as much as 86% of the water pollution loads. Industrial chemicals and iron

chemicals, pharmaceuticals, pesticides, dyes, fertilisers, paints, petroleum, asbestos, tanneries and chlor-alkali.

Indian industries are undergoing through rapid changes including process changes, technological upgradation, organisational restructuring, business reengineering and globalisation. Industries need to play a proactive role in bringing about these changes so as to ensure an environmentally sound development, which has positive impacts on the environment and the society.

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4 Agriculture

Introduction

Agriculture is the largest sector of economic activity in India. According to the 1991 census, 68% of the workforce was employed in this sector. Due to its importance, the Ninth Five Year Plan (1997–2002) has accorded top priority to agriculture and rural development with a view to generating adequate productive employment and eradicating poverty (Photo 4.1). Although the share of the agricultural sector to the gross domestic product (GDP) decreased from 50% in 1950/51 to 27.6% in 1996/97 (at 1980/81 prices), yet agricultural production increased by about 3.9% a year during the Eighth Plan, with the food grain output growing at 3% a year (CSO 1998).

The total food grain production in India increased from 51 MT (million tonnes) in 1950/51 to 191 MT in 1994/95, dropped to 180 MT in 1995/96, but increased to 203MT in 1998/99. However, the food grain output fell by 7 MT in 1997/98, but recovered marginally to 203 MT in 1998/99. According to the Executive Summary to the Ninth Five-year Plan, the food grain production is projected to increase from 199 MT in 1996/97 to 304 MT in 2011/12, whereas consumption is likely to increase from 195 MT in 1996/97 to 298 MT in 2011/12. The growth rate of yield is expected to be 2.9% a year over the entire Ninth Plan perspective period. According to the Ministry of Agriculture, GoI, agricultural production during 1996/97 registered a growth of about 6%, mainly due to a steep increase in the production of wheat (10%), coarse cereals (16%), pulses (10%), oilseeds (12%), and cotton (9%) (Photo 4.2).

Rice, wheat, and coarse food grains such as maize, bajra, and jowar are the major Indian crops occupying more than 90% of the area under food grains and 82% of the net sown area. The share of rice and wheat in total

Photo 4.1 Agricultural land

Photo 4.2 Food grain production in India
Source Annual report 1998-99, Ministry of Agriculture

food grain production increased from 53% in 1950 to 76% in 1994. Rice forms 43% of the total food grain production in India and is cultivated in 43 mha, which is about 30% of the net sown area. The demand for rice is expected to increase to 95–100 MT in the next five years and to 120–125 MT a decade after. This demand can be met if the productivity of crops increases from the present level of 1.9 tonnes per hectare to 2.47 tonnes per hectare and 3.5 tonnes per hectare by 2000 and 2010, respectively (MoA 1998).

Wheat accounts for one-third of the total food grain production. The high-yielding varieties now cover about 87% of the area under wheat cultivation and the same is increasing at the rate of 1.7% a year compared to 0.5% a year for rice. The annual production of 60 MT and a low growth rate of wheat in the past seven years (1.5%) indicates that the yield plateau for wheat has been reached. The production of high-yielding varieties and also irrigation coverage have almost reached saturation level in the wheat-growing belt of India. Further increase in production can only be expected through consumption and efficient use of fertilisers. The demand for wheat is expected to increase to 95 MT by 2020.

The progress in Indian agriculture can be attributed to i) development of improved agricultural techniques and improved varieties; ii) development of an efficient input production and delivery system; iii) progress being made in agrarian reforms, and iv) development of a rural infrastructure, input and output pricing policies, and marketing arrangements.

Agricultural inputs

Land

Out of the total geographical area of 329 million hectares (mha), only 305 mha is the reporting area, the rest being unadministered for various reasons. The net area sown increased from 119 mha in 1950/51 to 142 mha in 1995/96, mostly through reclamation of old fallow and cultivable wastelands and diversion of groves, and is expected to remain more or less constant at 143 mha throughout the Ninth Five-year Plan (MoA 1998) perspective period according to its Executive Summary. The cropping intensity, however, is projected to rise from 134.2% in 1996/97 to 150.35% in 2011/12.

Water

The distribution of rainfall in India is highly erratic in space and time. The annual average rainfall of the country is 1150 mm, of which 73% is received from the south-west monsoon. The country has been receiving normal rainfall for the sixth year in succession since 1993, as indicated by the proportion of actual rainfall as a percentage of normal rainfall. With just a small proportion of the cultivated area being irrigated, agriculture in India depends mostly on monsoons.

Irrigation

The area under irrigation has increased over time. The development in irrigation potential is largely through major, medium, and minor irrigation projects. Till 1992, 120 major and medium irrigation projects had been completed, and in the Eighth Five-year Plan (1992–97), 158 projects were ongoing. It is estimated that the country has an ultimate irrigation potential of 140 million hectares comprising 58.5 mha by major and medium irrigation schemes, about 17 mha by minor surface water schemes, and about 64.5 mha by groundwater. The net irrigated area has increased from about 31.11 mha in 1970/71 to 53 mha in 1994/95.This represents an increase from 22.1% to 37.1%, where the percentage of irrigated area is computed as a percentage of the net sown area.

High-yielding varieties

Good-quality certified seeds have been the basic and crucial inputs for enhancement of agricultural production. High-yielding varieties have been contributed significantly to increased yield of different crops. The total area under high-yielding varieties of different crops has increased from 15.38 mha in 1970/71 to 72.30 mha in 1995/96 (MoF 1999). As a result, the use of certified/quality seeds has increased from 0.2 MT in 1970/71 to 0.70 MT in 1996/97. The high-yielding varieties are, however, generally highly susceptible to pests and diseases and, therefore, need adequate care and plant protection measures.

Fertiliser use

India is the fourth largest fertiliser consumer in the world. The consumption has increased from 0.29 MT in 1960/61 to 19.2 MT in 1999/2000. With the introduction of high-yielding varieties around 1966, which are highly responsive to fertiliser use, their consumption increased steadily. The chemical fertiliser consumption was 80 kg/ha in 1994/95, but is estimated to stand at 185.81 kg/ha in 2011/12. Since such a level of chemical fertiliser may not be environment-friendly, a substitution of chemical fertilisers with bio-fertilisers to some extent seems essential. The Ninth Plan encourages greater use of bio-fertilisers and biotechnological research in this area (Photo 4.3).

The consumption of fertilisers in the gross cropped area in 1996/97 was 76.75 kg/ha. There has been a three-fold increase in consumption from 5.5 MT in 1980/81, to 14.3 MT in 1996/97, to 16.2 MT in 1997/98 and it is anticipated to increase to 19.2 MT in 1999/2000. Both nitrogenous and phosphatic fertilisers registered an increase in consumption, the increase being substantial in the case of nitrogenous fertilisers (0.4 MT between 1995/96 and 1996/97). The consumption of potassic fertilisers declined during this period.

Photo 4.3 Fertiliser use in agricultural fieldz
Source Annual report 1998-99, Ministry of Agriculture

Pesticides

The use of pesticides, commonly accepted as formulations that attack, repel, sterilize, stupefy, or destroy any insect, fungus, bacterium, rodent, etc. is on the increase. 133 pesticides have been registered for regular use in India which includes 34 that are either banned or restricted in some other countries, but are still used here (CPCB 1994). The promotion of IPM (integrated pest management) for all crops and throughout the country will continue to remain the main thrust of plant protection activities during the Ninth Plan (Photo 4.4).

Photo 4.4 Pesticide use in agricultural field
Source Annual report 1998-99, Ministry of Agriculture

The indiscriminate use of pesticides, however, has adversely affected both human and animal health, besides polluting air, water, and soil. The use of safer pesticides, including neem-based and biopesticides, is being encouraged to manage pest problems. Consequently, the consumption of pesticides (technical grade materials) has come down from 75.00 thousand tonnes during 1990/91 to an estimated 56.11 thousand tonnes during 1995/96 (MoA 1998).

The Ninth Plan target is to achieve a growth rate of about 4.5% a year in agricultural output and production of 234 MT of food grains by 2001/02. Agricultural development would be centered around achieving the objectives of sustainable employment generation, food and nutrition security, equity, and poverty alleviation.

Sustainable agriculture

For achieving sustainable agricultural development, greater emphasis will be laid during the ensuing period on i) conservation of land, water, and biological resources; ii) development of a rural infrastructure; iii) development of rain-fed agriculture (Photo 4.5); iv) development of minor irrigation; v) timely and adequate availability of inputs; vi) increasing flow of credit; vii) enhancing public sector investment; viii) enhancing support for research; ix) effective transfer of technology; and x) marketing infrastructure support and export promotion.

The National Agricultural Policy, which is being finalised will focus on the optimal use of land, water, and genetic resources in a sustainable manner. It will include leasing and consolidation of land, improvement of the rural marketing infrastructure, and use of 80 million hectares of wasteland and community land for agro-forestry (Photo 4.6).

Photo 4.5 Rain feed farming system
Source Annual report 1998-99, Ministry of Agriculture

Photo 4.6 Agro-forestry

The Ninth Plan will also focus on the social objectives of recognition of women's rights and protection of tribal's rights on land, and raising land productivity in eastern India.

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5 Tourism in India

Introduction

Tourism is one of the fastest growing industries the world over. Between 1990 and 1998 alone, international tourism receipts for the world as a whole grew from about US $269 billion to US $445 billion, an annual growth rate of 6.4%. During the same period, foreign exchange earnings from tourism in India grew from US $1,513 million to US $2,752 million, an annual growth rate of 7.7% (DoT 1998). The World Travel and Tourism Council's (WTTC) economic research reveals that the travel and tourism economy supports 17.4 million jobs in India or some 5.8% of the total employment and accounts for 5.6 % of the GDP. By 2010, this is forecast to rise to 25 million jobs or 6.8% of the total employment. The travel and tourism demand in India is expected to touch Rs 6,167 billion by 2010—an annual growth rate of 8.4%, more than double the global growth forecast of 4.1% (WTTC 1998).

By its very nature, tourism is an environment-sensitive activity. It not only thrives on a high quality natural and built environment but also impacts environmental quality around the areas it brings prosperity to. Environmental degradation, extinction of habitats, loss of values and evolution of a monoculture are some critical issues facing the tourism industry. At the same time, environmental goods clean water, beautiful scenery, fresh air—are fundamental to tourism so that both tourists and the tourist industry have a strong interest in their preservation. Thus tourism can provide a major economic rationale for the protection of scenic and biologically valuable areas and can generate direct visitor pay back into the management of these areas and their economically fragile communities.

For any one country in the world, India has perhaps the largest array of environmental situations by virtue of its tropical location, varied physical features and climatic types. Besides its abounding biodiversity, the country is also famous for its cultural diversity and rich national heritage. India thus has immense potential in tourism that may be culture, nature, coastal, adventure sports, city sites, and monuments (Photos 5.1 – 5.7).

Photo 5.1 Har-ki-pauri at Haridwar
Source http://travel.indiamart.com/

Trends in tourism

There has been a significant growth in the tourism sector, both in terms of number of tourists—domestic and foreign—and earnings from tourism. The number of international tourists to the country increased from 1.1 million in 1981 to 1.6 million in 1991 and further to 2.3 million in 1998.

Photo 5.2 Rohtang Pass, Manali
Source http://travel.indiamart.com/

Photo 5.4 Rafting in river Ganga
Source http://travel.indiamart.com/

The favourite months for foreign tourists as judged by the number of arrivals are November through February with December having the largest number. The summer months, particularly May and June, are a lean period for foreign tourism. The United Kingdom, USA, Sri Lanka, Germany and France are the top five tourist generating countries.

A survey undertaken by the Ministry of Tourism in 1996/97 (DoT 1998) revealed that about 54.5% tourists visited India in connection with their business. In the case of non-business tourists, the primary motivations for visiting India were cultural attractions (37.5%), general interest (17.7%), beaches (13.3%), wildlife (10.3%) and adventure sports (2.8%).

Domestic tourism too, has seen a boom in the past. Though there are no precise estimates, domestic tourist visits as per figures reported by various state governments increased from about 62.3 million in 1990 to almost 167 million in 1998 (DoT 1998). Among the main factors responsible for the dramatic rise in domestic tourism are increased disposable income and ownership of

Photo 5.3 Calangute beach at Goa
Source http://travel.indiamart.com/

Photo 5.5 Gateway of India, Mumbai
Source http://travel.indiamart.com/

Photo 5.6 Taj Mahal at Agra
Source http://travel.indiamart.com/

cars in the middle class, increased urbanisation and the stress of living in cities and towns, improved transportation, communication and budget accommodation. Advertising targeted at domestic tourists both by central and the state governments, as well as the tourist industry has also contributed to the spurt in domestic tourism.

Benefits from tourism

Tourism is now recognised as an activity generating a number of social and economic benefits. It promotes national integration and international understanding, and can foster redistribution of income from developed countries to emerging ones and, within a country or region, from more affluent areas to poorer ones. The sector creates enormous employment opportunities and augments foreign exchange earnings. Over the years, tourism has emerged as an important source of foreign exchange earnings to the country, comparable to some of the major merchandise exports. Foreign exchange earnings from tourism, which amounted to about Rs 325 million in 1971-72, stood at Rs 120 billion in 1998-99 (DoT 1998). The import of goods needed for tourism being limited, tourism earnings have a relatively large value added component. Figure 5.1 below shows the growth of foreign exchange earnings from tourism.

Photo 5.7 Qutab Minar at Delhi
Source http://travel.indiamart.com/

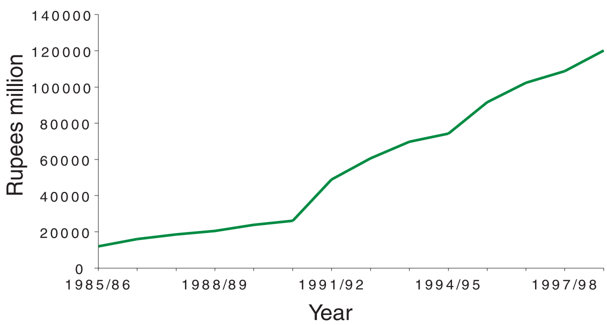

Figure 5.1 Foreign exchange earnings from tourism
Source DoT 1998

Apart from direct earnings and employment, a growth in tourism also generates a multiplier effect through inter-industry spending, creating income and employment indirectly. A study (MoT 1987)[1] conducted in 1987 estimated the income multipliers for international and domestic tourism at 1.451 and 1.238 respectively. Multipliers for employment generation were put at 1.48 and 1.68

respectively. The study thus found that in 1984/85, the total direct and indirect contribution of the tourism sector was about 5% to the Net National Income and 5.67 % (10.6 million) to the total employment in the country. The industry also generates considerable tax revenue. It provides support to local handicrafts and cultural activities. Additionally, a growth in tourism is accompanied by an improvement in social and physical infrastructure, which provides a stimulus to socioeconomic development in the region. All these benefits are achieved at a relatively low level of investment. Recognising this, the government, particularly the Seventh Plan onwards has been giving various incentives to propel the growth of this sector.

Environmental impacts

A number of studies have analysed at the impact of tourism on the environment at some popular destinations in the country. Common threats to the social and physical environment include:

- pollution (e.g. contamination of water, litter, and vehicle and boat exhaust fumes);
- deforestation from firewood use in backcountry areas;
- threats to wildlife due to human encroachment;
- depletion of water resources;
- soil erosion resulting from poorly planned infrastructure (e.g. roads, trails, camping areas, and tour boat routes);
- overuse of community infrastructure;
- erosion of cultural integrity and values due to the introduction of 'outside' influences to indigenous cultures;
- leakage of economic benefits outside the community due to non-local ownership of tourism businesses;
- inflation in the cost of land and local goods;
- exclusion of locals from their traditional 'use' areas; and
- overcrowding leading to a lessening of the tranquillity and simplicity of life that attracted visitors in the first place.

Studies for Goa, a coastal attraction, for instance note that unscientific growth of hotels in coastal villages such as Calangute resulted in contamination of ground water with sewage effluents (Gonsalves and D'Souza 1998). Development of tourism has also been found to cause erosion of sand dunes, an important part of the coastal ecosystem. Growth of tourism in Sikkim, another attraction has been found to cause additional pressure on local forests due to fuel, timber and fodder requirements (Rai and Sundriyal 1997). Garbage and litter collection have also become a major problem—in the Tshangu lake area of Sikkim, for instance, waste disposal of about 15 to 20 kg per day has been recorded during peak tourist season. The study also noted that much of the damage was caused by domestic tourists who constituted 90% of tourist traffic and were less aware of environmental concerns than foreign tourists. The study also provided evidence of leakage of tourism benefits outside the local community. An analysis of total expenditure by foreign tourists reveals that about 80% was spent on international travel, 8%–10% enroute to Sikkim, and only 10%–12% was spent within Sikkim for hotels, package tours, guides etc. In the absence of planned tourism, even this little may be tapped by a few resourceful people, leaving little for the locals.

There is growing concern about these issues. The Government of India has, from the outset recognised the need to develop the industry in harmony with the carrying

[1] Economic benefits of Tourism, 1987. Conducted by International Consultants and Technocrats Private Limited, for National Committee on Tourism. Ministry of Tourism, Government of India

capacity of the physical environment and resources. Recently, the government also issued policy guidelines on ecotourism in the country (Box 1). While ecotourism is a worthy objective to pursue, given the fact that it accounts for a small proportion of the tourism market (current global estimates vary between 3% and 7%), the real challenge lies in making all travel and tourism sustainable. This calls for a proactive involvement of all stakeholders in the industry—the government at both central and state levels, the local authorities, the tourism industry including operators, the visitors and the local community.

Box 1 Ecotourism in India

Ecotourism may be defined as nature-based tourism that is educative and ensures the sustainable use of environmental resources, while producing viable economic opportunities for the host communities.

India's geographic diversity provides a wealth of ecosystems that currently or potentially could support ecotourism activities. These include biosphere reserves, mangroves, coral reefs, deserts, mountains and forests, flora and fauna, seas, lakes and rivers and caves.

Annexure 1 provides some details on ecotourism resources in the country. While specific statistics on ecotourism growth in India are not available, statistics on visitation to selected parks and sanctuaries provide some indicators showing growing trends in visitor interest in nature-based activities in park settings. A study by the M. S. Swaminathan Research Foundation, indicates that Bandipur National Park in Karnataka and Gir Sanctuary in Gujarat, for instance, have shown high annual visitor growth rates of 25.6% and 16.3% respectively over several years

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Annexure I

Ecotourism resources of India (MoT 1998)[2]

Biosphere reserves

Biosphere reserves are multi-purpose protected areas intended to preserve the genetic diversity and integrity of plants, animals and microorganisms in representative ecosystems. There are seven such reserves in India.

- Niligri;
- Nanda Devi;
- Nokrek;
- Great Nicobar;
- Gulf of Mannar;
- Manas; and
- Sunderbans

Mangroves

Mangroves are specialised forest eeosystems located in tropical and sub-tropical areas bordering sheltered sea coasts and estuaries. India's mangrove areas include:

- Northern Andaman and Nicobar Islands;
- Sunderbans (West Bengal);
- Bhitarkanika and Mahanadi Delta (Orissa);
- Coringa, Godavari Delta and Krishna Estuary (Andhra Pradesh);
- Pichavaram and Point Calimere (Tamil Nadu);
- Goa;
- Gulf of Kachchh (Gujarat);
- Coondapur and Netravati (Karnataka);
- Achra/Ratnagiri (Maharashtra); and
- Vembanad (Kerala).

Coral reefs

Coral reefs can provide good opportunities for marine ecotourism activities such as 'controlled' snorkeling, scuba diving, and marine wildlife viewing. Four coral reef areas are identified within India to date:

- Gulf of Mannar;
- Andaman and Nicobar Islands;
- Lakshadweep Islands; and
- Gulf of Kachchh.

Currently, tourism and ecotourism operators are established on the Andaman and Nicobar Islands and on the Lakshadweep Islands.

Deserts

The Great Thar Desert and the little deserts in the northwestern region of India are distinct ecosystems providing unique opportunities for desert tourism and ecotourism, such as camel safaris.

Mountains and forests

The Himalayas, Western Ghats, other mountain ranges and forests in India provide settings for various ecotourism activities including trekking, wildlife viewing, and jungle safaris. The country has an area of about 75.2 million hectares notified as forest land and of this about 40.6 million hectares are classified as reserve forests and 21.5 million hectares as protected forests.

Flora and fauna

India has approximately 45,000 species of plants and 65,000 known fauna species. The latter includes 1228 bird species, 428 reptile species, 372 mammal species, 204 amphibians and 2,546 fish species. This diversity of flora and fauna provides a rich environment to support ecotourism. In order to preserve and protect these species, a large number of national parks and some 421 wildlife sanctuaries have been developed in various parts of the country. Table 5.1 provides a list of major wildlife sanctuaries, reserves and national parks in the country.

[2] Ecotourism in India-Policy and Guidelines, Ministry of Tourism, Government of India

Table 5.1 Major wildlife sanctuaries, reserves and parks in India[1]

Major wildlife sanctuaries, reserves & parks	*State*
Bharatpur (Keoladeo Ghana Bird Sanctuary)	Rajasthan
Sariska & Ranthambhore National Parks	Rajasthan
Dachigam Wildlife Sanctuary	Kashmir
Hazaribagh Wildlife Sanctuary	Bihar
Palamau Game Reserve	Bihar
Sunderbans Wildlife Sanctuary	West Bengal
Jaldhapara Wildlife Sanctuary	West Bengal
Manas Wildlife Sanctuary	Assam
Kaziranga National Park	Assam
Little Rann of Kachchh Wildlife Sanctuary	Gujarat
Gir Sanctuary / National Park	Gujarat
Velavadar National Park	Gujarat
Periyar Wildlife Sanctuary	Kerala
Vedantangal Bird Sanctuary	Tamil Nadu
Calimere Wildlife Sanctuary	Tamil Nadu
Mundathurai Tiger Sanctuary	Tamil Nadu
Anamalai Wildlife Sanctuary	Tamil Nadu
Valley of Flowers National Park	Uttar Pradesh
Corbett National Park	Uttar Pradesh
Madhav National Park	Madhya Pradesh
Kanha National Park	Madhya Pradesh
Bandhavgarh National Park	Madhya Pradesh
Similipal National Park	Orissa
Sanjay Gandhi National Park	Maharashtra
Taroba National Park	Maharashtra
Bandipur National Park	Karnataka

[1] Strengthening the management of the Gulf of Mannar Marine Biosphere Reserve United Nations Development Programme's Global Environment Facility and the M. S. Swaminathan Research Foundation, Asian Ecotechnology Information System
URL: www.mssrf.org/aeis

Water bodies and rivers

The Arabian Sea, Indian Ocean and Bay of Bengal border India's west, south and east coasts respectively, providing opportunities for ocean-based and island-based ecotourism. India also features major rivers, providing settings for river-based ecotourism and adventure tourism activities such as river rafting, canoeing, and kayaking.

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6 Natural disasters

Introduction

During the last 30 years, natural disasters have caused the death of at least three million people worldwide and have affected millions more. Their economic costs are on an alarming rise: compared to the 60s, the economic loss burden due to disasters has increased by a factor of 8, discounting inflation (GoI 1999). In the last ten years alone, major natural disasters worldwide have caused economic losses of more than US$ 400 billion. With such huge losses to life and property, natural disasters have become a serious threat to development especially in developing countries, already pressed for resources. A vulnerability to natural disasters is inextricably linked to environmental and poverty issues in these countries. Ninety percent of natural disasters and ninety five percent of all deaths from natural disasters occur in developing countries. All the top ten countries (except Australia), in terms of average annual loss to life due to natural disasters are developing ones. China tops the list with the average annual population affected being about 99 million and India follows second with 56.6 million[1].

Natural disasters in India

India's unique sub-continental dimensions, geographical position and the behaviour of the monsoons, make the country one of the most disaster-prone in the world. The Indian sub-continent is highly vulnerable to droughts, floods, cyclones and earthquakes, though landslides, avalanches and bush fires, too, frequently occur in the Himalayan region of the country. Among the 32 states/ union territories in the country, 21 are hazard prone. Table 6.1 lists the parts of the country and

Table 6.1 Frequently occurring natural disasters in India

Type	*Location/area*	*Affected population* (in million)
Cyclones	Entire 5700 km long coastline of Southern, Peninsular India covering 9 states viz. Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal and Union territory of Pondicherry besides islands of Lakshadweep and Andaman and Nicobar	10
Floods	8 major river valleys spread over 40 million hectares of area in the entire country	260
Droughts	About 68% of total sown area and 16% of total area of the country spread in 14 states of Andhra Pradesh, Bihar, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and Himachal Pradesh covering a total of 116 districts and 746 blocks	86
Earthquakes	56% of the total area of the country susceptible to seismic disturbances	400
Landslides	Entire sub Himalayan region and Western Ghats	10
Avalanches	Many parts of the Himalayas	1
Fires	States of Bihar, West Bengal, Orissa and North eastern States	140

Source MoEF 1995

[1] Top ten countries in terms of average annual number of people affected in 1987/96 are China (99.07), India (56.56), Bangladesh (18.57), Ethiopia (4.02), Philippines (3.69), Australia (2.28), Thailand (1.67), Sudan (1.48), Malawi (1.44), and Pakistan (1.40). Figures in brackets indicate in million, average number of people affected annually.

population susceptible to frequently occurring disasters.

Volcanoes are uncommon in the country. The two known active volcanoes in the country are in the Narcondum and Barren islands of the Andaman Islands in the Bay of Bengal. Of the various natural disasters listed above, the most devastating ones are floods, cyclones and earthquakes. Floods are caused mainly due to the peculiar rainfall pattern in the country. 75% of the total annual rainfall is concentrated over the short monsoon season of three to four months, resulting in a very heavy discharge from rivers during this period. The Indian Ocean is one of the six major cyclone-prone regions of the world. Out of approximately six cyclones formed every year, two or three may be severe. India suffers from these disasters year after year in one part of the country or the other. Some major disasters in the recent past are shown in Table 6.3.

Damage caused by natural disasters

Natural disasters cause irreparable damage to life and property year after year. Rapid population growth and urbanisation trends are accelerating vulnerability to disasters as settlements encroach into disaster-prone areas. Figure 6.1 shows the loss of human lives in India due to natural disasters during the nineties. India encountered two major calamities during nineties a) Orissa Super Cyclone and b) Gujarat earthquake. Box 1 and 2 illustrates about both these natural calamities.

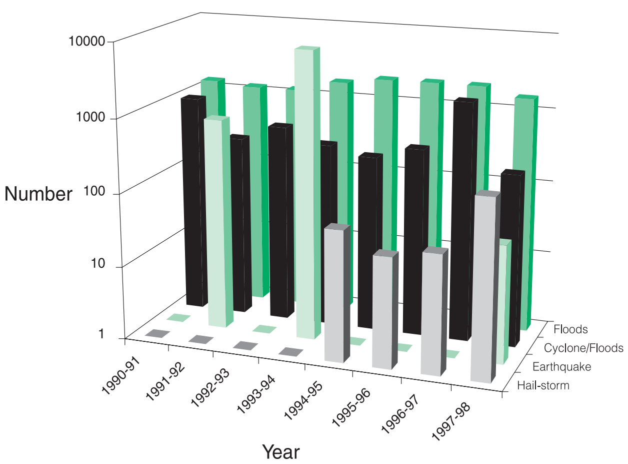

Figure 6.1 Human lives lost due to natural disasters
Source GoI 1999

Box 1 Super Cyclone – Orissa (29-31 October 1999)

With winds up to 300 km/h and tidal waves eight metres high, the cyclone left behind a trail of untold devastation. More than 10,000 people were killed while 15 million people were rendered homeless without food, shelter or water and their livestock population devastated. The cyclone damaged 1.8 million hectares of agriculture land, uprooted more than 90 million trees and caused significant infrastructure damage.

Sources http://www.nic.in/cycloneorissa/ (Accessed on 13 April 2001) http://news.indiainfo.com/spotlight/orissa/index.html (Accessed on 16 April 2001)

As the figure indicates, while events like earthquakes and hailstorms extract their toll of human lives randomly, floods and cyclones cause deaths each year. Over a period of ten years, between 1987 and 1996, more than 56.6 million people were affected by natural disasters in India, which averages 5.6 million per year. Apart from the loss of human life and hardships inflicted on the survivors, natural disasters cause heavy economic losses to property and agricultural crops, damage to transportation systems, communication facilities, electricity networks etc. Table 6.2 provides some estimates.

Disaster management

One discernible and desirable trend in disaster management in the country similar to that occurring internationally is the shift of focus from post-disaster management to

Table 6.2 Annual damage due to natural disasters in India

Year	*Number of people killed or missing*	*Number of people affected* (in millions)	*Number of houses & buildings partially or totally damaged* (in millions)	*Amount of property damages* (Rs billion)
1985	1,804	59.56	2.45	4.06
1986	1,200	55.00	2.05	3.74
1987	1,835	48.34	2.92	2.57
1988	4,533	10.15	0.24	4.63
1989	1,718	3.01	0.78	2.41
1990	1,855	3.17	1.02	1.71
1991	1,860	34.27	1.19	1.9
1992	1,367	190.90	0.57	2.05
1993	9,936	26.24	1.53	5.8
1994	2,344	23.53	1.05	1.83
1995	2,508	54.35	2.09	4.73
1996	3,789	54.99	2.38	5.43
1997	1,881	44.38	1.10	n. a.

Source GoI 1999

Box 2 Gujarat Earthquake (26 January 2001)

The powerful earthquake that struck the Kachhch area in Gujarat in western India on 26 January 2001 has been the most damaging earthquake in the last five decades in India. The quake, measuring 6.9 on the Richter scale, caused large-scale loss of life and property. Estimates indicate that over 20,000 people have been killed and 150 000 injured and 15.9 million affected. Official estimates place economic loss due to this quake at around $ 4.5 billion. The earthquake was felt in most parts of the country but the state of Gujarat, heartland of industries like petroleum, power and steel, was most severely hit.

Estimates of economic losses due to the Gujarat earthquake

Total losses	$ 4.5 billion
Housing losses	$ 2,100 million
GDP losses	$ 1,200 million
Public property	$ 100 million
Infrastructure loss	$ 150 million
Livelihood	$ 550 million

Sources http://gujarat-earthquake.gov.in/ (accessed on 13 April 2001)
Government of Gujarat as cited in "Measuring quake damage on dollar scale", The Times of India, April 13, 2001

preparedness and mitigation. An advanced system of forecasting, monitoring and issuing early warnings plays a central role in determining whether or not a natural event will assume disastrous proportions. The forecasting and monitoring systems in the country for some of the major disasters are discussed below.

Earthquakes

Seismological observations in the country are made through a national network of 57 seismic stations operated by the Indian Meteorological Department (IMD) which is the nodal agency. A few other organisations and river valley projects also operate local networks. Map 6.1 shows the potential earthquake zone in India.

Droughts

IMD monitors rainfall up to the district level and makes long range rainfall forecasts based on the Parametric Power Regression model. These forecasts are utilised for drought mitigation planning.

Map 6.1 Earthquake Zoning Map
Source India Meteorological Department
Note Zoning based on the Modified Mercalli Scale with damage risk increasing from zone I to V
URL: www.imd.ernet.in

Floods

The Central Water Commission maintains a network of 132 forecasting stations to cover most of the interstate flood-prone rivers besides inflow forecasts for 25 major reservoirs of the country.

Cyclones

IMD carries out cyclone tracking and warning through Cyclone Warning Centres in various parts of the country and the satellite-based Cyclone Warning Dissemination System.

Several other institutions are involved with pre-disaster management in the country. The Housing and Urban Development Cooperation (HUDCO) for instance, is doing pioneering work in developing and disseminating disaster- resistant building technologies.

With regard to post-disaster management, the state governments are responsible for rescue, relief and rehabilitation measures. At the central level, the Ministry of Agriculture is the nodal agency in charge of natural disasters. The role of the central government is supportive, in terms of physical and financial resources. In 1990, a Calamity Relief fund was set up for every state based on an average of ceilings of expenditure approved for various calamities by the central government for each state during the last 10 years ending 1988-89. The allocation to the fund is met by the central and state governments in the ratio 75:25. Various non governmental organisations also play an important role in disaster management.

Environmental aspects of natural disasters

Natural disasters have far-reaching ecological consequences. The beneficial effects to the ecology such as recharging of groundwater stocks after floods are limited and are far outweighed by immediate, negative impacts on the environment, societies and structures. Because of their extent over land area as well as time major floods and droughts generally create the greatest environmental impacts, whereas others such as hurricanes and thunderstorms cover less territory and their effects on the ecosystem are less pervasive and short term.

On the other side, there is enough evidence to suggest that the exploitation of the environment is changing the way the biosphere works and can significantly affect the frequency and severity of natural disasters. The loss of natural vegetation, particularly in forests around the world, is a major cause of preventable natural disasters such as landslides and floods. In the Himalayan foothills of northwest India, landslides killed more than 300 people within a week in August 1998. Researchers at the Wadia Institute of Himalayan Geology have noted that landslides have become an increasingly common feature of the region in the past decade as trees have been cleared for agriculture and road building (World Disasters Report 1999).

Global warming induced by greenhouse gases is also expected to alter the frequency, magnitude and character of climatic disasters. Firstly, the resultant rise in sea level will increase the risk of coastal areas to floods. India has a low-lying, densely populated coastline extending for about 5700 km and is recognised to be among the countries most vulnerable to a rise in sea level. Most of the coastal regions are agriculturally fertile, with paddy fields that are highly susceptible to inundation and salinisation. Coastal infrastructure, tourist activities, and onshore oil exploration are also at risk. A physical impact study (JNU 1993[2] as cited in TERI 1996) done for 8 of the 9 coastal states of India, showed

[2] JNU 1993, Impact of Greenhouse Induced Sea Level Rise on the Islands and Coasts of India. (Project for MoEF, Government of India) School of Environmental Sciences, New Delhi.

that in the absence of protection, a one-metre sea level rise on the Indian coastline is likely to affect a total area of 5763 sq km, and put 7.1 million people at risk. Though it is not easy to establish exact relationships, studies also postulate that a 2 degree Celsius increase in temperature without an increase in sea level rise, alone, could increase the surge height of tropical cyclones by 21% and inland inundation by 13% (TERI 1996).

To sum up, vulnerability to disasters is closely linked with environmental degradation and poverty. With almost a billion people now living in unplanned urban shanty towns, with deforestation wrecking ecological defences against catastrophic natural events and with global warming making the forces of the wind, rain and sun even harder to predict and counter, the world is at risk as never before (World Disasters Report 1999). Only by overcoming poverty, developing infrastructure, ensuring environmental protection and inculcating awareness can this vulnerability be diminished.

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Annexure I

Table 6.3 Major natural disasters in India since 1980

Year	*Type*	*Affected population* *Location/Area*	*Loss of human* (million)	*life*	*Loss to crops and property*
1980	Floods	Uttar Pradesh	30	1,525	Rs 2.0 billion
1981	Floods	Uttar Pradesh	13	362	1.5 million hectares of cropped area affected
1982	Floods	Orissa	10	1000	3 million hectares of agricultural land affected. Loss estimated to run into thousands of millions of rupees
1982	Cyclone	Saurashtra	-	514	Livestock death toll nearly 0.15 million. Loss to crops estimated at about Rs 1.27 billion
1983	Cyclone	Andhra Pradesh	-	134	Livestock death toll-42,800. Damage to crops estimated at Rs 0.34 billion
1984	Cyclone	Andhra Pradesh and Tamil Nadu	-	658	Livestock death toll- 90,650. Damage to crops estimated at Rs 2.32 billion
1985	Floods	Haryana, Punjab and Uttar Pradesh	-	Heavy toll	Large area of standing Kharif crop affected heavily
1986	Floods	Andhra Pradesh, Bihar and Uttar Pradesh	-	Heavy toll	Large area of standing Kharif crop affected heavily
1987	Floods	Assam, Bihar and West Bengal	-	Over 1400	-
1988	Cyclone	West Bengal	-	532	Livestock death toll- 57,604
1989	Floods	Andhra Pradesh, Assam, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Maharashtra, Orissa, Uttar Pradesh and West Bengal		Over 1400	-
1990*	Cyclone	Andhra Pradesh, Tamil Nadu	7.78	928	Rs 22.470 billion
1991*	Earthquake	Uttarkashi, Uttar Pradesh	0.40	768	Rs. 0.890 billion
1992	Drought	Maharashtra			Rs. 28.23 Billion
1993*	Flood	Arunachal Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, J&K, Mizoram, Punjab, Rajasthan, Tripura and Uttar Pradesh	28.80	1643	Rs 21.060 billion
1994	Cyclone	Andhra Pradesh and Tamil Nadu	-	226	Loss to property estimated at Rs 6.12 billion in Tamil Nadu and 4,44,194 hectares of land in Andhra Pradesh
1995	Floods	Large parts of the country	-	1360	Property worth Rs17.7 billion and crop in 2.35 million hectares damaged
1996	Floods	Large parts of the country	-	1700	Property worth Rs 22.0 billion and crop in 20.0 million hectares damaged
1996	Cyclone	Andhra Pradesh	-	1,058	0.3 million houses fully and a similar number partially damaged. 0.1 million hectares of crop damaged. Loss to property worth Rs 61.26 billion.
1997*	Earthquake	Jabalpur	-	39	-
1998**	Earthquake	Chamoli	-	100	-
1999**	Cyclone	Orissa	12.9	9887	1.8 million hectares of crop area and 1.6 houses damaged

* State of the Environment: India 1995, Ministry of Environment and Forests, Government of India; ** Ministry of Agriculture
Sources Disastrous weather events, various years. Indian Meteorological Department

7 Institutional mechanism and environmental policy

Institutional mechanisms

The Ministry of Environment and Forests, constituted in 1985, is the nodal agency in the administrative structure of the Central Government responsible for the protection and management of the environment in the country. It is also entrusted with the planning, promotion, coordination and overseeing of the implementation of environmental and forestry programmes. Different ministries, boards and organisations responsible for the protection and management of environment are shown in Figure 7.1. The MoEF, CPCB (Central Pollution Control Board) and SPCBs (state pollution control boards) form the regulatory and administrative core, while other ministries and bodies are also involved through various functions, policies and schemes to promote environmental management. The CPCB and SPCBs were set up under the Water Act of 1974 for controlling and monitoring environ-

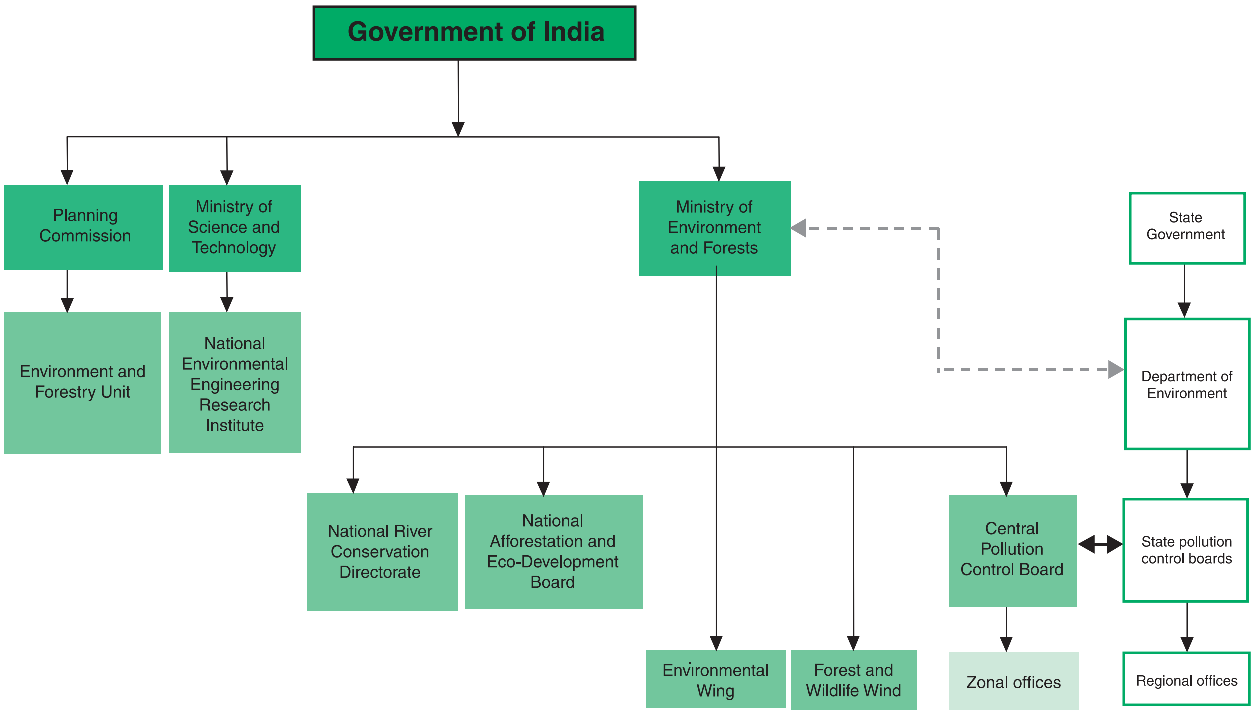

Figure 7.1 Protection and management of environment

mental degradation in the country. In addition, there is a network of government and non-governmental institutions, organisations and laboratories involved in monitoring, reporting, and studying environmental pollution and management. The ministry has also been designated as the nodal agency in the country for the UNEP (United Nations Environment Programme), International Centre for Integrated Mountain Development and looks after the follow up of the United Nations Conference on Environment and Development (TERI 1998). The CPCB was established for implementing the Water Act.

The Eleventh Schedule of the 73rd Constitutional Amendment in 1992 empowered Panchayat bodies and bestowed them with responsibilities in the areas of soil conservation, water management, watershed development, social and farm forestry, drinking water, fuel and fodder, non conventional energy sources and maintenance of community assets. Urban local bodies are empowered under the 74th Constitutional Amendment in 1992 to protect the environment and promotion of ecological effects. The NEAA (National Environmental Appellate Authority) was set up in 1997 to act as vigilant body to deal with the representations, complaints and appeals made against the decisions of competent authorities established under the EPA (Environment Protection Act), granting environmental clearance under the EIA (Environmental Impact Assessment) notification. NEAA is also expected to avoid delays arising out of protracted litigation involving development projects and affected people.

The MoEF has identified a total of 25 centres located throughout the country as part of an **Env**ironmental **I**nformation **S**ystem (ENVIS) network and these centres are responsible for the collection, collation, storage, retrieval and dissemination of information on various subject-specific areas of environment. All centres are actively involved in strengthening the environmental database and responding to national and international queries relating to their specific subject areas. The MoEF has also set up seven Centres of Excellence to carry out research, training and awareness programmes in priority areas of environmental science and management.

Environmental policy in India

The 1972 UN Conference on Human Development at Stockholm influenced the need for a well-developed legal mechanism to conserve resources, protect the environment and ensure the health and well being of the people. In 1976, the 42nd Constitutional Amendment was made to address environmental concerns. The India Constitution provides for necessary directives and powers to frame and enforce environmental legislation. The Constitution classifies the various legislative subjects into three categories, namely, Union List, State List and Concurrent List. Subjects include in the Union List are enacted by the Parliament. As stated in the Constitution of India, it is the duty of the state (Article 48 A) to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It imposes a duty on every citizen (Article 51 A) 'to protect and improve the natural environment including forests, lakes rivers and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights.

Over the years, the Government of India has promulgated a number of Acts, Rules and Notifications for the preservation and protection of the environment and a list of environment related laws are presented in Table 7.1. The Water Act, 1974, was enacted under Article 252 to address environmental issues at the national level. It was under this

Table 7.1 Environmental legislation, acts, rules, notification and amendments

Area	*Acts/rules/notification*	*Year*	*Description*
General			
	Environment (Siting for Industrial Projects) Rules	1999	The Rule provides the guidelines for establishment of new units with certain conditions, and prohibits the siting up of some industries in certain locations
	The National Environment Appellate Authority Ordinance	1997	Created to hear appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA (Environment Protection Act).
	Environmental Impact Assessment (EIA) of Development Projects-Notification	1994	Mandatory requirement of environmental clearance from the MoEF for 30 categories of projects
	The Environmental Standards Notification	1993	Industry specific standards adopted for effluent discharge and emissions for 24 designated industries
	The Environmental Audit Notification	1992	Every person who is carrying out an industry or an operation which require a consent from the CPCB/SPCB under section 25 of the Water Act and section 21 of the Air Act or both, has to submit an environmental audit report for the financial years ending on the 31st of March
	National Conservation Strategy and Policy Statement on Environment and Development	1992	Statement on priorities and strategies for action, development policies from environmental perspectives, international cooperation, and support policies and systems.
	The National Environment Tribunal Act	1995	Created to award compensation for damages to persons, property and the environment arising from any activity involving hazardous substances.
	Policy Statement on Abatement of Pollution	1992	Government's commitment to prevent further deterioration of the environment
	The Public Liability Insurance Act Rules-1992	1991	Provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance.
	The Environment (Protection) Act	1986	Authorised the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds.
	The Environment (Protection) Rules	1986	Lays down procedures for setting standards of emission or discharge of environmental pollutants.
Forests/Land			
	The Forest (Conservation) Act	1980	Protection of and the conservation of the forests.
	Rules-1981 National Forest Policy	1988	Objective of the policy is to ensure environmental sustainability and maintenance of ecological balance through defined strategy.
	Indian Forest Act Amended-1984	1927	It was enacted to 'consolidate the law related to forest, the transit of forest produce and the duty leviable on timber and other forest produce'.
	The Coal Mines (Conservation and Development) Amendment Act	1974	An Act to provide for conservation of coal and development of coal mines and for matters connected therewith or incidental thereto

Continued

Table 7.1 *continued*

Area	*Acts/rules/notification*	*Year*	*Description*
	The Mines and Minerals (Regulation and Development) Act Amended-1986	1957	The Act provides for regulation of prospecting, grant of lease and for mining operations under the control of the Central Government
	Dumping and disposal of fly ash	1999	This Notification was to protect the environment, conserve topsoil and prevent the dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land. The Notification makes it obligatory that clay bricks, tiles or blocks for construction activities will not be manufactured within a radius of 50 km is from coal or lignite based thermal power plants without mixing at least 25% of ash with soil on weight to weight basis
	Wildlife Protection Act Rules-1973 Amended-1991	1972	For the protection of birds and animals and for all matters that are connected to it whether it be their habitat or the waterhole or the forest that sustain them.
Water	The Water (Prevention and control of Pollution) Act Amended-1988 Rules-1975	1974	Establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The Pollution Control Board (CPCB) was constituted under this act.
	The Water (Prevention and Control of Pollution) Cess Act Amended-1991	1977	For the levy and collection of cess or a fees on water consuming industries and local authorities.
	The Coastal Regulation Zone Notification	1991	Puts regulations on activities such as construction. It gives some protection to the backwaters and estuaries.
	The Water (Prevention and Control of Pollution) Cess Rules	1977	This act provides for the levy and collection of cess on water consumed by industries.
	The Merchant Shipping Act	1970	Aims to deal with waste arising from ships along the coastal areas within a specified radius.
	The River Boards Act	1956	Enables the states to enroll the Central Government in setting up an Advisory River Board to resolve issues in inter state cooperation.
	The Indian Fisheries Act	1897	Establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisons fish in order to kill.
Air	The Air (Prevention and Control of Pollution) Act Amended-1987	1981	Provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the Central Pollution Control Board.
	The Factories Act and Amendment	1987	The first Act to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.
	The Motor Vehicles (Amendment) Act	1988	Clearly states that all hazardous waste is to be properly packaged, labelled and transported.
	The Air (Prevention and Control of Pollution) Rules	1982	Defines the procedures of the meetings of the Boards and the powers entrusted to them.
	The Atomic Energy Act	1982	Deals with the radioactive waste.

Continued

Table 7.1 *continued*

Area	*Acts/rules/notification*	*Year*	*Description*
	Noise Pollution (Regulation and Control) Rules	2000	Rules deal with ambient air quality standards in respect of noise for different areas/zones, enforcement of noise pollution control measures
	Ozone Depleting Substances (Regulation) Rules	2000	Regulation on production of ODS, use and sale of ODS, export and import, and new investment on ODS
	The Environment (Protection) Rules –Emission Standards for New Generator Sets	1999	Emission standards for new generator upto 19 kw capacity run on petrol and kerosene with implementation schedule
Hazardous waste	Bio-medical Waste (Management and Handling) Rules	1998	A legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection and treatment.
Municipal waste	Manufacture, Storage and Import of Hazardous Chemical Rules	1989	Provision on disclosure of information, collection, development and dissemination of information, preparation of onsite and off site emergency plan, condition on import of hazardous chemicals
	Manufacture, Use, Import and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells Rules	1989	Introduced with a view to protect the environment, nature and health, in connection with the application of gene technology and micro organisms.
	The Hazardous Wastes (Management and Handling) Rules, Amended-1998	1989	Objective is to control generation, collection, treatment, import, storage and handling of hazardous waste.
	Manufacture, Storage, and Import of Hazardous Chemicals Rules	1989	Defines the terms used in this context, and sets up an Authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities
	Municipal Solid Waste (Management & Handling)Rules	1999	Management of solid waste, specification of landfill sites, responsibility of municipality authority, implementation schedule
	Recycled Plastic manufacture and Usage Rules	1999	These Rules were notified to regulate the use of plastic carry bags, containers, packaging materials, etc. The Rules prohibit use of carry bags or containers made of recycled plastics by vendors, for storing, carrying; dispensing or packaging of foodstuffs.

Source TERI 1997

act that the CPCB and SPCBs were set up to control pollution in the country. The EPA was brought out in 1986 (considered an umbrella legislation) to address the whole range of environmental problems, laying down environmental standards, etc. The National Conservation Strategy and Policy Statement on Environment and Development was brought out by the MoEF in 1992 and this recognised the role of the government, NGOs, industries and public to preserve resources and protect the environment while ensuring developmental activities. This provides the basis for the integration and internalisation on environmental considerations in the policies and programmes of different sectors. In the same year, the Policy Statement for Abatement of Pollution was declared by the MoEF to promote voluntary initiatives for the protection and improvement of the environment, through the use of incentives, in addition to the development of a regulatory and legislative framework. These incentives may be fiscal or financial to promote cleaner technologies and production practices. In 1993, the Environment Action Programme was initiated to prepare a 'blueprint' for integrating environmental concerns into the development process. Emphasis was given to the promotion of a decentralised system and organisational strengthening for better environmental management. The MoEF is in the process of developing a comprehensive national policy on environment.

EIA is the process in which environmental factors are integrated into project planning and decision making so as to achieve ecologically sustainable development. Best practice EIA identifies environmental risks, lessens conflict by promoting community participation, minimises adverse environmental effects, informs decision makers and helps lay the base for environmentally sound projects. In India, the MoEF has under the EPA 1986, promulgated a notification on 27 January 1994, making environmental clearance mandatory for expansion or modernisation of any activity or for setting up new projects listed in schedule I of the notification. Till 1994, the EIA clearance was the administrative requirement for big projects undertaken by the government or public sector undertakings. The EIA clearance is required for 30 categories of industries from the central government as listed in Table 7.2. The notification states that the requirement of EIA can be dispensed with by the IAA (Impact Assessment Agency), which at present is the MoEF. The MoEF amended the EIA notification in 1997, making a public hearing mandatory for environmental clearance. The public hearing will be conducted by the State Pollution Control Boards before the proposals are sent to MoEF for obtaining environmental clearance and, for site specific projects, it is even before the site clearance applications are forwarded to MoEF. The MoEF, in 1997, delegated the responsibilities to state government, of conducting EIA for certain categories of thermal power plants.

The MoEF also functions as the nodal agency for the participation in international agreements relating to the environment such as the Montreal Protocol on Substances that Deplete the Ozone Layer, Vienna Convention for the Protection of the Ozone Layer, the Basal Convention on the control on Transboundary movement of Hazardous Substances, the United Nations Framework Convention on Climate Change, Male Declaration on prevention of air pollution, the Convention on Biological Diversity, the Convention to Combat Desertification, the Ramsar Convention on Wetlands of International Importance, the Convention of the Conversion of Migratory Species of Wild Animals (Bonn Convention), etc. The MoEF is also getting support from many bilateral and multilateral agencies in order to improve capacity building in the area of environmental management, decision making, reporting, monitoring, and participation. The Commission on Sustainable Development (CSD) was created to implement the Agenda 21 at the national, regional and international level. As part of the process, India contributed to CSD's country report 2000, by highlighting the initiatives taken in the areas of integrated planning and management of land resources, agriculture, financial resources, and trade and investment.

It is recognised that the public plays an important role in environmental protection strategy. The Government of India launched an eco-levelling scheme known as 'Ecomark" in 1991 for easy identification of environmentally friendly products. The 'Ecomark' level will be awarded to consumer goods, which meet the specified environmental criteria and the quality requirement of Indian standards. This will influence consumers to adopt clean and ecofriendly technologies and environmentally safe disposal of used products. Many new initiatives taken by the MoEF on policy,

Table 7.2 List of projects requiring environmental clearance

Number	*Projects*
1	Nuclear power and related projects such as heavy water plants, nuclear fuel complexes, rare earth
2	River valley projects, including hydel power, major irrigation, and their combination including flood control
3	Ports, harbours, and airports (except minor ports and harbours)
4	Petroleum refineries including crude and product pipelines
5	Chemical fertilisers (nitrogenous and phosphatic other than single super phosphate)
6	Pesticides (technical)
7	Petrochemical complexes (both olefinic and aromatic) and petrochemical intermediates such as dimethyl terephthalate, caprolactam, LAB, etc. and production of basic plastics such as low-density polyethylene, high-density polyethylene, polypropylene, polyvinyl
8	Bulk drugs and pharmaceuticals
9	Exploration for oil and gas and their production, transportation, and storage
10	Synthetic rubber
11	Asbestos and asbestos products
12	Hydrocyanic acid and its derivatives
13	■ Primary metallurgical industries (e.g., production of iron and steel, aluminium, copper, lead, and ferro alloys) ■ Electric arc furnaces (mini-steel plants)
14	Chlor-alkali industry
15	Integrated paint complexes including manufacture of resins and basic raw materials required in the manufacture of paints
16	Viscose staple fibre and filament yarn
17	Storage batteries integrated with manufacture of oxides of lead and lead antimony alloy
18	All tourism projects between 200 m and 500 m of high-tide line or at locations with an elevation of more than 100 m with investment of more than 50 million rupees
19	Thermal power plants
20	Mining projects (major minerals) with leases more than 5 ha
21	Highway projects
22	Tarred roads in Himalayas and/or forest areas
23	Distilleries
24	Raw skins and hides
25	Pulp, paper, and newsprint
26	Dyes
27	Cement
28	Foundries (individual)
29	Electroplating
30	Amino Phenol Acid

Source MoEF 1994

planning and implementation related to the environment in the last two years are presented in Table 7.3.

A few issues relating to existing environmental policy and institutional mechanism are discussed. The functions of agencies involved in policy formulation, implementation, and decision-making need to be well defined. Duplication of functions leads to poor coordination amongst agencies. Greater efforts should be made to adopt a decentralised approach to managing natural resources and environment. Such an approach would ensure greater participation of stakeholders in decision-making. Enforcement mechanisms need to be strengthened to ensure better performance. Greater transparency and accountability of agencies, well-defined regulations and

Table 7.3 Some of the new policy initiatives undertaken by MoEF

New policy initiatives	*Description*
National Environmental Action Plan for Control of Pollution	The Action Plan stipulates time bound schedules for controlling pollution from different sources by coordinating inter departmental initiatives
Environmental Management System (EMS)	A scheme on environmental management, to be launched very soon, will aid industry for effective legislative and regulatory compliance including effective monitoring of compliance of environmental conditions as also to actively pursue environmental performance improvement
Uniform Consent Procedure	Draft Prevention and Control of Pollution (Uniform Consent Procedure) Rules, 1999 have been gazetted on 20th December 1999
Legislation on Biodiversity	Adopting an extensive consultative process, the Ministry has developed a legislation on biodiversity with the main aim of securing equitable sharing of benefits arising from the use of India's biological resources and associated knowledge to the country and the people
National Biodiversity Strategy and Action Plan (NBSAP)	The Ministry has prepared a National Policy and Macro-level Action Strategy on Biodiversity, in consultation with various stakeholders. For developing micro-level action plans at State and regional levels, the Ministry is implementing a GEF project on NBSAP
Sustainable Development Networking Programme (SDNP)	ENVIS has been designated as the National Centre for the Sustainable Development Networking Programme (SDNP), a joint project by the Ministry, UNDP and International Development Research Centre (IDRC), Canada
SFC for setting up Treatment, Storage and Disposal Facility (TSDF)	A scheme to set up Treatment, Storage and Disposal Facility (TSDF) for hazardous wastes has been formulated. It is proposed to support projects costing Rs 8.4 crores to Rs. 2.00 crores
National scheme for capacity building	A scheme on capacity building for Chemical Emergency Preparedness and Response has been drafted. The scheme has two components namely; training of the first responders and setting up of Emergency Response Centre in the country
Development of Management Tools for Preventing environmental degradation	Traditionally, EIA has been adopted as a management and decision-making tool for assessing the likely impact of a project so that adverse effects could be either prevented or atleast mitigated. A number of other tools have subsequently emerged like NRA, LCA and Environmental Audit which can help identify the sources contributing to pollution and, therefore, in devising remedial action
Establishment of Indian Centre for Promotion of Cleaner Technologies (ICPC)	Switch over to efficient technologies also known as Cleaner or Environmentally Sound Technologies, is a pre-requisite for preventing pollution and improving productivity. As a follow-up of UNCED, ADB, etc. are promoting ESTs through financial and technical assistance the ESTs
Eco Villages	A model village on the periphery of forests in each district, to be designated 'ECO VILLAGE' is proposed to be identified and turned into a vehicle of change for sustainable development through afforestation and eco-development, adoption of bio-energy technology, provision of safe drinking water, rural sanitation and economic empowerment of the villagers
Joint Forest Management	JFM has been initiated and re-strengthened in 22 States of India (36,000 JIM committees) where 10 million ha of forest land and is being jointly protected, managed and developed on care and share basis to afforest degraded forest land with minimum financial inputs in terms of budgetary allocations

Continued

Table 7.3 *continued*

New policy initiatives	*Description*
Revision of Indian Forest Act 1927	Wider consultations with State Governments non-governmental organisations and individual environmentalists have been done to consolidate the IFA 1927 and make it more people oriented. The highlights of this Act are JFM, amelioration of shifting cultivation, constitution of apex bodies incorporates, amendments by the State Governments since 1952 and many others
National Forestry Research Plan	For the first time in India and probably in the world, forestry research need have been identified after wider consultations in 37 workshops held all over India where stakeholders have been consulted and involved

Source MoEF 2000

adoption of economic incentives in addition to a command-and-control approach are the determining factors in achieving better enforcement. Better monitoring and reporting systems would facilitate an improvement in the enforcement mechanism.

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Part III

Priority issues

Developmental activities in India have been pursued without giving much attention on environmental issues. This has resulted in pressure on its finite natural resources, besides creating impacts on human health and well being. 5 priority issues are discussed in the report. The priority issues identified are 1) land degradation 2) biodiversity 3) air pollution with special reference to vehicular pollution in urban cities 4) management of fresh water and 5) hazardous waste with special reference to municipal solid waste management. These priority issues are analyzed by following the pressure-state-impact-response framework. Conscious efforts need to be made to integrate the environmental planning into development planning to achieve the sustainable development.

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8 Land degradation

Introduction

Of India's total geographical area of 328.73 million hectare (mha), 304.89 mha comprise the reporting area and 264.5 mha only is under use for agriculture, forestry, pasture and other biomass production. Since 1970/71, the net area sown has remained around 140 mha (Ministry of Agriculture and Cooperation 1992) and was 142.22 mha during 1998/99.

India supports approximately 16% of the world's human population and 20% of the world's livestock population on merely 2.5% of the world's geographical area. The steady growth of human as well as livestock population, the widespread incidence of poverty, and the current phase of economic and trade liberalisation, are exerting heavy pressures on India's limited land resources for competing uses in forestry, agriculture, pastures, human settlements and industries. This has led to very significant land degradation. According to the latest estimates (Sehgal and Abrol 1994), about 187.8 mha (57% approximately) out of 328.73 mha of land area has been degraded in one way or the other. It appears therefore, that most of our land is degraded, is undergoing degradation or is at the risk of getting degraded.

Among the different categories, lands under cultivation face the biggest problem followed by grazing land and pastures, forests, barren lands, and unculturable lands in decreasing order.

The negative effects of land degradation are telling very heavily on India's environment and economy, which are causes of grave concern.

Pressure

Land in India suffers from varying degrees and types of degradation stemming mainly from unstable use and inappropriate management practices. Loss of vegetation occurs due to deforestation, cutting beyond the silviculturally permissible limit, unsustainable fuelwood and fodder extraction, shifting cultivation, encroachment into forest lands, forest fires and over grazing all of which subject the land to degradational forces. Other important factors responsible for large-scale degradation are the extension of cultivation to lands of low potential or high natural hazards, non-adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals such as fertilisers and pesticides, improper planning and management of irrigation systems and extraction of ground water in excess of the recharge capacity. In addition, there are a few underlying or indirect pressures such as land shortage, short-term or insecure land tenancy, open access resource, economic status and poverty of the agriculture dependent people, which are also instrumental to a significant extent, in the degradation of the land.

Land degradation manifest itself chiefly in the form of water erosion, followed by wind erosion, biophysical, and chemical deterioration.

Direct pressures

- Deforestation is both, a type of degradation by itself, and a cause for other types of degradation, principally, water erosion. Deforestation causes degradation firstly, when the land cleared is steeply sloping, or has shallow or easily erodible soils; and secondly, where the clearance is not followed by good land management (Photo 8.1). Between 1980 and 1990, forests were depleted at the rate of about 0.34 mha annually while, afforestation efforts covered about one mha of area annually during the same period (MoEF 1999). Forests in India have also been shrinking owing to pressures from user groups.

Photo 8.1 Land degradation due to deforestation

- Impoverishment of the natural woody cover of trees and shrubs is a major factor responsible for wind and water erosion, which occurs because the per capita forest land in the country is only 0.08 ha against the requirement of 0.47 ha to meet basic needs, creating excessive pressure on forest lands (Photo 8.2). This gap has resulted in unpermissible levels of timber, firewood, and fodder extraction from the forests. The demand for commercial timber comes from industries including pulp and paper, plywood, packaging, housing, matchwood, sports goods, furniture, agricultural implements and railway-coaches (FSI 1987). The total demand for timber, including small timber, was estimated at 64.4 million cum for 1996 with a growth rate of 5% per annum (FSI 1995).

Photo 8.2 Land degradation due to erosion

- Although, officially, extraction from the forests is organised so as to maintain a sustainable yield yet, in practice, the extraction far exceeds the limit resulting in a rapid depletion of forest stock. According to the State of Forest Report (FSI 1987), against the demand of more than 27 million cubic metre, the permissible felling of timber was only 12 million cubic metre creating an excess felling of about 15 million cubic metre over the permissible limit with a consequent loss of vegetative cover so essential for the health of the land.
- Firewood extraction from forests has been far exceeding the silviculturally permissible limit resulting in a rapid depletion of the forests (Photo 8.3). Extraction of wood from forests for fuel is believed to be one of the most important causes of forest

Photo 8.3 Firewood extraction

degradation in India. Fuelwood consumption was estimated at 260 million cubic metre in 1997 as against the sustainable supply of 52.6 million cubic metre and has grown at a rate of about 2.4% per annum between 1980 and 1994 (Pachauri and Sridharan 1998). This has been happening especially in the semi-arid and arid environments of India where fuelwood shortages are often severe and recurrent.

- A livestock population of 467 million grazes on 11 mha of pastures. This implies an average of 42 animals grazing in a hectare of land against the threshold level of 5 animals per hectare (Sahay 2000). In the absence of adequate grazing land, nearly a third of the fodder requirement is met from forests in the form of grazing and cut fodder for stall-feeding (MoEF 1999). An estimated 100 million cow units graze in forests against a sustainable level of 31 million per annum (Photo 8.4). A sample survey by the FSI estimates that the impact of grazing affects approximately 78% of India's forests. Overgrazing and over extraction of green fodder, both lead to forest and land degradation through a loss of vegetation and physical deterioration in the form of compaction and reduced infiltration, and increase in soil erodibility.

Photo 8.4 Extraction of fodder

- Shifting cultivation is traditionally practised in 13 states of the country and more extensively in the northeastern hill states, Orissa and the Eastern Ghats on an estimated forest area of about 4.35 mha. This contribute significantly towards forest land degradation With the progressive reduction in the land to population ratio, the fallow period between cultivations has fallen from 30 years to about 2 to 3 years. This in turn does not permit the natural processes of recuperation to repair the disturbed ecosystem resulting in erosion and a decline of soil fertility.
- An estimated 0.7 mha of forest lands are encroached upon for agriculture by the people who live in their vicinity, such lands are mostly of a marginal nature, susceptible to degradation.
- The occurrence of frequent forest fires has been a major cause of degradation of forest land in many parts of India. Apart from the destruction of vegetation, high intensity forest fires alter the physico-chemical and biological properties of the surface soil and leave the land prone to erosion and with a lowering of soil quality.
- The extension of cultivation to land of lower potential and fertility, with greater natural degradation hazards such as steep slopes areas of shallow or sandy soils, or with laterite crusts, arid or semi-arid land bordering to deserts, which are called fragile or marginal lands, in many parts of the country has resulted in their degradation.
- The use of agrochemicals has become essential for modern agriculture, but they, together with sewage sludge and composted municipal wastes are used improperly and indiscriminately, leading to the contamination of soil and water with toxic substances and heavy metals. This problem is widespread over the country although there is no exact estimate of the area affected.

- The expansion of canal irrigation has been associated with widespread waterlogging and salinity problems in command areas. Disturbances of the hydrological equilibrium resulting from excessive recharge because of inefficient use of irrigation water, poor land development, seepage from unlined water courses, non-conjunctive use of surface and ground water resources and poor drainage have all resulted in a rise of the water table in most canal command areas. Where the water table approaches the surface, waterlogging occurs associated with salinisation and/or sodification. Such phenomena have occurred on a large scale in several parts of canal command areas such as the Indo-Gangetic plains and the Indira Gandhi Nahar Project. In arid, semi-arid and sub-humid tracts of the country, large areas have been rendered barren due to the development of saline-sodic soils because of unhealthy land management in respect of irrigation, drainage and crop husbandry. An estimated 11 mha of land has thus been affected by varying degrees of salinity and sodicity in different parts of the country.
- An increase in industrialisation, urbanisation and infrastructural development is progressively taking away considerable areas of land from agriculture, forestry, grasslands and pastures, and unused lands with wild vegetation, resulting in environmental disturbances. Regional plans do not build in environmental components to provide zones for the above compatible with surrounding land uses. This process has resulted in the degradation of land directly through changed land use and also through the negative impacts of waste disposal.
- Land degradation is the inevitable result of any form of mining, particularly opencast mining, which thoroughly disturbs the physical, chemical, and biological features of the soil and alters the socioeconomic features of the area (Photos 8.5 and 8.6). Although there are no data available for the area actually affected by mining and quarrying, mining lease area is approximately 0.8 mha, which may be taken as degraded directly due to mining activities in addition to the areas affected indirectly.
- Water erosion across the country is the major cause of topsoil loss (in 132 mha) and terrain deformation (in 16.4 mha). Wind erosion is dominant in the western part of the country causing a loss of top soil and terrain deformation in 13 mha

Photo 8.5 Land degradation due to mining activities

Photo 8.6 Overburden dumps in forests

(Sehgal and Abrol 1994). Land management practices are often not geared to check water erosion on slopes and wind erosion on level lands of dry regions leading to considerable deterioration. Often, it is neither the environment nor the type of land use that necessarily leads to degradation, but the standard of land management.

Indirect or underlying pressures

Together with an increase in population land shortage in India has also increased in the already small per capita agricultural lands. As a result of fragmentation the number of land holdings has increased from 48 million in 1960 to 105 million in 1990 and is still more today. Most holdings (> 75%) are less than 2 ha (small and marginal). While there is virtually no culturable unused land in the country the population to be supported from this finite land resource is growing fast. The direct and indirect causes of land degradation are linked by a chain of cause and effect, or the causal nexus. The external, or driving forces are limited land resources and an increase in rural population. They combine to produce land shortages, resulting in small farms, low production per person and increasing landlessness whose consequence in term, is poverty. Land shortage and poverty, taken together, lead to non-sustainable land management practices, the direct causes of degradation. This has the effect of increasing land shortage, a vicious cycle of cause and effect.

State - Impacts

According to the estimates of actual land-use and vegetation cover by the National Remote Sensing Agency and the Forest Survey of India based on satellite imagery, 80 mha out of 142 mha under cultivation is substantially degraded and about 40 mha out of 75 mha under the forest departments has a canopy cover of less than 40% (Gadgil 1993). Nearly 11 mha of pasturelands is also substantially degraded. Thus, a total of 131 mha, representing about 40% of the country's landmass, has a productivity well below its potential. According to Wastelands Atlas of India 2000 (1:50,000 scale map), the total wastelands area covered in 584 districts is 63.85 million which accounts 20.17% of the total geographical area.

India supports approximately 16% of the world's human and 20% of livestock population on a mere 2.5% of the world's geographical area. The pressure on the country's land resources is obvious. Further, competing uses of land for forestry, agriculture, pastures, human settlements, and industries exert an enormous pressure on the country's finite land resources. This is mainly because the country has not been implementing a well-defined integrated land use policy and land management has largely been unscientific and arbitrary both of which have resulted in the current phase of degradation.

Land degradation in India has been brought about largely through i) displacement of soil materials and their deposition, and, ii) *in situ* degradation. Top soil loss and terrain deformation through water and wind erosion and also overblowing through wind erosion are manifestations of the first category and chemical degradation involving loss of nutrients and/or organic matter, salinisation and pollution, and physical degradation in the form of waterlogging, mass movement, land slides, compaction, crusting and sealing, in the second.

Soil erosion

The fertility status and the productivity of soil as a medium for biomass production depends largely on the top soil which, besides being a producer of biomass, is important for many other well-known important functions.
Soil erosion, by wind or water, affects these functions adversely and has produced considerable negative impacts both on-site as well as off-site. Out of the total estimated degraded

land of the country, about 162.4 mha is due to displacement of soil material by water and wind and 21.7 mha is due to *in situ* processes as salinity and waterlogging. The remaining 4 mha is affected by the depletion of nutrients (CSWCRTI 1994) (Photo 8.7).

Soil erosion by water results largely in the loss of top soil and terrain deformation, being a function of geological formation, rainfall, susceptibility to erosion, length and steepness of slope, cultural practices, vegetative cover,

Photo 8.7 Soil erosion

and conservation measures being followed. Soil erosion accounts for 87% of the total degraded land in India. Erosion due to water is greater in regions, which receive heavy rainfall over short periods than in places with low-intensity rainfall.

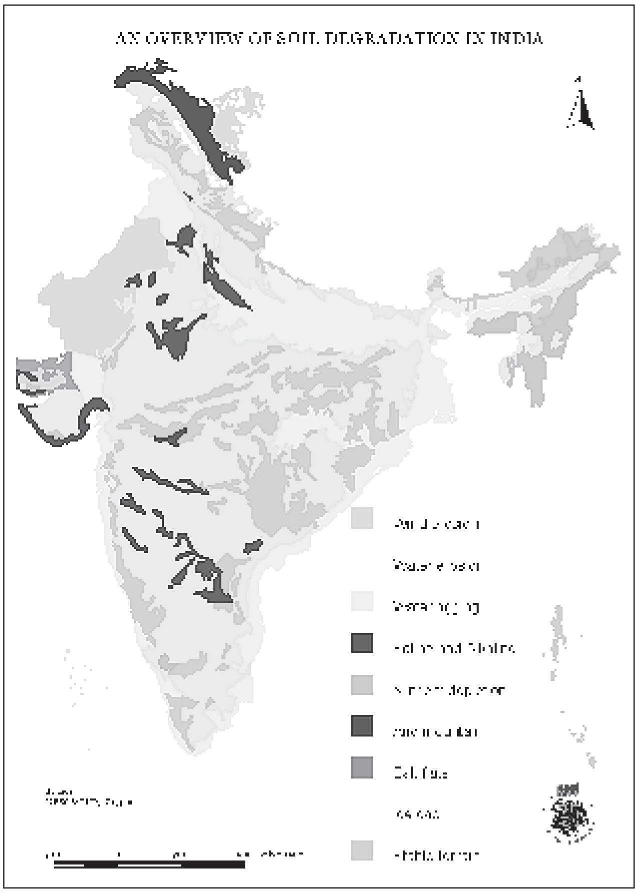
Non-adoption of proper soil and water conservation measures, improper crop rotation and extension of cultivation onto lands of low potential or high natural hazards, are some of important reasons contributing to soil erosion in lands under cultivation. Similarly, loss of vegetation due to deforestation, over cutting beyond silviculturally permissible limit, unsustainable fuel and fodder extraction, shifting cultivation, encroachment into forest land, forest fire and over grazing are mainly responsible for the degradation of forest lands (some estimates are given in the section on pressures). Obviously the governance is not properly geared to regulate and control the factors mentioned above and adequate enforcement is conspicuous by its absence (Photo 8.8).

Narayana and Ram Babu (1983) analysed the existing data on soil loss and concluded, as a first approximation, that soil was being eroded at an annual average rate of 16.35 tonnes per hectare, yielding a figure of 5.3

Photo 8.8 Forest degradation and soil erosion in West Khasi hills, Meghalaya
Source MoEF Annual report, 1997-98

billion tonnes a year for the entire country Of that, nearly 29% is permanently lost to the sea; about 10% is deposited in reservoirs (thereby decreasing their storage capacity by 2% annually); and the remaining 61% is merely displaced.

Gurmel Singh, Ram Babu, Narain, and others (1990) estimated that the annual erosion rate ranges from less than 5 tonnes/ha for dense forests, snow-clad cold deserts, and arid regions of western Rajasthan to more than 80 tonnes/ha in the Shiwalik hills. The single largest category is moderate erosion (5 to 10 tonnes/ha annually). The annual loss of soil amounts to nearly 5 billion tonnes, of



Map 8.1 An overview of soil degradation in India

Table 8.1 Soil erosion

Type of degradation	*Sehgal and Abrol (1994)*
Water erosion	148.9
Wind erosion	13.5
Total	162.4
Saline and alkali soils	10.1
Water-logging	11.6
Decline in soil fertility	3.7
Total	187.8

which 3.2 billion tonnes (64%) is contributed by highly eroded to very severely eroded areas, such as the Shiwalik hills, the Western Ghats, black and red soil areas, the north-eastern states and other ravinous tracts.

The loss of natural vegetative cover resulting from felling, excessive grazing, extension of agriculture to marginal areas, and the depletion of organic matter because of unsuitable cropping patterns, has been the major cause of accelerated wind erosion due to human activities. Structureless sandy soils, low in organic matter and water holding capacity, are vulnerable to strong desiccating winds. Wind erosion is a serious problem in arid and semi-arid regions and coastal areas, where soils are sandy, and in the cold desert regions of Leh in the extreme north of India. The threshold velocity for initiating wind erosion has been estimated at 10 km/hour.

The arid and semi-arid regions of the north-west cover 28 600 square kilometres, of which the sand dunes and sandy plains of western Rajasthan, Haryana, Punjab, and Gujarat account for 66% (Gupta 1990). Severe wind erosion is observed mostly in the extreme western sectors of the country. It is reported that the removal and deposition of sand during a 100-day period from April to June ranges between 1449 and 5560 tonnes/ha (Gurmel Singh, Ram Babu, Narain, and others 1990). The latest estimates show that area affected by wind erosion is 13.5 mha (4.1% of the total geographical area). The loss of topsoil accounts for 1.9% of the total area under soil degradation; terrain deformation for 1.2%; and shifting of sand dunes another 0.5% (Sehgat and Abrol 1994).

On-site impacts of erosion

In more than three-quarters of the area that suffers from soil erosion, productivity is lowered by 5% to more than 50% because the loss of productivity is directly linked to its severity. Different crops vary in their response to soil erosion - groundnut suffers the most and cotton the least. The difference in response is largely due to the differences in the rooting patterns of individual crops. Productivity loss is also influenced by the depth of soil - the shallower the soil, the greater the loss. According to a World Bank study (Brandon, Hommann, and Kishor 1995) the annual loss in production of major crops due to soil erosion in India has been estimated to be 13.5 million tonnes by Bansil (1990) and 7.2 million tonnes by UNDP, FAO and UNEP (1993). The loss in production of eleven major crops amounted to 1.7% of the total production of these crops in 1992/93 (UNDP, FAO, and UNEP 1993), and 4.1% of the total production in 1985/86 (Bansil 1990).

However, the current (one-year only) influence of past soil degradation actually undervalues the total loss resulting from the degradation. Erosion-induced productivity losses are not confined to a terminal year, but accumulate throughout most or all of the intervening period.

Loss of nutrients and/or organic matter

The loss of topsoil due to erosion depletes the productive substrate since a major portion of the essential plant nutrients are present there. Soils over much of the sub-continent are also highly deficient in Soil Organic Matter (SOM) with an associated proneness to degradation.

The National Bureau of Soil Survey and Land Use Planning (Sehgal and Abrol 1994) data show that nearly 3.7 million ha suffer from nutrient loss and/or depletion of organic matter. The problem is widespread in the cultivated areas of the subtropical belt, including areas under shifting cultivation or *jhumming* in the northeastern states.

Efforts have been made to estimate the loss of available nutrients by using the average content of nutrients in the top soil of each of the 24 soil types in India, the land area under each type, and the annual erosion rates in these soils estimated by the Central Soil and Water Conservation Research and Training Institute, ICAR. India loses nearly 74 million tonnes of major nutrients due to erosion annually. However, nearly 61% of the eroded soil is merely moved, and the effective loss is the remaining 39%. Thus, the country loses 0.8 million tonnes of nitrogen, 1.8 million tonnes of phosphorus, and 26.3 million tonnes of potassium every year. However, according to the Government of India, the quantity of nutrients lost due to erosion each year ranges from 5.8 to 8.4 million tonnes.

Off-site impacts of erosion

Higher erosion rates have resulted in the sedimentation of river beds, siltation of drainage channels, irrigation canals, and reservoirs. Siltation has changed the hydrology of several watersheds of the country, resulting in a greater frequency and severity of floods, and reducing water availability in dry season. The storage capacity of many reservoirs has been reduced drastically due to accelerated erosion and deposition. Siltation of major river courses and spillover sections due to excessive deposition of silt is observed extensively in Bihar and Uttar Pradesh since many flood-prone rivers flow through them. The total area affected by this problem is estimated to be 2.73 mha (Das 1977, Mukherjee *et al.* 1985). The Ganga and Brahmaputra carry the maximum sediment load, about 586 and 470 million tonnes, respectively, every year. Approximately 6 000 to 12 000 million tonnes of fertile soil are eroded annually and a significant proportion of it is deposited in the reservoirs resulting in a reduction of their storage capacity by 1%–2%.

The siltation rate of reservoirs in India has been estimated to be much higher than the values assumed at the time of designing. This has drastically reduced the life of projects, which involved huge investments. River valley projects reservoirs are prematurely getting silted up due to deposition of eroded soil. Against the designed rates of siltation (tonnes/ha/year) of 0.29 (Nizamsagar) to 4.29 (Ramganga), the actual siltation rates vary from 6.57 (Nizamsagar) to 17.3 (Ramganga). The siltation rate of the Mayurakshi reservoir is 20.09 against the designed rate of 3.61 (Bali 1994). The annual sediment load inflow into many reservoirs ranges from 0.6 to 122.7 ha-m/ 10 000 ha.

Flooding

The increasing frequency of floods in India is largely due to deforestation in the catchment areas, destruction of surface vegetation, changes in land-use, increased urbanisation, and other developmental activities. Processes leading to flooding are becoming more common due to increased sedimentation and reduced capacity of drainage systems. Increased gully erosion and ravine formation results in increased run-off and peak discharge for any given rainfall from watersheds. Increased sedimentation in streams, canals and rivers reduces their capacity but increases their width. Satellite imagery of Himalayan torrent shows that between 1990 and 1997 the width of torrents has increased by 106% and that of rivers by 36%. Consequently, streams and rivers overflow their banks, flooding the downstream areas.

These are of frequent occurrence in many parts of India, especially in hilly terrain, causing a disruption of normal life and considerable damage to the productive land system. The problem of human-induced waterlogging in India is more common in canal command areas (surface irrigation) because irrigation facilities are often introduced without adequate provision for drainage resulting in a rise of the water table.

Chemical degradation

Loss of plant nutrients. India has, over the past four decades, increased its annual food production from about 50 million tonnes in 1950/51 to 193.6 million tonnes in 1995/96. The increase in production is largely because of increased inputs – mainly nutrients and water – and partly because of an expanded cultivated area. Although the use of fertilisers has increased several fold, the overall consumption continues to be low in most parts of the country. Several studies have shown that in most regions there is a net negative balance of nutrients and a gradual depletion of the organic matter content of soil

It is estimated that every year, 20.2 million tonnes of the three major nutrients – nitrogen, phosphorus, and potassium – is removed by growing crops (Tandon 1992) but the corresponding addition through chemical fertilisers and organic manures falls short of this figure. It was determined that only 23% of the applied fertiliser is consumed by plants; the remaining 77% is either leached out beyond the root zone or lost by volatilisation, etc. Thus, out of 20.2 million tonnes of nutrients removed by plants, only 2.66 million tonnes comes from fertilisers and nearly 3 million tonnes from organic sources. This leaves a little less than 14 million tonnes, which is obviously contributed by soil. If the loss of nutrients due to soil erosion is included the loss of nutrients from the top soil is 43 million tonnes, which amounts to 0.24% of the nutrient reserves of the soils. According to Brandon, Hommann, and Kishor (1995), the annual loss in production of eleven major crops in India due to depletion of nutrient as a result of unsuitable agricultural practices amounts to 0.5 to 1.3 million tonnes. This estimate, however, does not take into account the loss due to erosion. The problem of maintaining the nutrient balance and preventive the consequent nutrient deficiencies will be a major concern in most cultivated areas.

Salininisation. Salt-affected soils are widespread in the arid, semi-arid, and sub-humid zones of the Indo-Gangetic Plain. Alkali soils dominate in areas with a mean annual rainfall of more than 600 mm, while saline soils are dominant in the arid, semi-arid, and coastal regions. About 7 mha is salt-affected, of which 2.5 mha represents the alkali soils in the Indo-Gangetic Plain and nearly 50% of the canal-irrigated areas as affected by salinisation and/or alkalisation due to inadequate drainage, inefficient use of available water resources, and socio-political reasons. Typical examples of salinisation caused by the rise in ground water are observed in Uttar Pradesh, Haryana, Rajasthan, Maharashtra, and Karnataka. A recent study by Sehgal and Abrol (1994) shows that a total of 10.1 mha is affected by salinity-alkalinity, of which about 2.5 mha occurs in the Indo-Gangetic Plain. Improper planning and management of surface irrigation systems contributes heavily towards salt affectation especially in canal command areas.

Salinity/sodicity directly affects the productivity of soils by making the soil unfavourable for good crop growth. Indirectly, it lowers productivity through adverse effects on the availability of nutrients and on the beneficial activities of soil microflora. According to Brandon, Hommann, and Kishor (1995), the loss in crop production due to salinity in India amounts to 6.2 million tonnes (FAO data) and 9.7 million tonnes (Indian data).

Pollution

Heavy metals. The pollution of soil with heavy metals due to improper disposal of industrial effluents, use of domestic and municipal wastes and pesticides, is becoming a major concern. Though no reliable estimates are available of the extent and degree of this type of soil degradation, it is believed that the problem is extensive and its effects are significant. Some commercial fertilisers also contain appreciable quantities of heavy metals, which have undesirable effects on the environment. The indiscriminate use of agro-chemicals such as fertilisers and pesticides is often responsible for land degradation.

Crusting and sealing are results of the impact of raindrops on bare soil. Red and black soils are especially vulnerable. Soil structure, infiltration and permeability characteristics are affected adversely to a considerable extent due to excessive grazing, fire and mismanagement of soil under cultivation but the data are too sketchy to arrive at even a rough estimate of the total area affected.

Response

A reclamation of the nearly 187 mha of existing degraded land in the country and concurrent efforts to arrest further degradation, as estimated, are of the utmost importance. Combating further land degradation and investing in conservation of land for the present as well as future generations will be a major task involving the promotion of sustainable development and nature conservation. This will be a major challenge in the coming decades that will involve a paradigm shift from the purely technical to a more holistic sustainable land management system that will be environmentally responsible, socially beneficial and economically viable.

Existing response

- Watershed management programmes have been taken up extensively in the recent past. The Soil and Water Conservation Division in the Ministry of Agriculture has been playing a key role in implementing integrated watershed management programmes with a plan to cover 86 mha. 26 mha (27 river valley catchments and 8 in flood prone rivers) are considered highly critical and have been given a priority under 35 centrally-sponsored projects. Over 30 000 hectares of shifting and semi-stable sand dunes have been treated with shelter belts and strip cropping (ESCAP 1995).

- The National Bureau of Soil Survey & Land Use Planning and the Central Soil and Water Conservation Research and Training Institute, ICAR, have jointly initiated the preparation of soil erosion maps of different states using the components of Universal Soil Loss Equation. A similar assessment needs to be carried out for other degradational processes also. In addition the All-India Soil and Land Use Survey, MoA, is engaged in generating spatial and non-spatial information on the soils of India and preparing of thematic maps like land capability classification, hydrological soil grouping irrigability classification, etc. The state governments are also working on various aspects of soil conservation following the guidelines of the centre.

Policy gap

Land management has been largely unsystematic, arbitrary and, by no means, sustainable. So far the country has not implemented a well-defined integrated land use policy. This lacuna has largely been responsible for the current phase of land degradation. To make things worse, there is no rural fuelwood as well as grazing and fodder policy also at the national level with the result, that grazing is far beyond the carrying capacity and extraction of fuel and fodder from forests is also far beyond the sustainable limits, creating enormous negative impacts on the forests and land.

Knowledge/information/data gap

Although land degradation is recognised as a serious problem, information available on the severity as also the area affected by various forms of degradation is limited, highly variable and sketchy.

Policy recommendations

- A well-defined integrated land use policy at the implementable level should be developed at the earliest, as also rural fuelwood and grazing and fodder policies to guide management of land and forest scientifically and sustainably.
- A National Land Use Commission entrusted with the responsibility of laying down such policies, implementing strategies and monitoring guidelines with support from the existing All-India Soil and Land Use Survey, National Bureau of Soil Survey and Land Use Planning and the Forest Survey of India under the stewardship of the Planning Commission will go a long way to address most of land-related issues.
- To ensure that land is put under right kind of use guarding against any deleterious effects, it is imperative that it is put to use according to its capability. For this purpose, guidance from the USDA Land Capability Classification with modifications to suit Indian conditions can be taken, which along with scientifically sound land management practices would address land degradation problems and maintain land quality for sustainable use.
- Land management in conjunction with water management needs to be the core of any agenda for national development as the two resources are absolutely inter-dependent and cannot be dealt with independent of the other. As far as possible, land should be managed on a natural watershed basis as it presents an ideal unit for most effective management and rational utilisation of land and water resources for optimum production with minimum hazard to the resources.
- Increasing the utilisation of irrigation potential, promoting water conservation and efficient water management along with expansion of irrigation facilities, especially

in drought-prone areas, need urgent attention to enhance production without harming land and soil. To ensure sustainability of production in rainfed areas, *in situ* soil and moisture conservation on mini-watershed basis, irrespective of whether they belong to forest department, private bodies or local communities, should be a major thrust area for increasing productivity levels.

- A correct assessment of the nature and extent of the existing degraded land through a rapid inventory using remote sensing techniques and GIS needs to be carried out as early as possible with scientifically sound criteria and indicators. Advantage of the Soil and Terrain Database (SOTER) and Global Assessment of Human-induced Soil Degradation (GLASOD) can also be taken. This will enable the adoption of measures to counter various types of degradation at the right time and place.
- Ministries or departments such as the MoEF, MoA, MoRD, MoWR, MoM, MoI, etc., at both the national as well as state level, are involved in land use in the country. The Land Use Commission should involve them, NGOs and other stakeholders to develop a coordinated approach for land use and management and for resolving related cross-cutting issues.
- Policy issues in sustainable land management may include coordination of land titling, economic policy, nature conservation policy, and population policy. Therefore, national strategies for sustainable use of land resources need to thoroughly harmonise, adapt, and integrate the different strategies and policies of governments, which are directly or indirectly linked to the use of land by stakeholders.
- Soil nutrient mining results in serious soil health and ecological problems, which needs urgent attention. Integrated Plant Nutrient System (IPNS), have to be adopted to improve fertiliser use efficiency and reduce the potential danger of pollution from higher nutrient use in agriculture.
- A systematic monitoring mechanism needs to be developed to assess the balance between input and withdrawal of nutrients to guard against possible nutrient depletion (Sarkar et al. 1991). Also, there is a need to define the threshold values for such additions and for promoting a balance with use of organic manure, chemical fertilisers, bio-fertilisers and agrochemicals to ensure sustainability and increased production.
- Domestic and municipal wastes, sludges, pesticides, industrial wastes, etc. need to be used with utmost caution to avoid the possibility of pollution of soil through heavy metals and other toxic substances which are often present in them.
- Shifting cultivation with a short fallow cycle does not allow enough time for the land to recuperate naturally and is responsible for large-scale (about 4.5 mha) land degradation in several parts of the country. The practice, a socio-economic outlet, needs to be discouraged and alternatives to the people engaged in the practice need to be provided in a phased manner for their livelihood.
- Limited land resources and an increase in rural population, both produce land shortages through fragmentation of holdings resulting in small farms, low production per person and increase in landlessness, which leads to poverty. Land shortages and poverty farther lead to non-sustainable land management practices, one of the important causes and effect nexuses of land degradation. The major challenge in the agriculture sector is to check the fragmentation of land holdings which can be achieved by: providing security of land rights and land tenure; encouraging the efficient use of marginal lands; developing

areas of untapped potential thereby correcting uneven utilisation of land; and using the irrigation potential efficiently. A tenure regime should be clear, flexible and secure.

- Implementation of land-related policies is a complex and sensitive task. It would require government as well as non-governmental sectors such as communities, private bodies to come to a common platform. Additionally, the steps, mechanisms and institutional structures for policy implementation need to be drafted along with a detailed action plan clearly designating responsibilities and taking into consideration the intrinsic character of land, the concerned user groups and future possibilities.
- Improvements in sustainable land use and development impinge on the interests of all stakeholders—both individuals and groups. Therefore, a multi-level stakeholder approach for the planning process is essential to obtain socially balanced results in which the economic and ecological objectives are both given due weightage. All stakeholders such as farmers/conservationists, owners/tenants, individuals/communities as well as administrators, planners, governments, etc. should participate in problem analysis, express and evaluate their needs, interests and aims, and then negotiate options and priorities for action. This approach implies democratic and, to some extent, formalised procedures, but which are based on a sound information foundation that includes data on the properties of the land, the land uses and their functions in the recovery of the ecosystem. In a multi-stakeholder approach, three principles must converge—good land husbandry, sustainable land use, and an enabling institutional environment. Technology transfer and training needs for farmers, especially women, small and marginal farmers and other disadvantaged sections of rural society are of paramount importance.
- Failure of land-users and community leaders to recognise or to be educated about the causes, urgency, seriousness, and full consequences of degradation often works against any measures to counter degradation. In this context, the negotiated participatory approach needs to be adopted to mitigate some of these adverse effects.
- An increase in industrialisation, urbanisation, mining and infrastructure development is taking away considerable areas of land from agriculture, forestry, grassland, pasture, etc. resulting in environmental disturbances. To harmonise such developmental activities and make them compatible with surrounding land use and guard against any form of land degradation,

  an Area-wide Environment Quality Management (AEQM) approach needs to be adopted.
- The agricultural extension system of the country needs revamping to make it more efficient and far-reaching and the lab-to-land concept needs to be translated to practice so that multidisciplinary technical information, viable land use options and alternatives identified for various agro-ecological and socio-economic units and crop combinations and crop rotations suitable for them, as suggested by the ICAR, can be advanced to the land users for more vigourous and effective land management results.
- Education, training, research, and technology development would enable to focus on analysing and adapting conditions and principles for sustainable land use as well as resource conservation technologies and practices. Research institutes should look for ways of working closely with land users and communities.
- Informal and formal institutions and organisations – from farmer groups, local NGOs and communities to ministries, government policies, and legislations can only be sustained, if they are accepted and

supported by their respective populations. This means that local knowledge systems, norms and values, must be respected. Negotiation processes among all stakeholders, which must be a part of good governance and administrative management, can be enhanced by better information and knowledge about land user's visions, options and needs with respect to sustainable land management.

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9 Biodiversity

Introduction

Biodiversity is defined as 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems'. Conservation and sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend. Every country has the responsibility to conserve, restore and sustainably use the biological diversity within its jurisdiction. Biological diversity is fundamental to the fulfilment of human needs. An environment rich in biological diversity offers the broadest array of options for sustainable economic activity, for sustaining human welfare and for adapting to change. Loss of biodiversity has serious economic and social costs for any country. The experience of the past few decades has shown that as industrialization and economic development in the classical sense takes place, patterns of consumption, production and needs, change, straining, altering and even destroying ecosystems. India, a megabiodiversity country, while following the path of development, has been sensitive to needs of conservation and hence is still rich in biological resources. Ethos of conservation and harmonious living with nature is very much ingrained in the lifestyles of India's people.

India is one of 12 megadiversity countries of the world. The innumerable life forms harboured by the forests, deserts, mountains, other land, air and oceans provide food, fodder, fuel, medicine, textiles etc. There are innumerable species, the potential of which is not as yet known. It would therefore be prudent to not only conserve the species we already have information about, but also species we have not yet identified and described from economic point of view. *Taxus baccata,* a tree found in the Sub-Himalayan regions, once believe to be of no value is now considered to be effective in the treatment of certain types of cancer. The diversity of genes, species and ecosystem is a valuable resource that can be tapped as human needs and demands change, the still more basic reasons for conservation are the moral, cultural and religious values. The importance of biodiversity can be understood, it is not easy to define the value of biodiversity, and very often difficult to estimate it. The value of biodiversity is classified into direct and indirect values.
Biodiversity has direct consumptive value in agriculture, medicine and industry. Approximately 80 000 edible plants have been used at one time or another in human history, of which only about 150 have even been cultivated on a large scale. Today a mere 10 to 20 species provide 80%–90% food requirements of the world. The indirect values imply the functions performed by biodiversity which are not of any direct use such as ecological processes etc. In India, many rural communities particularly the tribals obtain considerable part of their daily food from the wild plants. Some examples are: *Ceropegia bubosa* in Central India and Western Ghats; *Codonopisis ovata* in Himalayan region; *Ardisia* and *Meliosma pinnata* in the North-east; *Eremurus himalaicus, Origanum vulgare* and *Urtica hyperborea* in Lahul-Spiti and Ladakh; *Allium carolinianum* and *Cicer microphyllum* in Kashmir and *Sesuvium portulacastrum* in Coastal areas. Similarly, a variety of faunal species, e.g.,

insects, molluscs, spiders, wild herbivores are consumed by many tribal and non-tribal communities in India.

At one time, nearly all medicines were derived from biological resources. Even today they remain vital and as much as 67%–70% of modern medicine are derived from natural products. In developing countries, a large majority of the people rely on traditional medicines for their primary health care, most of which involve the use of plant extracts (Photo 9.1).

Around 20,000 plant species are believed to be used medicinally in the third world. In India, almost 95% of the prescriptions are plant-based in the traditional systems of Unani, Ayurveda and Sidha. Many indigenous medicines also utilize animals and their parts or extracts as remedies for various diseases. Diverse habitats and species also have non-consumptive use-value. Tourism, recreation and scientific research are the major examples. The indirect use-value of biodiversity includes ecosystem process of biological diversity, which provides valuable ecological services to the biosphere; some examples are the ecosystem's ability to absorb pollution, maintain soil fertility and micro-climates, recharge ground water, and provide other invaluable services. Many plants, animals and their parts are used in rituals all over the country. To name a few: flowers of *Hibiscus, Datura* and *Euphorbia*; leaves of *Aegle marmelos* (bel), *Eragrostis cynasuroides* (kusa grass), rice til, chenopods, odorous roots of *Dolomiaea macrocephala* (dhup). Further, sacred values are attached to entire ecosystems, for example patches of forests were believed to be the abode of gods, and are used only for prayers and rituals. Many sacred groves still exist in different parts of India (MoEF 1999).

Photo 9.1 Adhotoda zeylanica: a medicinal plant
Source MoEF Annual report 1998-99

Pressure

Habitat destruction, overexploitation, pollution, and species introduction are the major causes of biodiversity loss in India. Other factors included fires, which adversely affect regeneration in some cases, and such natural calamities as droughts, diseases, cyclones, and floods. Habitat destruction, decimation of species, and the fragmentation of large contiguous populations into isolated, small, and scattered ones has rendered them increasingly vulnerable to inbreeding depression, high infant mortality, and susceptibility to environmental stochasticity and, in the long run, possibly to extinction.

Besides these, the failure to stem this tide of destruction results from an amalgamation of lacunae in economic, policy, institutional, and governance systems. Among others, these include.

- Management with limited local community participation and involvement and inadequate implementation of ecodevelopment programmes; poor implementation of the Wildlife (Protection) Act of 1972 as amended in 1991.

- Poor conviction rates of wildlife cases due to inadequate legal competence in the forest department, and the lackadaisical approach of courts with cases pending for years.

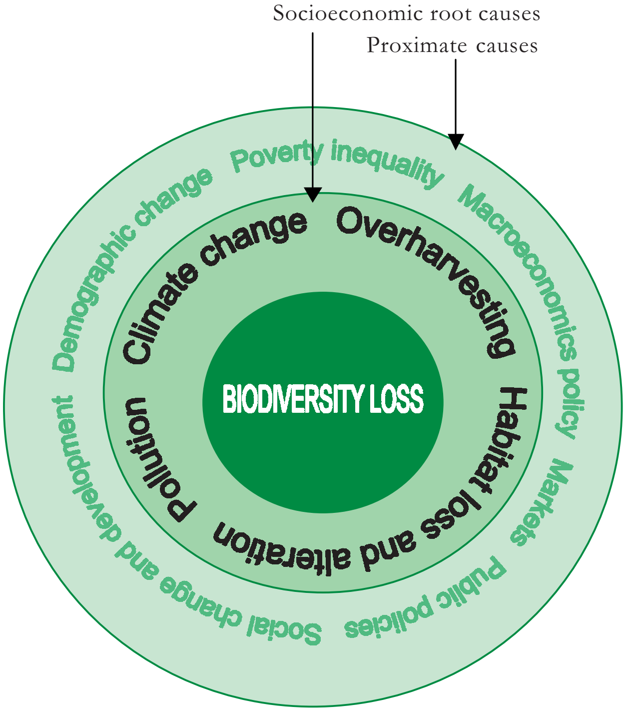


Figure 9.1 Biodiversity loss: proximate and socio-economic root causes
Adapted from: The root causes of biodiversity loss, 2000

Protected Area Network comprises National Parks and Sanctuaries which covers a mere 4.2% of the land area and is inadequate in protecting such ecologically important and fragile ecosystems such as wetlands, mangroves, and grasslands that lie outside such protected areas. The protected areas themselves are susceptible to denotification and further reduction in extent due to other pressures emanating from the industrial-commercial-political combine.

Biodiversity conservation in India is also impeded by a lack of knowledge of the magnitude, patterns, causes, and rates of deforestation and biodiversity loss at the ecosystem and landscape level. Poaching and trade in wildlife species are among the most important concerns in the management of protected areas today but information on poaching, trade, and trade routes is sketchy and current wildlife protection and law enforcement measures are inadequate and inefficient (Photo 9.2).

Photo 9.2 Lioness with family at Gir forest, Gujarat : needs conservation
Source MoEF Annual report 1996-97

Major problems with biodiversity conservation

- Low priority for conservation of living natural resources.
- Exploitation of living natural resources for monetary gain.
- Values and knowledge about the species and ecosystem inadequately known.
- Unplanned urbanization and uncontrolled industrialization.

Major biodiversity threats

- Habitat destruction
- Extension of agriculture
- Filling up of wetlands
- Conversion of rich bio-diversity site for human settlement and industrial development

- Destruction of coastal areas
- Uncontrolled commercial exploitation

This erosion of biodiversity is largely due to habitat loss caused by the expansion of various development projects such as mines, dams, and road and canal construction. It is estimated that, after Independence, the country has lost 4,696 million hectares of forestland to non-forestry purposes. While 0.07 million ha of forest land has been illegally encroached upon, 4.37 million ha has been subjected to cultivation, 0.52 million ha given to river valley projects, 0.14 million ha to industries and townships, 0.06 million ha for transmission lines and roads; and the rest for miscellaneous purposes (MoEF 1999). Habitat loss leads to the fragmentation of continuous stretches of land and consequently fragments wildlife populations inhabiting them. These small populations are increasingly vulnerable to inbreeding depression, high infant mortality, susceptibility to environmental stochasticity, and, in the long run, possibly to extinction. Apart from the primary loss of habitats, there are numerous other problems contributing to the loss and endangered status of several plant and animal species. Habitat degradation such as changes in forest composition and quality can in turn lead to declines in primary food species for wildlife. Poaching is another insidious threat that has emerged in recent years as one of the primary reasons for extinction of species such as the tiger. Poaching pressures, however, are unevenly distributed since certain selected species are more heavily targeted than others. Population pressures and concomitant increases in the collection of fuelwood and fodder, and grazing in forests by local communities also take their toll on the forests and consequently its biodiversity. Other minor factors include fires, which adversely affect regeneration in some cases, and natural calamities like droughts, diseases, cyclones, and landslides.

India's contribution to agro-biodiversity has been impressive. India stands seventh in the world as far as the number of species contributed to agriculture and animal husbandry is concerned. In qualitative terms too, the contribution has been significant, as it has contributed such useful animal species as water buffalo and camel and plant species such as rice and sugarcane. India has also been a secondary centre of domestication for animal species such as horse and goat, and

Table 9.1 Comparative statement of recorded number of animal species in India and the World (endemic and threatened animals species for India are also shown)

	India				
Taxa	*Species*	*Endemic species*	*Threatened species*	*World*	*Percentage of India to the world*
Protista	2577			31259	8.24
Mollusca	5070	967		66535	7.62
Arthropoda	68389	16214 (Insects)		987949	6.90
Other Invertebrates	8329		22	87121	9.56
Protochordata	119			2106	5.65
Pisces	2546		4	21723	11.72
Amphibia	209	110	3	5150	4.06
Reptilia	456	214	16	5817	7.84
Aves	1232	69	73	9026	13.66
Mamalia	390	38	75	4629	8.42

Source MoEF 1999; Baillie 1996

such plant species as potato and maize (Khoshoo 1996). Animal species, which are reported to be threatened in India, have been listed in
Table 9.1.

India has 47 000 species of flowering and non-flowering plants representing about 12% of the recorded world's flora. Out of 47 000 species of plants, 5 150 are endemic and 2 532 species are found in the Himalayas and adjoining regions and 1 782 in the peninsular India. India is also rich in the number of endemic faunal species it possesses, while its record in agro-biodiversity is very impressive as well. There are 166 crop species and 320 wild relatives (Table 9.2) along with numerous wild relatives of domesticated animals (Table 9.3). Overall India ranks seventh in terms of contribution to world agriculture.

Table 9.2 Wild relatives of some crops and medicinal plants

Crop	*No. of wild relatives*
Millets	51
Fruits	104
Spices and condiments	27
Vegetables and pulses	55
Fibre crops	24
Oil seeds, tea, coffee, tobacco and sugarcane	12
Medicinal plants	3000

Source MoEF 1999

Table 9.3 Wild relatives of domesticated animals

Group	*Nos.*
Cattle	27
Sheep	40
Goats	22
Camels	8
Horses	6
Donkeys	2
Poultry	18
Buffalo	8

Source MoEF 1999

State impact

Status of biodiversity in India

India occupies only 2.4% of the world's land area but its contribution to the world's biodiversity is approximately 8% of the total number of species (Khoshoo 1996), which is estimated to be 1.75 million (As per Global Biodiversity Assessment of UNEP of 1995, described number of species so far is 1.75 million). Of these, 126 188 have been described in India. The species recorded includes flowering plants (angiosperms), mammals, fish, birds, reptiles, and amphibians, constitute 17.3% of the total whereas nearly 60% of India's bio-wealth is contributed by fungi and insects (Khoshoo 1996). Such a distribution is similar to that found in the tropics and the subtropics. Biogeographically, India is situated at the trijunction of three realms namely afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms probably is a fact which is believed to partly account for its rich and unique in biological diversity. Based on the available data, India ranks tenth in the world and fourth in Asia in plant diversity, and ranks tenth in the number of endemic species of higher vertebrates in the world. There are 10 biogeographical zones in India. They can be classified as under:

The Biogeographic classification of India (Rodgers and Pawar 1990)

- Trans-Himalayas. An extension of the Tibetan plateau, harboring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.
- Himalayas. The entire mountain chain running from north-western to north-eastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.
- Desert. The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.
- Semi-arid. The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass.
- Western ghats. The hill ranges and plains running along the western coastline, south of the Tapti river, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.
- Deccan peninsula. The largest of the zones, covering much of the southern and south-central plateau with a predominantly deciduous vegetation. 4.3 % of the country's landmass.
- Gangetic plain. Defined by the Ganges river system, these plains are relatively homogenous. 11% of the country's landmass.
- North-east India. The plains and non-Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass.
- Islands. The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.
- Coasts. A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadeep islands are included in this with the percent area being negligible.

Apart from the biogeographic classifications described above ecosystems can also be demarcated on the basis of purely geographical or geological features like mountains, islands, valleys, plateaux, oceans; on the basis of vegetative cover like forests, grasslands, mangroves and deserts; on the basis of climatic conditions like arid and semi-arid areas, permanently snow-bound areas, high rainfall areas; on the basis of soil characteristic and other such criteria.

In some descriptions the biomes/ecosystems are clubbed together into very general habitat classifications. The main natural habitat types are:

- Forests
- Grasslands
- Wetlands
- Mangroves
- Coral reefs
- Deserts

Photo 9.3 Mixed coniferous forest
Source MoEF Annual report 1998-99

Table 9.4 Forest types – distribution and percentage

Forest type	*Distribution*	*% of forest area*
Tropical forests		
Tropical wet evergreen	North East & South, Andaman & Nicobar island	5.8
Tropical semi evergreen	South & East	2.5
Tropical moist deciduous	Central & East	30.3
Tropical littoral & swamp	Along the coast	0.9
Tropical dry deciduous	West & Central	38.2
Tropical thorn	West & Central	6.7
Tropical dry evergreen	Central & South	0.1
Subtropical forests		
Subtropical broad leaved hill forests	South	0.4
Subtropical pine	Sub-Himalayan tract	5.0
Subtropical dry evergreen	North-East & South	0.2
Temperate forests		
Montane wet temperate	Himalaya & Nilgiris (in Western Ghats)	2.0
Himalayan moist temperate	Temperate areas of Himalayas	3.4
Himalayan dry temperate	Dry temperate areas of Himalayas	0.2
Sub-alpine and alpine forests		
Sub-alpine	Himalaya	4.3
Moist alpine shrub	Himalaya	4.3
Dry alpine shrub	Himalaya	4.3

Source GoI 1999

Forests

The forest cover of the country is placed at 633 397 sq km according to the forest survey of India assessment (1997). This presents 19.27% of India's total geographical areas. India is endowed with diverse forest types ranging from the Tropical wet evergreen forests in North-Eastern to the Tropical thorn forests in the Central and Western India (Photo 9.3). The forests of the country can be divided into 16 major groups comprising 221 types. The distribution of these groups, and the percentage of total forest area covered by each are given in Table 9.4.

Grasslands

In India the spread of grassland and shrubland is put at 12% of the total landmass (Olson et al. 1983) while the planning commission (1989) and Grasslands and Fodder research Institute, Jhansi (1993) gives an estimate of about 3.7 to 3.9%.

The diversity of grasslands in India is high ranging from semi-arid pastures of the western part of the Deccan peninsula, the humid, semi-waterlogged tall grassland of the Terai belt, the rolling shola grasslands of the western ghat hilltops, and the high-altitude alpine pastures of the Himalayas.

The grass flora in India is also quite diverse, consisting of about 1256 species in 245 genera and an estimated 370 endemic species reported (Shukla, 1983). Unfortunately due to greater neglect than Forests the status of grasslands is not so well known or documented.

Wetlands

Wetlands cover 3% of the Indian landmass, or nearly 100 000 sq. Km (Olson et al. 1983). Wetlands in India harbor a vast variety of life forms that are a part of the complex food of these transitional ecosystems. About 320 species of birds are associated with the Indian

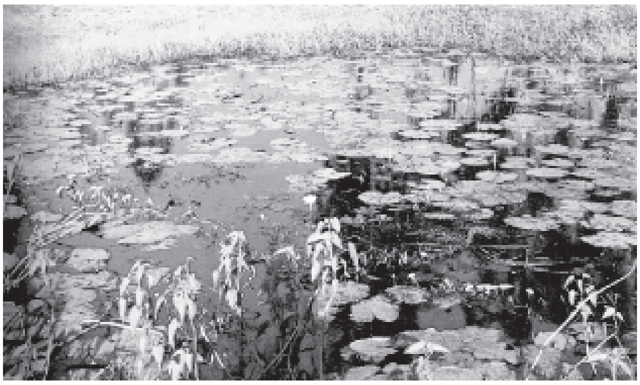


Photo 9.4 Wetlands of West Bengal
Source MoEF Annual report 1999-2000

Wetlands (Photo 9.4). Apart from birds, the wetlands support a diverse population of plants and animals including 150 species of amphibians. Wetlands are the habitat of some of the world's endangered and threatened flora and fauna. The Western and Central flock of Siberian crane, one of the most endangered cranes in the world, uses Keoladeo as its winter site. The brown antlered deer (*Cervus eldi eldi*) or 'sangai' is found only in *phumadis* (floating landmasses) of Lok Tak Lake. Gahirmatha beach is a major breeding site of olive ridley turtles. Chilka is the habitat of many threatened species such as green sea turtle, Hawksbill turtle, dugong, and blackbuck.

Photo 9.5 Waterway in the Pitchavaram mangrove forest flanked by Avicennia and Rhizophora trees
Source MoEF Annual report 1998-99

Mangroves

Government of India estimated mangrove cover of 674 000 ha, which is about 7% of the world's mangrove.

Mangroves are salt-tolerant ecosystems in tropical and subtropical regions. These ecosystems are largely characterized by assemblage of unrelated tree genera that share the common ability to grow in saline tidal zone. India harbours some of the best mangroves swamps in the world, located in the alluvial deltas of Ganga, Mahanadi, Godavari, Krishna, and Cauveri rivers and on the Andaman and Nicobar group of Islands (Photo 9.5). The total area covered by mangroves in India is estimated at about 6,700 sq km. amounting to about 7% of the Worlds mangroves.

The largest stretch of mangroves in the country lies in the Sunderbans in West Bengal covering an area of about 4,200 sq. km. The predominant mangroves species are *Avicennia officinalis Excoecaria agallocha, Heritiera fomes, Bruguiera parviflora, Ceriops decandra, Rhizophora mucronata* and *Xylocarpus granatum*. Mangroves also harbour a number of molluscs, polychaetes and honeybees. The

Photo 9.6 Soft corals (Sinularia sp.) of Andaman and Nicobar Islands
Source MoEF Annual report 1996-97

Indian mangroves are host to 105 species of fish, 20 kinds of shellfish, and 229 crustacean species. The Royal Bengal tiger is found in the Sunderban mangroves. Different species of monkeys, otters, deer, fishing cats, snakes and wild pigs are common. A total of 117 species of migratory and residential birds have been reported. The most common birds are flamingos, storks, sea eagles, kites, kingfishers, sandpipers, bulbuls, and whistlers.

Coral reefs

Accurate estimates of coral reef extent in the world are not available. A rough estimate puts it at 600 000 sq Km (Smith 1978) out of which 60% occurs in the Indian Ocean region and most of it in south-east Asia (Photo 9.6).

The coral reef cover in Indian waters is roughly estimated upto 19,000 sq. Km (Wafar 1992). Indian reefs belong to the following categories:

PalkBay and Gulf of Mannar	: Fringing
Gulf of Kachchh	: Fringing, Patchy
Andaman and Nicobar Islands	: Fringing
Lakshadeep Islands	: Atolls
Central West coast	: Patchy

The diversity of the Indian coral reefs is very impressive with about 200 coral species belonging to 71 genera (Untawale and Dhargalkar 1993). The richest being Andaman and Nicobar Islands which alone harbors 179 species (Subba Rao 1989).

Deserts

In India, deserts extend over about 2% of the landmass (Olson et al. 1983). Three kinds of deserts are noticeable in India:

- The sand desert of western Rajasthan and neighbouring areas.
- The vast salt desert of Gujarat
- The high-altitude cold desert of Jammu and Kashmir and Himachal Pradesh.

Desert fauna in India is also quite diverse, with about 1200 sp. of animals reported from Thar region of which 440 are vertebrates and 755 are invertebrates. Desert fox, Desert cat, Houbara Bustard and some Sandgrouse species are restricted to the Thar area (Rodgers and Pawar 1988). In the remote part of Great Rann, Gujarat lies the nesting ground of Flamingoes and the only known population of Asiatic wild ass.

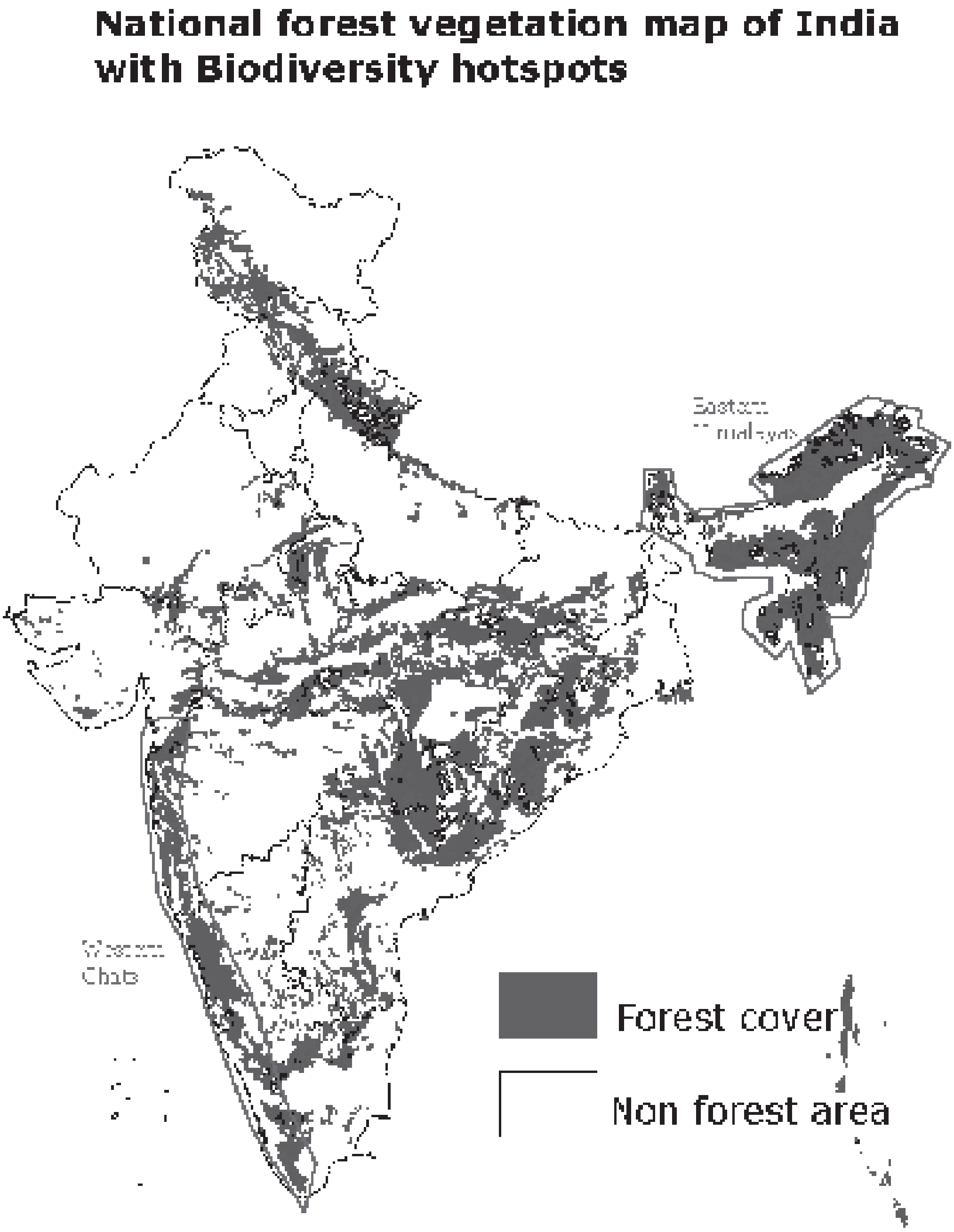
The cold deserts in India cover a vast area of 109 990 sq. Km, about 87,780 sq. km in Laddakh (Jammu and Kashmir) and 22,210 sq. Km in Lahaul -Spiti (Himachal Pradesh). The diversity of the high altitude cold deserts has been studied only recently with many insect species being endemic. Interestingly the cold desert harbors *Kiang* a close relative of the Indian wild ass found the Rann of Kachchh. Other distinctive animals include Snow leopard, Yak, Tibetan antelope, Ibex, Blue sheep, Tibetan gazelle, Woolly hare etc.

Biodiversity hotspots

Biodiversity hotspots are areas that are unusually rich in species, most of which are endemic, and are under a constant threat of being overexploited. Among the 18 hot spots in the world, two are found in India. These are two distinct areas: the Eastern Himalayas and the Western Ghats and are also depicted in the National forest vegetation map of India. Together these 18 sites contain approximately 49 955 endemic plant species, or 20% of the world's recorded plants species, in only 746 400 sq km or 0.5% of the earth's land surface.

Eastern Himalayas

Phytogeographically, the Eastern Himalayas forms a distinct floral region and comprises Nepal, Bhutan, neighbouring states of east and north-east India, and a contiguous sector Yunnan province in south western China. In the whole of Eastern Himalayas, there are an estimated 9000 plant species, with 3500 (i.e. 39%) of them being endemic. In India's sector of the area, there occur some 5800 plant species, roughly 2000 (i.e. 36%) of them being endemic.



Map 9.1 National forest vegetation map of India with biodiversity hotspots

At least 55 flowering plants endemic to this area are recognized as rare, for example, the pitcher plant (*Nepenthes khasiana)*.

The area has long been recognized as a rich centre of primitive flowering plants and the area is recognized as '*Cradle of Speciation*'.

Species of several families of monocotyledons, Orchidaceae, Zingiberaceae and Arecaceae abound in the area. Gymnosperms and pteridophytes (ferns) are also well represented in the area.

The area is also rich in wild relatives of plants of economic significance, e.g. rice banana, citrus, ginger, chilli, jute and sugarcane. The region is regarded as the centre of origin and diversification of five palms of commercial importance namely, coconut, arecanut, palmyra palm, sugar palm and wild date palm.

Tea (*Thea sinensis*) is reported to be in cultivation in this region for the last 40,000 years. Many wild and allied species of tea, the leaves of which are used as substitute of tea, are found growing in the North East in the natural habitats.

The 'taxol' plant *Taxus wallichiana* is sparsely distributed in the region and has come under red data category due to its over exploitation for extraction of a drug effectively used against cancer.

As regards faunal diversity, 63% of the genera of land mammals in India are know from this area. During the last four decades, two new mammals have been discovered from the region: Golden Langur from Assam – Bhutan region, and Namdapha flying squirrel from Arunachal Pradesh indicating the species richness of the region.

The area is also a rich centre of avian diversity – more than 60% of the Indian birds are recorded in the North East. The region also has two endemic genera of lizards, and 35 endemic reptilian species, including two turtle. Of the 204 Indian amphibians, at least 68 species are known from North East, 20 of which are endemic.

From Namdapha National Park itself, a new genus of mammal, a new subspecies of bird, 6 new species of amphibia, four new species of fish, at least 15 new spcies of beetles and 6 new species of flies have been discovered (Babu and Arora 1999).

Photo 9.7 The Malabar Tree Nymph (Idea malabarica) found only in wet evergreen forest of the Western Ghats
Source MoEF Annual report 1997-98

Western ghats

The Western Ghats region is considered as one of the most important biogeographic zones of India, as it is one of the richest centres of endemism. Due to varied topography and micro-climatic regimes, some areas within the region are considered to be active zones of speciation.

The region has 490 arborescent taxa, of which as many as 308 are endemics this endemism of tree species shows a distinct trend, being the highest (43%) in 8N-10°30'N location and declining to 11% in 16N - 16°30'N location.

About 1 500 endemic species of dicotyledonous plants are reported from the Western Ghats. 245 species of orchids belonging to 75 genera are found here, of which 112 species in 10 genera are endemic to the region (Photo 9.7).

As regards the fauna, as many as 315 species of vertebrates belonging to 22 genera are endemic, these include 12 species of mammals, 13 species of birds, 89 species of reptiles, 87 species of amphibians and 104 species of fish.

Photo 9.8 Renanthera imschortians: a highly threatened species of orchid commonly known as "Red Vanda"
Source MoEF Annual report 1998-99

Photo 9.9 Lion-tailed Macaque: an endangered species
Source MoEF Annual report 1999-2000

The extent of endemism is high in amphibian and reptiles. There occur 117 species of amphibians in the region, of which 89 species (i.e. 76%) are endemic. Of the 165 species of reptiles found in Western Ghats, 88 species are endemic.

Many of the endemics and other species are listed as threatened (Photo 9.8). Nearly 235 species of endemic flowering plants are considered endangered. Rare fauna of the region includes: Lion Tailed Macaque (Photo 9.9), Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill (Babu and Arora 1999).

Biodiversity contribution to Indian economy

Biodiversity products have obtained a commercial value and have been increasingly exchanged in the markets having a monetary value, from which their share in the national economy can be judged. In the Indian context it is difficult to put a value on diversity as such because the marketable products are of various kinds both legal and illegal e.g wood and non-wood products from forests where wood comprises the major commercial produce is both legally exported as well as illegally smuggled out of the country. Many non-wood forest produce and the illegal produce is not accounted for in the official documents.

The contribution of natural and agricultural biodiversity in terms of crops, live stock, fisheries etc is very substantial in terms of commercial value.

Such biodiversity has a major contribution to make to the Indian GDP (gross domestic product). The large economic implications of biodiversity in its wild and domesticated forms is the rice improvement programme. Rice accounts for 22% of the total cropped area and 39% of the total area under cereals, which reflects its importance in the country's struggle to attain self-sufficiency in food. When the rice crop was doomed due to the grassy stunt virus in the 1970s, one single gene from the wild strain of rice, namely *Oryza nivara* from Uttar Pradesh, showed resistance to this virus and proved vital in the fight against the virus.

With respect to the commercial value of the plant species of medicinal value, the world trade is of several billion dollars and this is growing. The export market for medicinal plants has also increased. India's foreign exchange reserves from horticultural products are from high yielding varieties (ICAR 1999). Increased production of oilseeds also helped in saving large amounts of foreign exchange spent on edible oil import.

The aforesaid pressures will lead to loss of biodiversity in India and will also result in considerable drop in Indian GDP and foreign exchange earnings from horticultural products, oil seeds, oil meal, and oil cake will drop down to a great extent.

Response

The Ministry of Environment and Forests (MoEF) is the nodal agency in the Government of India for planning, promotion, coordination, and overseeing the implementation of the environmental and forestry programmes. The MoEF is also the focal point for implementation of the Convention on Biological Diversity. The mandates of the Ministry interalia include survey of flora, fauna, forests and wildlife, and conservation of natural resources (Photo 9.10). These objectives are supported by legislative and regulatory measures. A number of institutions affiliated with the Ministry are involved in the work related to various aspects of biological diversity. Survey and inventorization of the floral and faunal resources are carried out by the Botanical Survey of India (BSI) established in 1890, and the Zoological Survey of India (ZSI) established in 1916. The Forest Survey of India established in 1981 assesses the forest cover, with a view to develop an accurate database for planning and monitoring purposes. The Wildlife Institute of India undertakes studies of endangered species of animals and critical ecosystems. Over 47,000 species of plants and 89,000 animals species have been recorded by the BSI and ZSI respectively.

Photo 9.10 Black buck: needs conservation
Source MoEF Annual report 1997-98

Photo 9.11 Pitcher plant: an endangered species
Source MoEF Annual report 1997-98

The Survey organizations have published over the years, documents on flora and fauna at country, state and in some cases district levels and for selected ecosystems. Besides, extensive reports on inventories of resources indicating level of biodiversity in selected areas have also been brought out. The Surveys have also published Red Data Books on endangered species (Photo 9.11). The voucher specimens are preserved in Central National Herbarium (CNH) of BSI and National Zoological Collection (NZC) of ZSI.

The Forest Survey of India publishes every three years, a State of Forest in India report based on remote sensing and ground truth data.

Photo 9.12 A herd of Cheetal at Bandipur Wildlife Sanctuary
Source MoEF Annual report 1999-2000

Existing policy response

In situ conservation (within natural habitat)

Some important measures taken are as follows:

- Approximately 4.2% of the total geographical area of the country has been earmarked for extensive in situ conservation of habitats and ecosystems. A protected area network of 85 National Parks and 448 Wildlife Sanctuaries have been created (Photo 9.12). The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles, elephants, etc.
- The Indian Council of Forestry Research and Education **(ICFRE)** has identified 309 forest preservation plots of representative forest types for conservation of viable and representative areas of biodiversity. 187 of these plots are in natural forests and 112 in plantations, covering a total area of 8,500 hectares.
- A programme entitled **"Eco-development"** for in situ conservation of biological diversity involving local communities has been initiated in recent years. The concept of eco-development integrates the ecological and economic parameters for sustained conservation of ecosystems by involving the local communities with the maintenance of earmarked regions surrounding protected areas. The economic needs of the local communities are taken care of under this programme through provision of alternative sources of income and a steady availability of forest and related produce.

Table 9.5 Biosphere reserves set up

Name of the site	*Date of notification*	*Location (State)*
Nilgiri	01.08.86	Part of Wynad , Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills (Tamil Nadu)
Nanda Devi	18.01.88	Part of Chamoli, Pithoragarh, Almora Districts (Uttar Pradesh)
Nokrerk	01.09.88	Part of Gora Hills (Meghalaya)
Manas	14.03.89	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang district (Assam)
Sunderbans	29.03.89	Part of delta of Ganga & Brahamaputra river system (West Bengal)
Gulf of Mannar	18.02.89	Indan part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
Great Nicobar	06.01.89	Southern most islands of Andaman and Nicobar (A&N islands)
Similpal	21.06.94	Part of Mayurbhanj district (Orissa)
Dibru-Saikhowa	28.07.97	Part of Dibrugarh and Tinsukia district (Assam)
Dehang Debang	02.09.98	Part of Siang and Debang velley in Arunachal Pradesh
Pachmarhi	03.03.99	Parts of Betul, Hoshangabad and Chindwara districts of Madhya Pradesh
Kanchanjanga	07.02.2000	Part of Kanchanjanga Hills and Sikkim

Source MoEF 2000

Photo 9.13 Den of the Royal Bengal Tiger of Sundarbans Biosphere Reserves
Source MoEF Annual report 1999-2000

- To conserve the respective ecosystems, a **Biosphere Reserve Programme** is being implemented. Twelve biodiversity rich areas of the country have been designated as Biosphere Reserves (Table 9.5) applying the diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of the living resources (Photo 9.13).
- Programmes have also been launched for scientific management and wise use of fragile ecosystem. Specific programmes for management and conservation of wetlands, mangroves, and coral reef systems are also being implemented. 21 wetlands, 15 mangrove areas and 4 coral reef areas have been identified for management. National and sub-national level committees oversee and guide these programme to ensure strong policy and strategic support.
- Six internationally significant wetlands of India have been declared as "**Ramsar Sites**" under the Ramsar Convention. To focus attention on urban wetlands threatened by pollution and other anthropogenic activities, State Governments were requested to identify lakes that could be include the National Lake Conservation Plan. The activities of the NLCP include formulation of perspective plans for conservation based on resource survey using remote sensing technology and GIS studies on biodiversity and related ecological matters, prevention of pollution from point and non-point sources, treatment of catchment, desilting and weed control.
- Wild Life Protection Act is in the final stage of revision and provisions have been made for conservation reserves and community reserves to allow restrictive use to make it more people oriented. Presently Biodiversity Act which is in the final stage, has got the component of National Biodiversity Authority to control access to genetic resources form international community. There will also be State Biodiversity Boards to control access to domestic consumers.

Table 9.6 World heritage sites

Site	*Location*
Kaziranga National Park	Assam
Keoladeo Ghana National Park	Rajasthan
Manas Wildlife Sanctuary	Assam
Nanda Devi National Park	Uttar Pradesh
Sundarban National Park	West Bengal

- Under the World Heritage Convention, five natural sites have been declared as "**World Heritage Sites**", the name of which are under:
- The Tura Range in Gora Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild Citrus and Musa species.
- Sanctuaries for rhododendrons and orchids have been established in Sikkim.
- Large mammal species targeted protection based on the perception of threat to them have been under implementation.
- **Project Tiger.** A potential example of an highly endangered species is the Indian Tiger (*Panthera tigris*) The fall and rise in the number of Tiger's in India is an index of the extent and nature of conservation efforts. It is estimated that India had about 40 000 tigers in 1900, and the number declined to a mere about 1 800 in 1972. Hence, Project Tiger was launched in 1973 with the following objectives:
  - To ensure maintenance of available population of Tigers in India for scientific, economic, aesthetic, cultural and ecological value
  - To preserve, for all times, the areas of such biological importance as a national heritage for the benefit, education and enjoyment of the people
  - At present there are 25 Tiger Reserves spreading over in 14 states and covering an area of about 33 875 sq km and the Tiger population has more than doubled now due to a total ban on hunting and trading tiger products at national and international levels and the implementation of habitat improvement and anti-poaching measures (MoEF 2000)

Photo 9.14 Herd of elephants of North-east India
Source MoEF Annual report 1998-99

- **Project Elephant** was launched in 1991-92 to assist States having free ranging population of wild elephants to ensure long term survival of identified viable populations of elephants in their natural habitats (Photo 9.14). Major activities of Project Elephant are:
  - Ecological restoration of existing natural habitats and migratory routes of elephants
  - Development of scientific and planned management for conservation of elephants habitats and value population of wild Asiatic elephants in India
  - Promotion of measures for mitigation of man-elephant conflict in crucial habitats and moderating pressures of human and domestic stock activities in crucial elephant habitats
  - Strengthening of measures for protection of wild elephants from poachers and unnatural caused of death
  - Research on Project Elephant management related issues
  - Public education and awareness programmes
  - Eco-development
  - Veterinary care

- Rhinos have been given special attention in selected sanctuaries and national parks in the North East and North-west India. All these programmes, though focussed on a single species, have a wider impact as they conserve habitats and a variety of other species in those habitats.

Photo 9.15 Joint Forest Management

- The Ministry of Environment and Forests constituted the National Afforestation and Eco-development Board (NAEB) in August 1992. National Afforestation and Eco-development Board has evolved specific schemes for promoting afforestation and management strategies, which help the states in developing specific afforestation and management strategies and eco-development packages for augmenting biomass production through a participatory planning process of Joint Forest Management and microplanning (Photo 9.15).

Ex-situ conservation (outside natural habitats)

To complement in situ conservation, attention has been paid to ex-situ conservation measures. According to currently available survey, Central Government and State Government together run and manage 33 Botanical Gardens. Universities have their own botanic gardens. There are 275 zoos, deer parks, safari parks, aquaria etc. A Central Zoo Authority was set up to secure better management of zoos. A scheme entitled Assistance to Botanic Gardens provides one-time assistance to botanic gardens to strengthen and institute measure for ex-situ conservation of threatened and endangered species in their respective regions.

Recent conservation initiatives

Several recent initiatives of the Indian Government have focused on wetland, mangroves and coral reef management. In 1998-99, an amount of Rs. 140 lakhs were released to the State Governments for the preparation of management action plans for Pongdam in Himachal Pradesh, Wullar in Kashmir, Loktak in Manipur, Rudrasagar in Tripura and Kolleru in Andhra Pradesh. Additionally, one more wetland has been identified for conservation, i.e. Rudrasagar from Tripura, thus increasing the list to 20 wetlands for intensive conservation in the country. Additionally, a wetland strategy has been drafted.

The National Committee on Conservation and Management of Mangroves and Coral Reefs in September 1998 recommended the establishment of an Indian Coral Reef Monitoring Network to develop Action Plans for important coral reefs of the country. Preparation of these plans is already underway. Moreover, financial assistance from UNDP/GEF has led to a PDF-B project on strengthening the Gulf of Mannar Biosphere Reserve. The ZSI (Zoological Survey of India) has initiated another UNDP/GEF project relating to management of Andaman's coral reefs.

Policy gaps

- Lack of policies for protection of wetlands, grasslands, sacred groves and other areas significant from the point of view of biodiversity.
- Lacunae in economic policy, institutional and governance system
- Inadequate enforcement of existing laws
- Poor implementation of wildlife protection act 1972 as amended in 1991
- Inadequate implementation of eco-development programmes
- Need for enhanced role of NGOs and other institutions
- Need for political commitment and good will.
- Need for providing Institutional Structure
- Need for more sectoral financial outlay
- Human resource development - limited local community participation

Knowledge/information/data

- Documentation of biodiversity is an urgent requirement as latest statistics and data on floral and faunal biodiversity of India has not been compiled and documented.
- The information and data should be made available to the scientific and socio-economic agencies to support the evaluation/ revision of the policies.
- Lack of knowledge of the magnitude, patterns, causes and rates of deforestation and biodiversity laws at the ecosystem and landscape level.
- Information on poaching trade and trade routes is sketchy and current wildlife protection and law enforcement measures are inadequate and inefficient procedure.
- Biodiversity Act /Bill should not override the provisions of Wildlife Protection Act.

Policy recommendations

- Most of the legal provisions pertain mainly to use/exploitation of biological resources, rather than their conservation. Even Wild Life Protection Act 1972, focuses on protection rather than conservation. Protection under Wild Life Protection Act is largely directed towards large animal species (charismatic terrestrial species) rather than the large spectrum of fauna and flora also found in the marine realm.
- Hence the existing laws relating to biodiversity shall be examined in order to bring them in tune with the provisions of convention to reflect current understanding of biodiversity conservation.
- Need for comprehensive legislation on biodiversity conservation and use especially fisheries policies, which is generally ignored.
- Formulation of policies for protection of wetlands, grasslands, sacred groves, marine flora and fauna and other areas significant from the point of view of biodiversity.
- Improving policy environment.
- Passage of biodiversity bill.
- A presence of a biodiversity cell in all development departments impinging on land and water.
- Documentation of biodiversity.
- Increase allocation of financial resources for conservation of biodiversity.
- Integrating conservation with development
- Incentives and disincentives for improper use of biodiversity
- Biodiversity Act / Bill should not override the provisions of Wildlife Protection act.
- There should be continuous monitoring of biodiversity use for review of results of implementation of policies and programmes.

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10 Air pollution with special reference to vehicular pollution in urban cities

Introduction

Air pollution has been aggravated by developments that typically occur as countries become industrialised: growing cities, increasing traffic, rapid economic development and industrialisation, and higher levels of energy consumption. The high influx of population to urban areas, increase in consumption patterns and unplanned urban and industrial development have led to the problem of air pollution. Currently, in India, air pollution is widespread in urban areas where vehicles are the major contributors and in a few other areas with a high concentration of industries and thermal power plants. Vehicular emissions are of particular concern since these are ground level sources and thus have the maximum impact on the general population. Also, vehicles contribute significantly to the total air pollution load in many urban areas.

Pressure

Increase in urban population

Between 1951 and 1991, the urban population has tripled, from 62.4 million to 217.6 million, and its proportion has increased from 17.3% to 25.7%.

Nearly two-thirds of the urban population is concentrated in 317 class I cities (population of over 100 000), half of which lives in 23 metropolitan areas with populations exceeding 1 million. The number of urban agglomerations/cities with populations of over a million has increased from 5 in 1951 to 9 in 1971 and 23 in 1991 (Pachauri and Sridharan 1998).

This rapid increase in urban population has resulted in unplanned urban development, increase in consumption patterns and higher demands for transport, energy, other infrastructure, thereby leading to pollution problems.

Increase in number of vehicles

The number of motor vehicles has increased from 0.3 million in 1951 to 37.2 million in 1997 (MoST 2000). Out of these, 32% are concentrated in 23 metropolitan cities. Delhi itself accounts for about 8% of the total registered vehicles and has more registered vehicles than those in the other three metros (Mumbai, Calcutta, and Chennai) taken together. Figure 10.1 shows the steep growth in the number of vehicles in India (Photo 10.1).

At the all-India level, the percentage of two-wheeled vehicles in the total number of motor vehicles increased from 9% in 1951 to 69% in 1997, and the share of buses declined from 11% to 1.3% during the same period (MoST 2000). This clearly points to a tremendous increase in the share of personal transport vehicles. In 1997, personal transport vehicles (two-wheeled vehicles and cars only) constituted 78.5% of the total number of registered vehicles.

Road-based passenger transport has recorded very high growth in recent years especially since 1980-81. It is estimated that the roads accounted for 44.8 billion passenger kilometer (PKM) in 1951 which has since grown to 2,515 billion PKM in 1996. The freight traffic handled by road in 1996 was about 720 billion tonne kilometer (TKM) which has increased from 12.1 TKM in 1951 (MoST 1996). In contrast, the total road network has increased only 8 times from 0.4

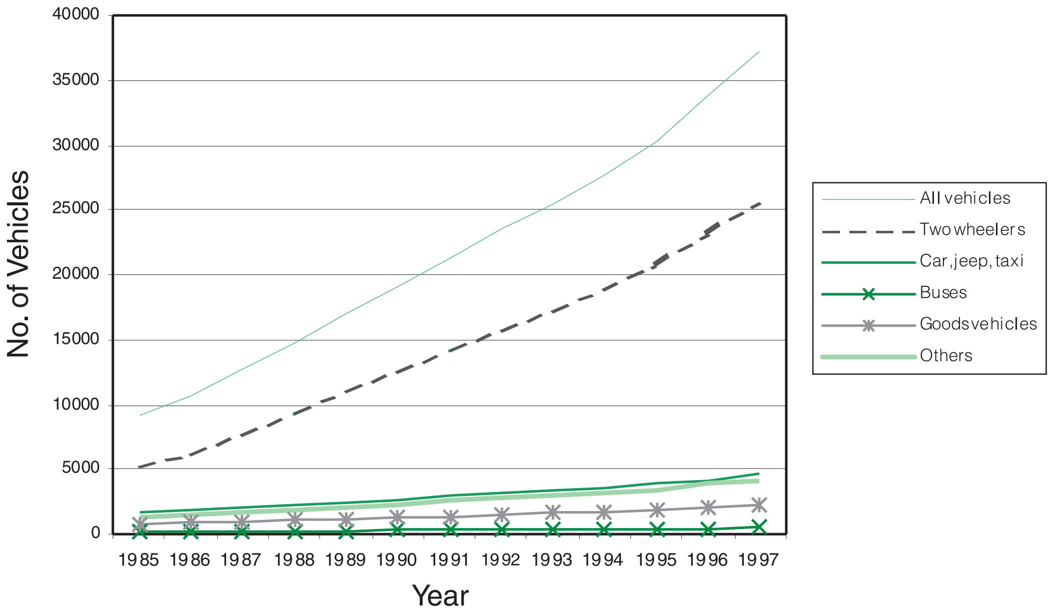


Figure 10.1 Vehicular growth in India

Photo 10.1 Vehicular growth in Delhi

million kms in 1950-51 to 3.3 million kms in 1995-96. The slow growth of road infrastructure and high growth of transport performance and number of vehicles all imply that Indian roads are reaching a saturation point in utilising the existing capacities. The consumption of gasoline and HSD has grown more than 3 times during the period 1980-1997. While the consumption of gasoline and HSD were 1,522 and 9,050 thousand tonnes in 1980-81, it increased to 4,955 and 30,357 thousand tonnes in 1996-97, respectively (CMIE 2000).

Increase in industrial activity

India has made rapid strides in industrialisation, and it is one of the ten most industrialised nations of the world. But this status, has brought with it unwanted and unanticipated consequences such as unplanned urbanisation, pollution and the risk of accidents.

The CPCB (Central Pollution Control Board) has identified seventeen categories of industries (large and medium scale) as significantly polluting and the list includes highly air polluting industries such as integrated iron and steel, thermal power plants, copper/zinc/aluminium smelters, cement, oil refineries, petrochemicals, pesticides and fertiliser units.

The state-wise distribution of these pre-1991 industries indicates that the states of Maharashtra, Uttar Pradesh, Gujarat, Andhra Pradesh and Tamil Nadu have a large number of industries in these sectors. The category-wise distribution of these units reveals that sugar sector has the maximum number of industries, followed by pharmaceuticals, distillery, cement and fertiliser. It also indicates that agro-based and chemical industries have major shares of 47% and 37% of the total number of industries respectively. The status of pollution control as on 30 June 2000 is as follows: out of 1,551 industries, 1,324 have so far been provided the necessary pollution control facilities, 165 industries have been closed down and the remaining 62 industries are defaulters (CPCB 2000a). It may be noted that in some of the key sectors such as iron and steel, 6 out of 8 units belong to the defaulters category in terms of having pollution control facilities to comply with the standards. On the other hand, cement, petrochemicals and oil refinery sectors do not have any defaulters.

Small scale industries are a special feature of the Indian economy and play an important role in pollution. India has over 3 million small scale units accounting for over 40 percent of the total industrial output in the country (CII and SII 1996). In general, Indian small scale industries lack pollution control mechanisms. While the larger industries are better organised to adopt pollution control measures, the small scale sector is poorly equipped (both financially and technically) to handle this problem. They have a very high aggregate pollution potential. Also, in many urban centres, industrial units are located in densely populated areas, thereby affecting a large number of people.

Increase in power generation

Since 1950-51, the electricity generation capacity in India has multiplied 55 times from a meager 1.7 thousand MW to 93.3 thousand MW (MoF 2000). The generating capacity in India comprises a mix of hydro, thermal, and nuclear plants. Since the early seventies, the hydro-thermal capacity mix has changed significantly with the share of hydro in total capacity declining from 43% in 1970-71 to 24% in 1998-99. Thermal power constitutes about 74% of the total installed power generation capacity. However, increasing reliance on this source of energy leads to many environmental problems.

India's coal has a very high in ash content (24%–45%). The increased dependence of the power sector on an inferior quality coal has been associated with emissions from power plants in the form of particulate matter, toxic elements, fly ash, oxides of nitrogen, sulphur and carbon besides ash, which required vast stretches of land for disposal. During 1998-99, the power stations consumed 208 million tonnes of coal, which in turn produced 80 million tonnes of ash posing a major problem disposal (CPCB 2000b).

Thermal power plants belong to the 17 categories of highly polluting industries. As on 30 June 2000, out of the 97 pre-1991 TPP's, 20 plants had not yet provided the requisite pollution control facilities (CPCB 2000a) (Photo 10.2).

Domestic pollution

Pollution from different types of cooking stoves using coal, fuelwood, and other biomass fuels contributes to some extent, to the overall pollution load in urban areas. For example, in Delhi, the share of the domestic sector is about 7%–8% of the total pollution load (MoEF 1997). The main concern is the use of inefficient and highly polluting fuels in

Photo 10.2 Air pollution from TPP

the poorer households leading to a deterioration in indoor air-quality and health. However, a positive development in the domestic energy consumption is that liquefied petroleum gas is fast becoming the most popular cooking fuel, especially in urban areas, as it is cleaner and more efficient than traditional cooking fuels (Photo 10.3).

Photo 10.3 Indoor air pollution

Other sources

The problem of air pollution in urban areas is also aggravated due to inadequate power supply for industrial, commercial and residential activities due to, which consumers have to use diesel-based captive power generation units emitting high levels NO_x and SO_x. In addition, non-point sources such as waste burning, construction activities, and roadside air borne dust due to vehicular movement also contribute to the total emission load.

State

Air pollutant emission load

The direct impact of a growth in various causal factors/pressures is the increase in the emission loads of various pollutants, which has led to deterioration in the air quality. In India, there is no systemic time series data available related to air pollutant emission loads and trends. The availability of emission factors for Indian conditions is another issue that has not been given due attention so far.

TERI (1998) provides some broad estimates of the increase in pollution load from various sectors in India. The total estimated pollution load from the transport sector increased from 0.15 million tonnes in 1947 to 10.3 million tonnes in 1997. In 1997, CO claimed the largest share (43%) of the total, followed by NO_x (30%), HC (20%), SPM (5%), and SO_2 (2%). Likewise, in the thermal power sector, the total estimated pollution load of SPM, SO_2 and NO_x increased from 0.3 million tonnes in 1947 to 15 million tonnes in 1997. In 1997, SPM claimed the largest share (86%) of the total. In the industrial sector, the total estimated emissions of SPM from the 7 critical industries (iron and steel, cement, sugar, fertilisers, paper and paper board, copper and aluminium) increased from 0.2 million tonnes in 1947 to 3 million tonnes in 1997.

The World Bank (1996) study shows that pollution is concentrated among a few industrial sub-sectors and that a sector's contribution to pollution is often disproportionate to its contribution to industrial output. For example, petroleum refineries, textiles, pulp and paper, and industrial chemicals produce 27% of the industrial output but contribute 87% of sulphur emissions and 70% of nitrogen emissions from the industrial sector. Likewise, iron and steel, and non-metallic mineral products, produce about 16% of the industrial output but account for 55% of the particulate emissions.

Vehicular emissions

The drastic increase in number of vehicles has also resulted in a significant increase in the emission load of various pollutants.

The quantum of vehicular pollutants emitted is highest in Delhi followed by Mumbai, Bangalore, Calcutta and Ahmedabad. The daily pollution load generated due to automobiles in 12 metropolitan cities is shown in Table 10.1. Carbon monoxide (CO) and hydrocarbons (HC) account for 64% and 23%, respectively, of the total emission load due to vehicles in all these cities considered together (CPCB 1995).

Apart from the concentration of vehicles in urban areas, other reasons for increasing vehicular pollution are the types of engines used, age of vehicles, congested traffic, poor road conditions, and outdated automotive technologies and traffic management systems.

Vehicles are a major source of pollutants in metropolitan cities. In Delhi, the daily pollution load has increased from 1,450 tonnes in 1991 to 3,000 metric tonnes in 1997 (MoEF 1997). The share of the transport sector has increased from 64% to 67% during the same period while that of the industrial sector (including power plants) has decreased from 29% to 25% (MoEF 1997) (Photo 10.4).

Ambient air quality

Under the National Ambient Air Quality Monitoring (NAAQM) network, three criteria air pollutants, namely, SPM, SO_2, and NO_2 have been identified for regular monitoring at all the 290 stations spread across the country.

CPCB (2000c) analyses the status and trends of air quality at various cities in India for the period 1990-98. Figures 10.2 to 10.4 show the minimum, maximum and annual averages of SPM, SO_2, and NO_2 in 16 cities in the country between 1990 and 1998. The most prevalent form of air pollution appears to be SPM although there are many stations at which SO_2 and NO_2 levels exceed permissible limits. The high influx of population to urban areas increase in consumption patterns, unplanned urban and industrial development and poor enforcement mechanism has led to the problem of air pollution.

The government has taken a number of measures such as legislation, emission standards for industries, guidelines for siting of industries, environmental audit, EIA, vehicular

Table 10.1 Estimated vehicular emission load in metropolitan cities, 1994

	Vehicular pollution load (tonnes per day)					
Name of the city	*Particulates*	*SO_2*	*NO_X*	*HC*	*CO*	*Total*
Delhi	10.30	8.96	126.46	249.57	651.01	1046.30
Mumbai	5.59	4.03	70.82	108.21	469.92	659.57
Bangalore	2.62	1.76	26.22	78.51	195.36	304.47
Calcutta	3.25	3.65	54.69	43.88	188.24	293.71
Ahmedabad	2.95	2.89	40.00	67.75	179.14	292.73
Pune	2.39	1.28	16.20	73.20	162.24	255.31
Madras	2.34	2.02	28.21	50.46	143.22	226.25
Hyderabad	1.94	1.56	16.84	56.33	126.17	202.84
Jaipur	1.98	1.25	15.29	20.99	51.28	88.99
Kanpur	1.06	1.08	13.37	22.24	48.42	86.17
Lucknow	1.14	0.95	9.68	22.50	49.22	83.49
Nagpur	0.55	0.41	5.10	16.32	34.99	57.37
Grand total	35.31	29.84	422.88	809.96	2299.21	3597.20

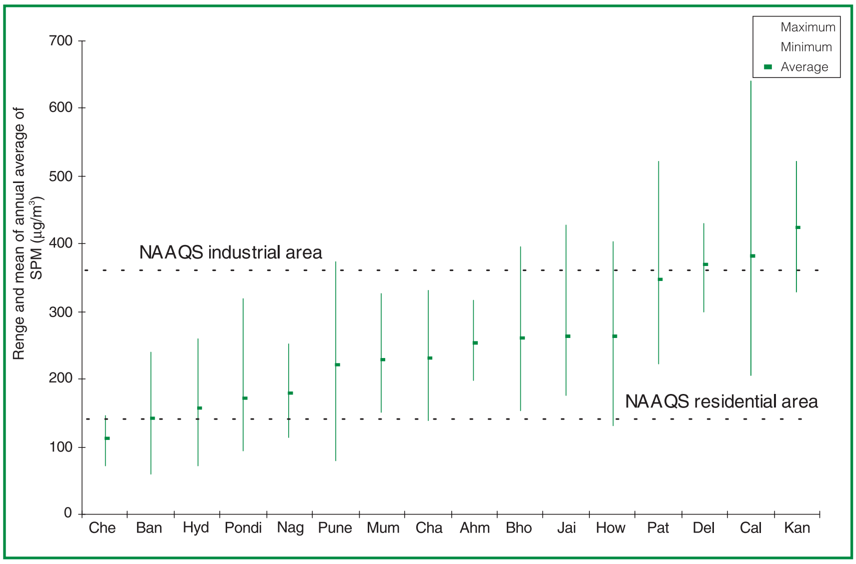
Source CPCB 1995

Photo 10.4 Vehicular pollution in urban cities

pollution control measures, pollution prevention technologies, action plan for problem areas, development of environmental standards, and promotion of environmental awareness. However, despite all these measures, air pollution still remains one of the major environmental problems. At the same time, there have been success stories as well such as the reduction of ambient lead levels (due to introduction of unleaded petrol) and comparatively lower SO_2 levels (due to progressive reduction of sulphur content in fuel).

SPM

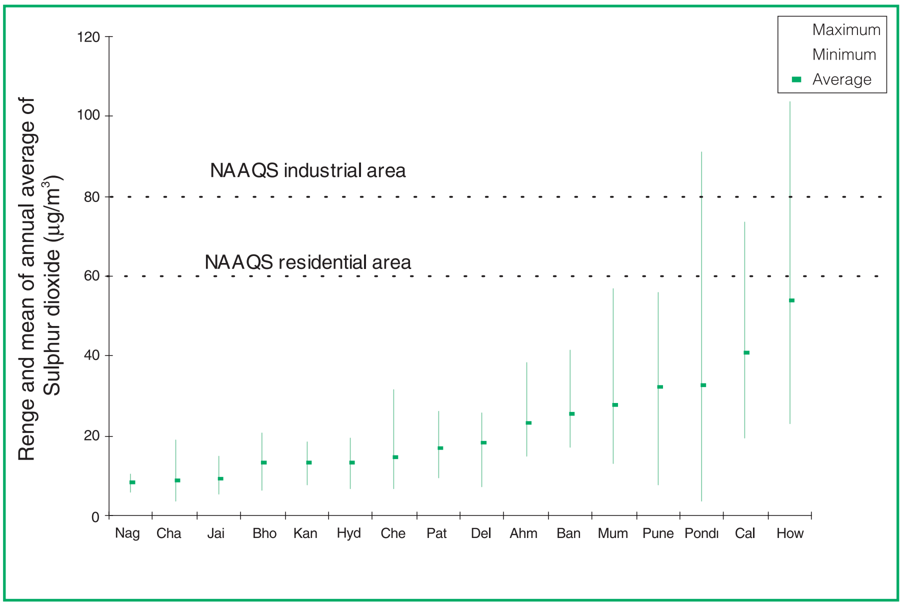
Suspended particulate matter is one of the most critical air pollutants in most of the urban areas in the country and permissible standards are frequently violated several moni-



Che – Chennai; Ban – Bangalore; Hyd – Hyderabad; Pondi – Pondicherry; Nag – Nagpur; Pune – Pune; Mum – Mumbai; Cha – Chandigarh; Ahm – Ahmedabad; Bho – Bhopal; Jai – Jaipur; How – Howrah; Pat – Patna; Del – Delhi; Cal – Calcutta; Kan – Kanpur.

Figure 10.2 Range and mean of annual averages (1990-98) of SPM in various cities

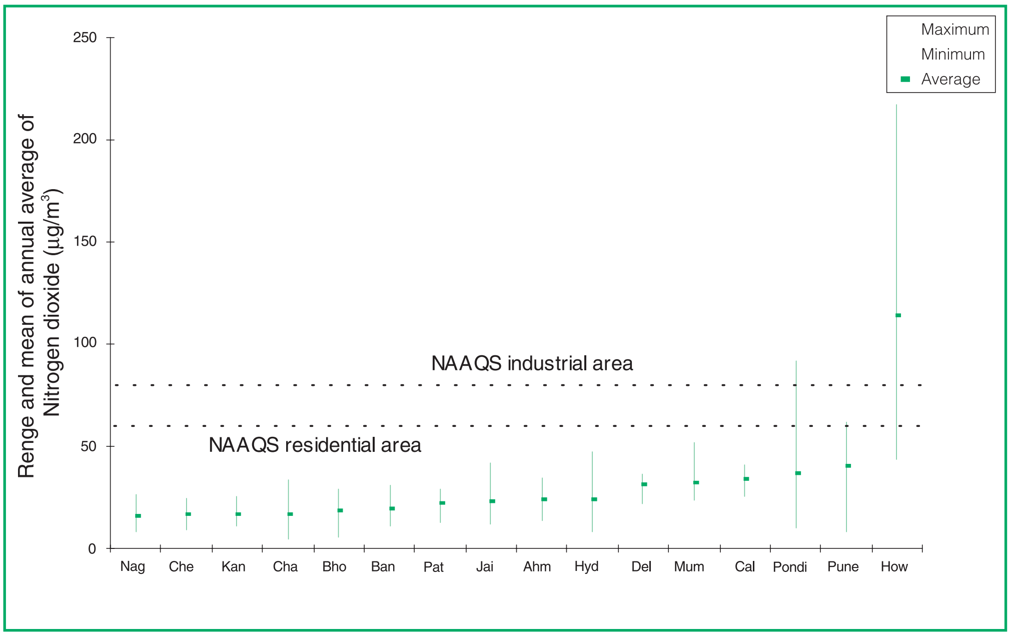
Source CPCB 2000c



Nag – Nagpur; Cha – Chandigarh; Jai – Jaipur; Bho – Bhopal; Kan – Kanpur; Hyd – Hyderabad; Che – Chennai; Pat – Patna; Del – Delhi; Ahm – Ahmedabad; Ban – Bangalore; Mum – Mumbai; Pune – Pune; Pondi – Pondicherry; Cal – Calcutta; How – Howrah.

Figure 10.3 Range and mean of annual averages (1990-98) of SO_2 in various cities

Source CPCB 2000c



Nag – Nagpur; Che – Chennai; Kan – Kanpur; Cha – Chandigarh; Bho – Bhopal; Ban – Bangalore; Pat – Patna; Jai – Jaipur; Ahm – Ahmedabad; Hyd – Hyderabad; Del – Delhi; Mum – Mumbai; Cal – Calcutta; Pondi – Pondicherry; Pune – Pune; How – Howrah.

Figure 10.4 Range and mean of annual averages (1990-98) of NO_2 in various cities

Source CPCB 2000c

tored locations. Its levels have been consistently high in various cities over the past several years.

The annual average minimum and maximum SPM concentration in residential areas of various cities ranged from 60 µg/m^3 (at Bangalore during 1991) to 521 µg/m^3 (at Patna during 1995), while in industrial areas the annual average ranged between 53 µg/m^3 (Chennai during 1992) and 640 µg/m^3 (Calcutta during 1993). The mean of average values of SPM for nine years (1990 to 1998) ranged between 99 µg/m^3 and 390 µg/m^3 in residential areas and between 123 µg/m^3 and 457 µg/m^3 in industrial areas indicating that the annual average limit of suspended particulate matter for residential areas (140 µg/m^3) and for industrial areas (360 µg/m^3) had been frequently violated in most cities.

The maximum suspended particulate matter (SPM) values were observed in Kanpur, Calcutta, and Delhi, while low values have been recorded in the south Indian cities of Chennai, Bangalore, and Hyderabad.

The SPM non-attainment areas are dispersed throughout the country. The states with maximum SPM problems are Gujarat, Maharashtra, and Madhya Pradesh, where SPM problems are high to critical in a large number of cities. The widespread criticality of the SPM problem in the country is due to the synergistic effects of both anthropogenic and natural sources. Some of these are extensive urbanisation and construction activities, vehicular pollution increase, extensive use of fossil fuel in industrial activities, inadequacy of pollution control measures, biomass burning, presence of large acid and semi-acid area in north-west part of India, increasing desertification, and decreasing vegetation cover.

SO_2

The annual average level fluctuation of SO_2 was highest in residential areas of Howrah (West Bengal) recording between 40.6 µg/m^3 and 103.8 µg/m^3 while it was quite low in residential areas of Nagpur, Chandigarh, and Jaipur (below 10 µg/m^3). Among the industrial areas, the recorded sulphur dioxide levels were high at Pondicherry, Calcutta, Mumbai, and Howrah, and low at Nagpur, Jaipur, and Chandigarh. Thus, based on the mean average sulphur dioxide value, Nagpur, Chandigarh and Jaipur are cities with the least problems related to sulphur dioxide in the ambient air, while the problem is significant in Howrah, Calcutta, and Pondicherry, where annual average limits (60 and 80 µg/m^3 for residential and industrial areas) have been violated many times during the past several years.

The sulphur dioxide levels have generally attained air quality standards in the country except some cities of dense urban and industrial activities like Dhanbad (Bihar), Ahmedabad, Ankleshwar, Vadodara and Surat (Gujarat); Nagda (Madhya Pradesh); Pondicherry; and Howrah (West Bengal). Some of the measures taken such as cleaner fuel quality (reduction of sulphur content in diesel) and switch over to cleaner fuel option have contributed t lower SO_2 ambient levels.

NO_2

The air quality monitoring data indicate that the annual average nitrogen dioxide has been well within the annual average limit (60 µg/m^3 for residential area and 80 µg/m^3 for industrial areas) at most urban cities except in some years in residential areas of Howrah, Vishakhapatnam, Kota, and industrial areas of Howrah. The annual average concentration has been low at Nagpur, Chennai, Kanpur, and Chandigarh while levels are moderate in other cities.

The nitrogen dioxide non-attainment areas were at Vishakhapatnam (AP), Jabalpur (MP), Pondicherry, Alwar, Kota, Udaipur (Rajasthan) and Howrah (West Bengal). The criticality of problem was observed at Vishakhapatnam, Kota, and Howrah.

Status of other air pollutants

The salient results of additional parameters at some stations in the metropolitan cities of Delhi, Calcutta, Mumbai, and Chennai for the years 1996-97 are as follows (CPCB 1998):

- The annual mean concentration of respirable particulate matter (RPM) is much higher than the prescribed limits of 120 µg/m^3 (industrial) and 60 µg/m^3 (residential and other uses) in Delhi and Calcutta. However, RPM in Mumbai and Chennai is not very high but is greater than prescribed ambient air quality standards.
- Though particulate lead in the ambient air of Calcutta and Delhi is higher as compared to the other two cities (Chennai and Mumbai), it is well within the prescribed limits for the different area classes.
- The concentration of polycyclic aromatic hydrocarbons (PAHs) is showing an upward trend. However, at present permissible limits for PAHs have not been notified.

It may be noted that lead free gasoline has been introduced throughout the country w.e.f. February 1, 2000, and in all metropolitan cities since 1995. This has resulted in a downward trend in the lead concentrations in the ambient air (CPCB 2000c).

Air quality at traffic intersections

Air quality monitoring conducted at different traffic intersections in Delhi (MoEF 2000a) revealed the following:

- Respirable particulate matter was excessively high at all the monitoring locations.
- Sulphur dioxide was recorded within limits at all the locations.
- Nitrogen dioxide was recorded well within the limits except a few locations.
- The carbon monoxide levels at most locations was much higher than the prescribed permissible limit. This is because of high traffic density and large number of motor vehicles operating on the roads.

Measures such as stringent emission norms for vehicles, cleaner fuel quality, inspection and maintenance programmes are expected to make some contribution towards improvement in the air quality. However, in the absence of mass transport system, the tremendous increase in personal vehicles is a cause for concern.

Air pollution and health impacts

In India, millions of people breathe air with high concentrations of dreaded pollutants. The air is highly polluted in terms of suspended particulate matter in most cities. This has led to a greater incidence of associated health effects on the population manifested in the form of sub-clinical effects, impaired pulmonary functions, use of medication, reduced physical performance, frequent medical consultations and hospital admissions with complicated morbidity and even death in the exposed population. As per a World Bank (1993) study, respiratory infections contribute to 10.9% of the total burden of diseases, which may be both due to presence of communicable diseases as well as high air pollution levels, while cerebro vascular disease (2.1%) ischemic heart disease (2.8%) and pulmonary obstructions (0.6%) are much lower. The prevalence of cancer is about 4.1% amongst all the diseases indicating that the effects of air pollution are visualised on the urban population (CPCB 2000c).

A WHO/UNEP study compared standardised prevalences of respiratory diseases in different areas of Mumbai, classified according to ambient average concentrations of sulphur dioxide. The study revealed a relatively higher prevalence of most respiratory diseases in polluted urban areas than in the rural control area (WHO/UNEP 1992, cited in Repetto 1994).

In India, in a study of 2031 children and adults in five mega cities, of the 1852 children tested, 51.4% had blood lead levels above 10 µg/dl. The percentage of children having 10 µg/dl or higher blood lead levels ranged from 39.9% in Bangalore to 61.8% in Mumbai.

Among the adults, 40.2% had blood lead levels of about 10 μg/dl (George Foundation 1999, cited in CPCB 2000c).

Brandon, Hommann, and Kishor (1995) estimated the total magnitude of economic costs associated with environmental degradation in India. Using the 1991-92 air pollution data for particulates, SO_2, NO_X, and lead from 36 cities, health impacts were estimated in terms of reductions in morbidity and mortality if pollutant levels in these cities were reduced to the WHO annual average standard. The total health costs due to air pollution were estimated to be $517-2102 million. Also, the physical impacts were in terms of 40,000 premature deaths avoided.

TERI (1998) estimated the incidence of mortality and morbidity in different groups in India due to exposure to PM_{10} and translated these impacts into economic values. The results indicated 2.5 million premature deaths and total morbidity and mortality costs of Rs 885 billion to Rs 4250 billion annually.

Noise pollution

Studies by the CPCB on the ambient noise levels show that they exceed the prescribed standards in most of the big cities. The major sources of noise are vehicles and industrial manufacturing processes (MoEF 1998).

Other impacts

Some of the other impacts due to air pollution include damage to materials, impact on vegetation (including yield loss), and physical and aesthetic effects (such as reduction in visibility).

Response

Existing policy response

Legislation

The government has formulated a number of legislations, policies, and programmes for protecting the environment. Some of these related to air pollution are the Air (Prevention and control of pollution) Act, 1981 and the Environment (Protection) Act, 1986. India has also adopted the Male declaration on Control and Prevention of air pollution and its likely transboundary effects for South Asia in April 1998.

Ambient air quality standards

Ambient air quality standards (both short-term, i.e., 24 hourly, and long-term, i.e., annual) have been laid down for industrial, residential/rural/other, and sensitive areas with respect to pollutants such as SO_2, NO_X, SPM, RPM, Pb, and CO. Ambient air quality standards for NH_3 have also been notified.

Guidelines for siting of industries

Guidelines for siting industries are prescribed so that the possible adverse effects on the environment and quality of life can be minimised. Some natural life-sustaining systems and specific land-uses are more sensitive, and that has been taken into account while specifying the minimum prescribed distance for siting a given industry.

Environmental impact assessment (EIA)

EIA is mandatory for 29 specific activities/ projects and also for some of the activities to be taken up in identified areas such as the coastal zone, Doon valley, etc. The procedure for examining the impact of different activities includes the preparation of EIA report, holding of a public hearing and examination by a duly constituted expert committee (MoEF 1999). Also, MoEF has taken up carrying capacity-based regional planning studies in certain selected areas of the country.

Emission standards for industries

The CPCB has laid down the maximum permissible limits for different pollutants for many categories of industries that contribute to air pollution. The standards have been notified by MoEF under the Environment (Protection) Act 1986.

Environmental audit

Submission of an environmental statement by polluting units to the concerned State Pollution Control Boards has been made mandatory under the Environment (Protection) Act, 1986.

Zoning atlas for siting of industries

In order to delineate the areas that are suitable for industrial siting, a district-wise zoning atlas project has been taken up by the CPCB that zones and classifies the environment in a district. The industrial zones are identified based on the sensitivity and pollution-receiving potential of the district (MoEF 2000a).

Development of pollution prevention technologies

Industries are encouraged to use cleaner and low waste or no waste technologies to reduce waste generation and the emission of pollutants. Various pollution prevention technologies are being developed and promoted (CPCB 2000c). A good scope exists for the demonstration and replication of cleaner technologies in clusters of small-scale industries such as foundry (Howrah), pottery (Khurja), and glass (Firozabad).

Beneficiated coal

The Ministry of Environment and Forests has made it mandatory for thermal power plants located beyond 1000 km from the coal pithead, or in urban, ecologically sensitive or critically-polluted areas, to use beneficiated/ blended coal containing ash not more than 34%, with effect from June 2001. The power plants using FBC (Fluidized Bed Combustion) and IGCC (Integrated Gasification Combined Cycle) combustion technologies are, however, exempted to use beneficiated coal irrespective of their locations (CPCB 2000b).

Pollution control in problem areas

Twenty-four problem areas have been identified in the country for pollution control through concerted efforts involving all the concerned agencies / industries. Action plans have been prepared and are being implemented (MoEF 2000a).

Epidemiological studies

MoEF has initiated the environmental epidemiological studies in 7 critically polluted areas viz. Vapi (Gujarat), Angul-Talcher (Orissa), Chembur (Mumbai), Cochin (Kerala), Kanpur (UP), Mandi-Govindgarh (Punjab), Najafgarh drain basin Delhi and also in Pune. The details of epidemiological studies undertaken / under progress are given in Annexure I (Table 10.2). The initial feedback from the studies indicate that the incidence of symptomatic morbidity (eye irritation, respiratory problem, and skin lesion / irritation) is high in areas of industrial activity. However, no conclusive data on morbidity and mortality rates could be established having direct correlation with the environmental pollution (MoEF 2000b).

Control of vehicular pollution

The various measures taken by government to mitigate emissions from transport sector are as follows:

Stringent emission norms. The mass emission standards for new vehicles had been first notified in the year 1991 in India. Stringent emission norms along with fuel quality specifications were laid down in 1996 and 2000. Euro I norms are applicable from 1 April 2000 and Euro II norms will be applicable all over India from 1 April 2005. However, in the case of the NCR, the norms were brought forward to 1 June 1999 and 1 April 2000 for Euro I and Euro II, respectively (CPCB 1999, SIAM 1999).

Cleaner fuel quality. To conform to the stringent emission norms, it is imperative that both fuel specification and engine technologies go hand in hand. Fuel quality specifications have been laid down by the BIS (Bureau of Indian Standards) for gasoline and diesel for the period 2000-2005 and beyond 2005 for the country (BIS 1997a, BIS 1997b).

Given the increased usage of diesel in our country, it becomes necessary to reduce its sulphur content. In a recent directive by the Supreme Court, the Ministry of Petroleum and Natural Gas is to supply diesel with 0.05% m/m sulphur to the NCT by 31 December 2000 and entire NCR from 30 June 2001. For gasoline, lead has been phased out in the entire country w.e.f. 1 February 2000. Similarly the benzene content is to be reduced and by 1 October 2000, gasoline with 1% benzene is to be supplied to the whole of the NCT region. For NCR, it should be supplied by 31 March 2001 (CPCB 2000c; CSE 2000). Later, it has to be extended to other parts of the country as well.

Inspection and maintenance (I&M). The first and most important step towards emission control for the large in-use fleet of vehicles is the formulation of an inspection and maintenance system. It is possible to reduce 30-40% pollution loads generated by vehicles through proper periodical inspections and maintenance of vehicles (CPCB 2000c). I&M measures for in-use vehicles are an essential complement to emission standards for new vehicles. In India, the existing mechanism of I&M is inadequate. Thus, there is a great need to establish effective periodic I&M programmes.

Other stringent measures in certain areas. On 1st April 1999, the specifications for 2T oil became effective. In order to prevent the use of 2T oil in excess of the required quantity, premixed 2T oil dispensers have been installed in all gasoline stations of Delhi (CPCB 1999). Other measures include bans on commercial vehicles more than 15 years old, a ban on the registration of new auto-rickshaws with front engine, replacement of all pre-1990 autos and taxis with new vehicles using clean fuels; and the removal of 8 year old buses from the roads unless they use CNG or some other clean fuel. It is also planned that all buses in Delhi are to switch over to CNG instead of diesel by 31 March 2001 (CPCB 1999).

Role of the judiciary

In recent years, the judiciary has played a prominent role in environmental protection. A number of judgements relating to stringent vehicle emission norms, fuel quality, introduction of cleaner fuels, phasing-out of older vehicles, and shifting of hazardous industries have provided a great deal of momentum to the efforts for improvement of air quality.

Policy gaps

- Prevention based environmental policy needs to be strengthened. Issues such as cleaner technology and land use planning incorporating environmental considerations need to be given priority.
- Effectiveness and impact of various policy measures not assessed.
- No separate transport policy exists at the national and state levels.
- No well defined policy to promote private participation in public transport.
- Lack of coordination between various government agencies to improve transport services.

Knowledge/information/data gaps

- Strengthening of monitoring at hotspots/ traffic intersections; more stations to be established and frequency of monitoring increased.
- Additional air quality parameters need to be monitored such as ozone, benzene, PAH, $PM_{2.5}$, dry deposition of sulphates and nitrates.
- Private/Community participation in monitoring activity.
- Emission factor development for various activities.

- Emission load mapping at regular intervals for all the urban areas.
- Air pollution modelling as a tool for forecasting and urban planning.
- Strengthening of information on number of vehicles on road, vehicle usage, etc.

Policy recommendations

Despite the aforementioned legislative/policy measures as well as a host of other decisions taken by the government, air pollution remains a major concern. Besides continuing and consolidating the ongoing schemes/ programmes, new initiatives and definite programmes need to be formulated for the efficient management of urban air pollution.

Vehicular pollution control

Since vehicles contribute significantly to the total air pollution load in most urban areas, vehicular pollution control deserves top priority. A practical strategy should be devised that reduces both emissions and congestion, using a mixed set of instruments, which are dictated by command and control, and/or the market based principles. Some of the these are:

- Augmentation of public transport system.
- Mass Rapid Transport System may be considered for the fast expanding and major urban areas in the country.
- Incentives and regulations affecting vehicles with a view to reducing the rate of growth in ownership of personal vehicles.
- Traffic planning and management. Also, construction of express highways linking major urban areas should be undertaken.
- Taxes on fuels, vehicles—the revenue so generated could be used for pollution control measures.
- Further tightening of emission norms and fuel quality specifications.
- Greater promotion and use of alternative fuels such as CNG/LPG/Propane/ battery operated vehicles. Expansion of CNG dispensing facilities and increased fiscal incentives for CNG kits.
- Replacement of two-stroke engines.
- Curbing fuel adulteration—state-of-the-art testing facilities and deterrent legal action.
- Strengthening of inspection and maintenance (I&M) system: The I&M system, comprising inspection, maintenance, and certification of vehicles, is crucial for regulating pollution for the large fleet of in-use vehicles. It should include testing of various elements of safety, road worthiness and compliance to pollution norms.

Industrial pollution control

- Thrust for cleaner technologies
  - Waste minimisation technologies involving process change, raw material substitution, improved housekeeping, etc.
  - Waste utilisation technologies involving reclamation and utilisation of wastes as secondary raw material
  - Flue gas desulphurisation
  - Combustion modification for NO_x reduction
  - Incentives for the development and adoption of clean technology and emission reduction

- Database on clean technology
  - Database on available technologies, their performance, sources, investment required, etc, should be created, regularly updated, and widely disseminated

- Strengthening of emission standards
  - Emission standards for various categories of industries need to be strengthened. To shift from pollution control to pollution prevention, rules related to load based standards instead of concentration based standards need to be enforced.

- Appropriate siting of high pollution potential industries/projects
- Fiscal incentives for pollution prevention and control measures

Other pollution abatement measures

- Strengthening of monitoring network
  - The monitoring network requires a massive quality control programme and expansion of its operations to cover new stations as well as more pollutants (e.g., RPM_{10}, $RPM_{2.5}$, O_3, Pb, CO, and hydrocarbons such as benzene and PAHs) on a regular basis. Smaller cities should also be covered so that preventive measures could be taken before the pollution problem becomes acute.

- Information dissemination/mass awareness/training
  - State-of-the-art technology should be used for wider dissemination of environmental information. Transparency and access to the data to be improved. Measures such as pollution bulletins and air pollution forecasts should be started on a regular basis
  - Massive thrust should be provided to mass awareness campaigns involving community organisations such as residents associations, students, voluntary bodies and NGOs. Strategic action plans for implementation should be devised
  - Support measures such as training and education for the industry, governmental agencies, and the public, as well as greater coordination among institutions, are important

- Air quality management strategy
  - A comprehensive urban air quality management strategy should be formulated that includes information related to urban planning, ambient air quality, emission inventory, and air quality dispersion models.
  - Effectiveness of EIA as a tool and environmental audit needs to be critically assessed
  - Systematically planned emission load mapping studies should be undertaken at regular intervals. Development of emission factors for Indian conditions should be taken up

- Fiscal measures
  - Economic instruments need to be in place to encourage a shift from curative to preventive measures, internalisation of the cost of environmental degradation, and conservation of resources. The revenue generated may be used for enforcement, collection, treatment facilities, and research and development.
  - Incentives for environmentally benign substitute, technologies and energy conservation

- Promotion of renewable energy sources such as hydro, wind, and solar
- Use of cleaner fuels like LPG and kerosene for domestic consumption would reduce indoor air pollution
- Air quality standards should be based on local dose-response relationships for which appropriate environmental epidemiological studies should be undertaken
- Non-point sources of pollution also to be controlled such as pollution from generators, waste burning, etc
- Increase in green cover. Appropriate design of green belts/barriers and proper selection of plant species
- Noise pollution is also a major problem in metro cities and adequate preventive and control measures need to be taken.
- Enforcement mechanism
  - Significant improvements in the enforcement mechanism required to ensure that the policies are implemented both in letter and spirit
  - Wherever necessary, the policies/standards need to be reformulated keeping in mind the fast-changing scenario

- An effective environment management plan should be devised that includes environmental strategy, regulation, institutional capacity-building, and economic incentives and penalties.

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Annexure I

Table 10.2 Details of epidemiological studies undertaken/ under progress

Name of the area for environmental epidemiological study	*Name of the institute carrying out the study*	*Source of funding*
Chembur	KEM Hospital, Mumbai	MoEF
Vapi	NIOH, Ahmedabad	MoEF
Greater Cochin	Medical College, Thiruvananthapuram	MoEF
Angul-Talcher	NIOH (Reg. Off.) Calcutta	MoEF
Kanpur	ITRC, Lucknow	MoEF
Mandi-Govindgarh	PGI, Chandigarh	MoEF
Najafgarh Drain Basin	AIIMS, Delhi	MoEF
Delhi (respiratory morbidity due to air pollution)	VP Chest Institute, Delhi	WHO
Delhi (effect of lead on children)	AIIMS, Delhi	WHO
Epidemiological studies in industrial complex in Pune	Ramazini Research Institute of Occupational Health Services, Pune	MoEF
Epidemiological study on the prevalence of pulmonary and extra pulmonary silicosis in quarry workers around Delhi	AIIMS, Delhi 1997-98	WHO

Source MoEF 2000b

11 Management of freshwater resources

Introduction

Fresh water as a commodity generates concern being an exhaustible resource and due to the environmental issues related to its degradation. With a phenomenal development of water resources since independence, India has successfully met water requirements for different usages. Preserving the quality and availability of freshwater resources however, is becoming the most pressing of many environmental challenges on the national horizon. Perhaps, because water is considered a cheap readily available resource, people fail to realise just how much stress human demands for water are placing on natural ecosystems. The stress on water resources is from multiple sources and the impact can take diverse forms. The growth of urban megalopolises, increased industrial activity and dependence of the agricultural sector on chemicals and fertilisers has led to the overcharging of the carrying capacity of our water bodies to assimilate and decompose wastes. A deterioration in water quality and contamination of lakes, rivers and ground water aquifers has therefore resulted.

The need is to bring about a perceivable shift in our philosophy and address water problems. Water resource managers and professionals are beginning to focus on the use of existing infrastructure to meet the demands of a growing population by improving efficiency, reallocating of water for different uses, prioritising the water demand sector-wise and adopting policies and practices that check resource degradation.

Pressure

Uneven resource distribution

India receives an average annual rainfall equivalent of about 4,000 billion cubic metres (BCM). This only source of water is unevenly distributed both spatially as well as temporally. Most of the rainfall is confined to the monsoon season, from June to September, and levels of precipitation vary from 100 mm a year in western Rajasthan to over 9,000 mm a year in the northeastern state of Meghalaya (Engleman and Roy 1993). With 3,000 BCM of rainfall concentrated over the four monsoon months and the other 1,000 BCM spread over the remaining eight months, our rivers carry 90% of the water during the period from June-November. Thus, only 10% of the river flow is available during the other six months.

National level statistics for water availability mask huge disparities from basin-to-basin and region to region. Spatially, the utilisable resource availability in the country varies from 18,417 cubic meters in the Brahmaputra valley to as low as 180 cubic metres in the Sabarmati basin (Chitale 1992). Even within the Ganga basin, water availability varies from 740 cubic meters in Yamuna to 3,379 cubic meters in the Gandak. Rajasthan, for instance, with 8% of the country's population has only 1% of the country's water resources while Bihar with 10% of population has just 5% of the water resources. Thus, while India is considered rich in terms of annual rainfall and total water resources, its uneven geographical distribution causes severe regional and temporal shortages.

Declining resource availability

Surface water

Of 4,000 BCM of available water from precipitation, the mean flow in the country's rivers is about 1,900 BCM. Out of this, only 690 BCM is utilisable. With 177 BCM of live storage created by the existing major and medium projects and another 75 BCM of storage from projects under construction, there is still a gap of 440 BCM of water, which is utilised (CWC 1997).

Groundwater

The latest assessment of replenishable ground water resources has been made at 431.9 BCM by the Central Ground Water Board through a large volume of hydrologic and related data (CGWB 1996). This is the sum total of potential due to natural recharge from rainfall and due to recharge contributions from canal irrigation. The utilisable ground water resources have been assessed at 395.6 BCM (70.0 BCM for domestic and industrial uses and 325.6 BCM for irrigation). The CGWB has also assessed the quantum of static ground water resources (one time available) at 10,812 BCM.

Water availability from other sources and through desalinisation of sea and ground waters is considered negligible in view of the high cost. The basin-wise details of various water resources and their utilisable components are shown in Table 11.1. The assessed gross available and utilisable water resources of the country, based on conventional technology, are therefore 2,384 BCM (billion cubic metres) and 1,086 BCM, respectively. With an estimated population of one billion in 2000, the available and utilisable water resources per capita per year are 2,384 m^3 and 1,086 m^3 respectively against an estimated availability of 6008 m^3 in 1947. This itself, gives a broad indication of the growing resource scarcity in India in the fifty three years since independence. The status of per capita resource availability in different basins of the country is show in as Map 11.1.

Increasing resource demand

Since independence, India has witnessed an unprecedented increase in population. From a population of about 343 million in 1947, the population has grown at a rate of 2.04% to cross the 1,000 million mark in 2000. With an increasing number of mouths to feed, there has been an additional pressure on agriculture resulting in an increase in net sown area from 119 million hectares in 1951 to 142 million hectares in 1997; high cropping intensity has also resulted in an increased demand for water resources. Domestic water need in the urban areas has also grown notably with the current urban population at 4.5 times the population level in 1950s (TERI 1998). The water requirement of the manufacturing sector has increased in proportion to the increase in the sector's share in GDP from about 12% in 1950s to 20% in 1990s.

Further, there is a substantial variance in the different user sectors—agriculture, domestic and industry, vis-à-vis their share of water demand, resource pricing structure and usage efficiencies, which creates inter-sectoral competitions and conflicts. The agriculture sector, for instance, accounts for about 95% of the total water demand with the subsidised and free regime of supply of power and water resulting in the over-exploitation and inefficient usage of water. The high resource cost for industries, on the other hand, cross- subsidises the water consumed by the other sectors (TERI 2001).

The demand for fresh water has been identified, as the quantity of water required to be supplied for specific use and includes consumptive as well as necessary non-consumptive water requirements for the user sector. The total water withdrawal/utilisation for all uses in 1990 was about 518 BCM or 609 m^3/capita/year. Estimates for total national level water requirements, through an iterative and building block approach, have been made for the years 2010, 2025 and 2050 (Table 11.2) based on a 4.5% growth in expenditure and median variant population

Table 11.1 Mean flow utilisable surface and ground water resource—basin-wise (**in BCM**)

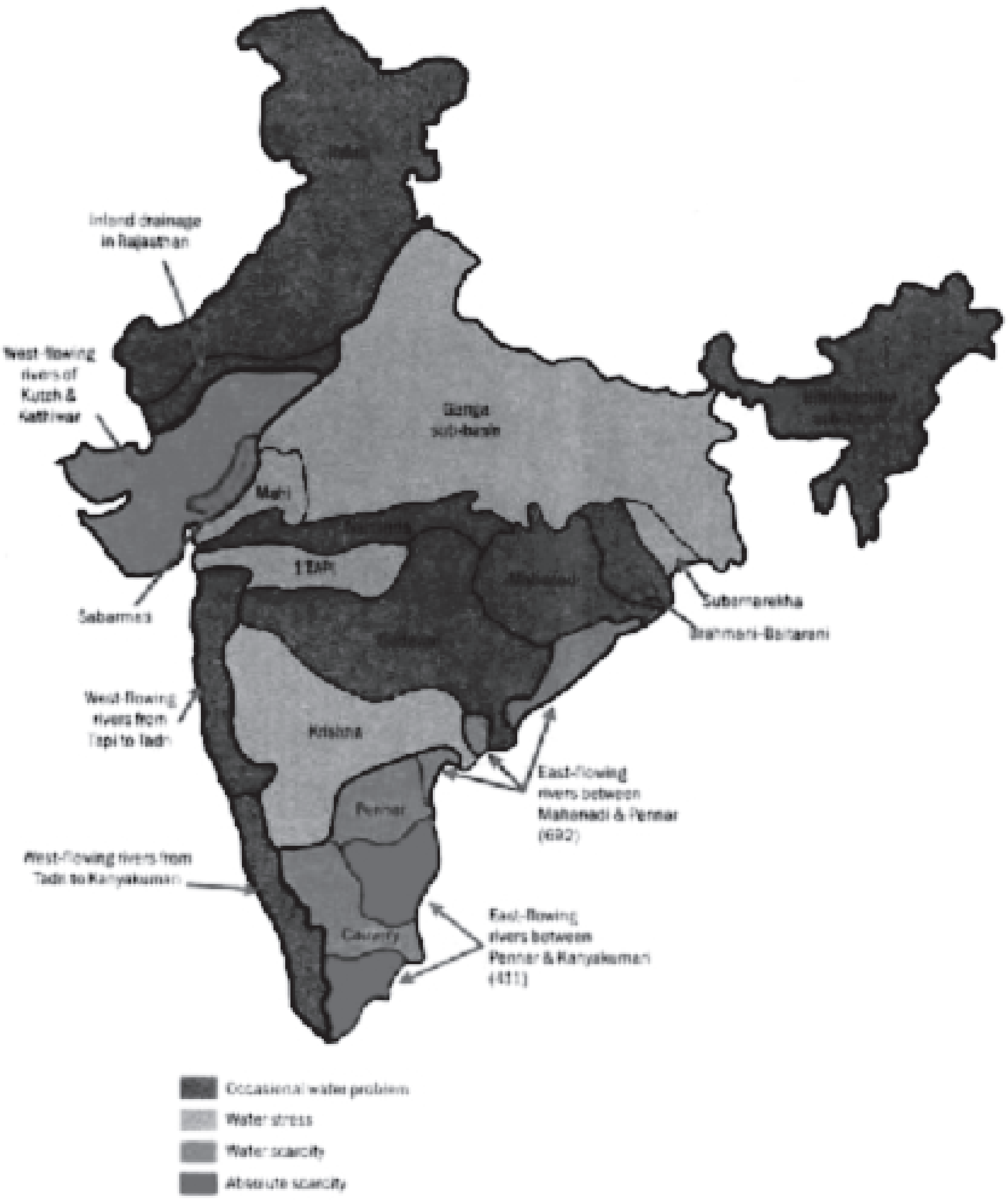
River Basin	*Surface water* Mean flow	*Surface water* Utilisable	*Ground water* Replenishable	*Ground water* Utilisable[c]
Indus	73.31	46.00	26.50	24.3
Ganga	525.02	250.00	171.00	156.80
Brahmaputra	629.05[a]	24.00	26.55	24.40
Barak	48.36	-	8.52	7.80
Godavari	110.54	76.30	40.64	37.20
Krishna	69.81[b]	58.00	26.40	24.20
Cauvery	21.36	19.00	12.30	11.30
Subernarekha	12.37	6.80	1.82	1.70
Brahmani-Baitarni	28.48	18.30	4.05	3.70
Mahanadi	66.88	50.00	16.50	15.10
Pennar	6.32	6.90	4.93	4.50
Mahi	11.02	3.10	7.20	6.60
Sabarmati	3.81	1.90	-	-
Narmada	45.64	34.50	10.80	9.90
Tapi	14.88	14.50	8.27	7.60
West flowing rivers between Tapi and Tadri	87.41	11.90	17.70	16.20
West flowing between Tadri and Kanyakumari	113.53	24.30	-	-
East flowing rivers between Mahanadi and Pennar	22.52	13.10	11.22	10.30
East flowing rivers between Pennar and Kanyakumari	16.46	16.70	18.80	17.20
West flowing rivers of Kachchh, Saurashtra and Luni	15.10	15.00	0.00	0.00
Area of inland drainage in Rajasthan	0.00	-	-	-
Minor rivers draining into Bangladesh and Myanmar	31.00	-	18.12	16.80
Total	1952.87	690.30	431.32	395.60

Source National Commission for Integrated Water Resources Development Plan, 1999
[a] includes additional contribution of 91.81 BCM being flow of 9 tributaries joining Brahmaputra; [b] assessment is based on mean flow of the yield series accepted by KWDT award; [c] The figure of the CWC assessed from run-off data at Vijaywada is 78.12 BCM computed on proportionate basis from annual replenishment

projections of the United Nations. The country's total water requirement by the year 2050 will become 1,422 BCM, which will be much in excess of the total utilisable average water resources of 1,086 BCM. At the national level, it would be a very difficult task to increase the availability of water for use from the 1990 level of approximately 520 BCM to the desired level of 1,422 BCM by the year 2050 as most of the undeveloped utilisable water resources are concentrated in a few river basins such as the Brahmaputra, Ganga, Godavari, and Mahanadi.

Inequitable water supply

Although about 88% of the population, on average, has been covered with organised drinking water supply in class I cities and class II towns of the country, there is a huge disparity in quantity of water supplied. Of the 299 class I cities, only 77 cities have cent percent water supply coverage. The per capita water supply also ranges from as low as 9 litres per capita per day (lpcd) in Tuticorin to as high as 584 lpcd in Triuvannamalai (CPCB 2000a). Similarly, 203 of the 345 class II towns have low per capita supplies of less than 100 lpcd (CPCB 2000b). Table 11.3 highlights the wide disparity that exists in the per capita



Map 11.1 Per capita resource availability in the country's river basins (Chitale 1992)

water supply in different urban areas of the country. Besides an inequitable distribution of water in a given city, the supplies are erratic with water quality degrading continuously over time.

Efforts have been made to provide safe drinking water in rural areas by providing funds in the state budgets from the First Five Year Plan onwards. The Central Government assists the states through programmes such as

Table 11.2 Water requirement for different uses **(in BCM)**

Category	*2010*	*2025*	*2050*
Irrigation	536	688	1008
Domestic	41.6	52	67
Industries	37	67	81
Energy	4.4	13	40
Inland navigation	-	4	7
Flood control	-	-	-
Afforestation	33	67	134
Ecology	5	10	20
Evaporation	36	42	65
Total	693	942	1422

Source National Commission for Integrated Water Resources Development Plan, 1999

the Accelerated Rural Water Supply Programme (ARWSP) and Rajiv Gandhi National Drinking Water Mission (RGNDWM). The status of coverage of habitations as on 1 April 1999, shows that about 267 347 habitations (18.6% of total) are still either not covered or partially covered. Cent percent rural habitation coverage was only in Uttar Pradesh, Delhi, Pondicherry and Chandigarh. Percentage habitations fully covered in Assam, Punjab and Kerala are only 57.4%, 33.3% and 22.2% respectively (MoRD 1999).

Resource degradation

Discharge of untreated domestic wastewater is a predominant source of pollution of aquatic resources in India. Urban centres contribute more than 25% of the sewage generated in the country. The smaller towns and rural areas do not contribute significant amounts of sewage due to the low per capita water supply. Wastewater generated normally percolates into the soil or evaporates.

The CPCB conducted a survey in 1994-95 (CPCB 2000a, CPCB 2000b) on water supply and wastewater generation, collection, treatment and disposal in 299 class I cities and 345 class II towns of the country. The survey findings indicated that, most cities did not have organised wastewater collection and treatment facilities. The status of wastewater generation, collection, and treatment in urban areas is as given in Table 11.4.

It also emerged that the class I cities and class II towns of Maharashtra, Delhi, Uttar Pradesh, West Bengal, and Gujarat contribute 59% of the total wastewater generated in the country. The infrastructure to collect and treat wastewater in these states is as given in Table 11.5. Furthermore, the facilities constructed to treat wastewater do not function properly and remain closed most of the time due to improper design and poor maintenance, together with a non-technical and unskilled approach. Photo 11.1 depicts one such drain in Delhi carrying a mix of industrial and domestic wastewaters.

Table 11.3 Disparity in per capita water supply in class I cities and class II towns

Type	*Number of cities/ towns*	*Number of cities/ towns with per capita supply* (litres per capita demand)				*Average supply*	*Minimum supply*	*Maximum supply*
		Low (<100)	*Normal (100-200)*	*High (200-300)*	*Very high (>300)*			
Class-I	299	109	138	36	16	183	9	584
Class-II	345	203	120	18	4	103	7	776

Source CPCB 2000a

Rural sanitation is a state subject, and is looked after by the state governments under the MNP (minimum needs programme) and supplemented by the CRSP (Centrally Sponsored Rural Sanitation Programme) aiming at increased coverage and eradicating manual scavenging. It has been targeted to achieve at least 50% coverage by the end of Ninth Plan period.

Inefficient resource utilisation

With government policies that provide hardly any incentive to encourage efficient usage, water has conventionally been considered as a free commodity. Distribution losses of treated water range between 25% and 40%; losses in irrigation are even to the extent of 45% due to seepage and excess application and storage losses are estimated to be about 15% (MoWR 1999). Photo 11.2 shows such a case of resource loss due to water overflow. Industrial output per unit of water withdrawal in India is only $5 per cubic metre as against output at $25 and $32 for such developed countries as Japan and Sweden. Even in the domestic sector, areas with high per capita water availability are known for poor water utilisation. The subsidy regime in the domestic sector further leaves the service providers with insufficient funds for proper upkeep of the system and finally affects the quality of service and its efficiency.

Table 11.4 Status of wastewater generation (w/w), collection, and treatment in class I cities and class II towns **(million litres per day)**

Type	*Number of cities/ towns*	*w/w generated* (mld)*	*w/w collected* (mld)	*%age of w/w collected*	*w/w treated* (mld)	*%age of w/w treated (of collected)*	*%age of w/w treated (of total)*
Class I cities	299	16662.5	11938.2	72	4037.2	33.8	24
Class II towns	345	1649.6	1090.3	66	61.5	5.6	3.7
Total	644	18312.1	13028.5	71	4098.7	31.5	22.4

* Also includes information gathered on industrial wastewater
Source CPCB 2000a

Table 11.5 Status of wastewater (w/w) generation, collection, and treatment in major contributing states **(million litres per day)**

State	*Number of Type*	*w/w generated cities/towns*	*w/w collected* (mld)*	*%age w/w* (mld)	*w/w treated collected*	*%age w/w* (mld)	*treated*
Gujarat	Class-I	21	1175.8	936.7	78.6	676	51.3
	Class-II	27	191.2	137.8		25	
Maharashtra	Class-I	27	3593.4	3139	85.6	481.4	13.3
	Class-II	28	160.4	73.8		18	
Uttar Pradesh	Class-I	41	1557.7	1048.9	66.7	246.2	13.4
	Class-II	45	275.5	174		-	
West Bengal	Class-I	23	1623.1	1183	72.2	-	-
	Class-II	18	66.9	36.7		-	
Delhi	Class-I	1	2160	1270	58.8	1270	58.8
Total		231	10804	8000	74.04	2716.6	25.14

* Also includes information gathered on industrial wastewater
Source CPCB 2000a

Photo 11.1 Delhi's Viswas Nagar Drain carrying a mix of domestic and industrial wastewater to the Trans-Yamuna drain

State

Resource quantity

Comparing water availability in the country's basins with the standard definition[1] by Engleman and Roy, only four of the twenty basins had more than 1,700 m^3 per capita per year renewable fresh water resources, nine basins had between 1,000 to 1,700 m^3, five basins had between 500 to 1,000 m^3, and two basins had less than 500 m^3 in 1991. In 1997, at an agro-ecological zone[2] (AEZ) level, availability exceeded requirements throughout the country with the exception of AEZ 2 (western plains and Kachchh) and AEZ 9 (northern plains) where it is less than the demand (Map 11.1). By 2047 it is anticipated that demand will exceed availability in five of the twenty AEZs and of these, the situation will be particularly critical in AEZs 2, 9, and 15 (Bengal and Assam plains) where availability is less than 75% of the total demand (TERI 2001). Despite the fact that the National Water Policy accords top priority to drinking water, the coverage of population for safe water supplies is still less than 100 % in most urban and rural areas. Though maximising water availability, water pricing and water zoning for proper management of resources have all been addressed in this national document, poor execution presents a diametrically opposite picture on ground. Further, with water being a state subject and with the absence of water policies at the state level, resource management and conflict resolution ultimately affect resource availability. Inadequate legal framework for withdrawals also affects resource accessibility due to overexploitation.

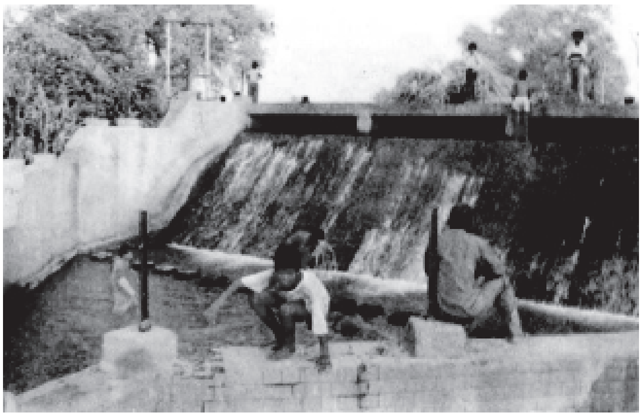


Photo 11.2 Water overflow from the conduit carrying freshwater to the Bhagirathi Water Treatment Plant

Resource quality

The major rivers of the country have generally retained pristine water quality in the less densely populated upper stretches where the likelihood of getting affected by man's interference is minimal. As the rivers enter the plains, these start getting exploited for irrigation and receiving pollution discharges due to human activities such as intensive agriculture,

[1] According to a standard definition, for water availability from 1000 m^3/capita/year to 1700 m^3/capita/year, shortage will be local and rare. Below 1000m^3 per capita per year, water supply begins to hamper health, economic development and human well-being. At less than 500m^3 per capita per year, water supply is primary constraint to life (Engleman R and Roy P 1993).

[2] Twenty zones into which the country has been divided on the basis of physiological features, soil type, climate etc to facilitate easy accounting of natural resources

use of fertilisers and insecticides, domestic sewage, industrial effluents etc. Thus in the middle stretches, the rivers are most affected both, due to increased water requirement for various consumptive and non-consumptive uses, and degraded water quality. Increased quantity of wastes of a more complex nature finds way into the river and tends to deteriorate the water quality. This makes the situation grave especially during the lean flow season when the amount of dilution water available is less.

The Central Pollution Control has been monitoring water quality of national aquatic resources in collaboration with concerned State Pollution Control Boards at 507 locations (CPCB 1999a), of which 430 stations are under MINARS (Monitoring of Indian National Aquatic Resources), 50 stations are under GEMS (Global Environmental Monitoring Systems) and 27 stations under the YAP (Yamuna Action Plan). The polluted stretches identified in some of the major rivers (Table 11.6) are based on regular monitoring. The water quality and desired water quality have been classified as A, B, C, D, and E, which reflect the best use of the water.

The water quality monitoring results obtained during 1998 indicate that organic and bacterial contamination still continue to be critical sources of pollution in Indian aquatic resources. Table 11.7 lists the number of observations in different broad ranges of observed values for BOD, total coliform and faecal coliform at different locations. The results show that BOD concentrations below 3 mg/l were observed in 61% of the samples as against 65% in 1997. BOD between 3 to 6 mg/l was observed in 24% of the samples as against 28% in 1997 and BOD exceeding 6 mg/l was observed in 14% of the samples, which is the same as in 1997. The number of observations having high coliform density increased in 1998 against 1997. The Yamuna river is the most polluted in the country having high BOD and coliform in the stretch between Delhi and Etawah. Other severely-polluted rivers are the Sabarmati at Ahmedabad, Gomti at Lucknow, Kali, Adyar, Cooum (entire stretches), Veghai at Madurai, and Musi d/s of Hyderabad.

A profile of water quality of major Indian rivers is shown in Map 11.2 (CPCB 1999a).

In an effort to assess the health of a water body, the CPCB is developing a bio-monitoring methodology under the Indo-Dutch Collaboration Programme on the Environment. Intensive exercises have been carried out for the Yamuna River and the methodology has been developed and tested for other rivers. In the first phase, 215 locations have been selected for the introduction of bio-monitoring on the basis of the interpretation of physico-chemical data at different locations (CPCB 1999b).

CPCB has also carried out limited water quality monitoring of the wells in different states and calculated percent violations over the desired levels of water quality in terms of pH, dissolved oxygen, BOD and total coliform. Certain locations in these states reported 100% violation over the desired levels for dissolved oxygen and total coliform (CPCB 1999a). CWC's studies on chemical composition of groundwater in phreatic zones have revealed that in many cases anomalously high concentrations of nitrates, potassium and even phosphates are present in contrast to their virtual absence or low concentration (nitrate and potassium < 10 mg/l) in semi-confined and confined aquifers. The unsystematic use of synthetic fertilisers coupled with improper water management has affected the groundwater quality in many parts of the country. The statewise brief account of the incidence of groundwater pollution also reflects the occurrence of high concentrations of heavy/toxic metals, fluoride and nitrates at different locations around the country. The presence of zinc in shallow aquifers of Delhi is reported at

Table 11.6 List of polluted river stretches[a]

River	*Polluted stretch*	*Desired class*	*Existing class*	*Critical parameters*[b]	*Possible source of pollution*
Sabarmati	Immediate upstream of Ahmedabad up to Sabarmati Ashram	B	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
	Sabarmati Ashram to Vautha	D	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
Subarnarekha	Hatia dam to Bharagora	C	D/E	-do-	Domestic and industrial waste from Ranchi and Jamshedpur
Godavari	Downstream of Nasik and Nanded	C	D/E	BOD	Wastes from sugar industries, distilleries and food processing industries
Krishna	Karad to Sangli	C	D/E	BOD	Wastes from sugar industries and distilleries
Sutlej	Downstream of Ludhiana to Haike	C	D/E	DO, BOD	Industrial wastes from hosieries, tanneries, electro-plating and engineering industries and domestic waste from Ludhiana and Jalandhar
	Downstream of Nangal	C	D/E	Ammonia	Wastes from fertiliser and chloralkali mills from Nangal
Yamuna	Delhi to confluence with Chambal	C	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
	In the city limits of Delhi, Mathura and Agra	B	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
Hindon	Saharanpur to confluence with Yamuna	C	D	DO, BOD, Toxicity	Industrial and domestic wastes from Saharanpur and Ghaziabad
Chambal	Downstream of Nagda and downstream of Kota	C	D/E	BOD, DO	Domestic and industrial waste from Nagda and Kota
Damodar	Downstream of Dhanbad	C	D/E	BOD, Toxicity	Industrial wastes from Dhanbad, Durgapur, Asansol, Haldia and Burnpur
Gomti	Lucknow to confluence with Ganges	C	D/E	DO, BOD, Coliform	Industrial wastes from distilleries and domestic wastes from Lucknow
Kali	Downstream of Modinagar to confluence with Ganges	C	D/E	BOD, Coliform	Industrial and domestic wastes from Modinagar

[a] Class A stands for drinking water without conventional treatment but after disinfection, Class B water is suitable for outdoor bathing, while Class C stands for water suitable for drinking after conventional treatment. Class D water is suitable for propagation of wildlife and fisheries. Class E water can be used for irrigation, industrial cooling and controlled waste disposal
[b] DO is Dissolved Oxygen, BOD is Biochemical Oxygen demand
Source CPCB 1999a

places located close to areas of intensive agricultural practices coupled with extensive use of chemical fertilisers (CGWB 1997). Even with strong legislative provisions such as the Water (Prevention and Control of Pollution) Act and the Environment Protection Act, since 1974 and 1986 respectively, 851 defaulting industries were located along the rivers and lakes in 1997. The Water Cess Act, 1977 has also failed to act as a market based instrument in reducing the quantity of polluted discharges.

Table 11.7 Water quality status in India (1998)

State	*BOD* (mg/l)			*Total Coliform* (MPN/100 ml)			*Faecal Coliform* (MPN/100 ml)		
	< 3	*3-6*	*>6*	*<500*	*500-5000*	*> 5000*	*< 500*	*500-5000*	*> 5000*
Andhra Pradesh	202	56	19	16	25	0	37	0	0
Assam	113	4	9	15	49	23	22	21	0
Bihar	146	3	1	15	48	82	35	106	2
Daman & Diu	28	0	0	11	13	0	12	9	0
D & N Haveli	16	0	0	3	11	0	6	7	0
Delhi	11	4	14	0	6	14	10	5	5
Gujarat	224	82	125	200	63	164	214	90	116
Goa	33	15	0	48	0	0	44	0	0
Himachal Pradesh	88	1	0	61	27	1	83	6	0
Haryana	28	4	9	0	0	0	0	0	0
Karnataka	247	49	52	94	283	0	113	136	1
Kerala	275	1	0	10	238	24	71	192	12
Lakshdweep	6	2	0	3	5	0	6	2	0
Maharashtra	0	326	123	375	73	0	391	0	0
Manipur	30	2	0	27	5	0	0	0	0
Meghalaya	0	4	16	12	6	2	9	8	0
Madhya Pradesh	345	114	48	373	124	0	209	0	0
Orissa	22	298	57	234	143	0	299	78	0
Punjab	26	26	20	72	0	0	71	1	0
Pondicherry	15	1	3	0	0	0	0	0	0
Rajasthan	71	5	2	36	42	0	78	0	0
Tamil Nadu	260	38	6	168	72	63	219	53	31
Tripura	30	1	1	4	17	0	18	3	0
Uttar Pradesh	210	165	176	29	123	161	114	123	49
West Bengal	110	24	0	89	0	0	89	0	0
Total	2536	1225	681	1895	1373	534	2150	840	216

Source CPCB 1999a

Response

Existing response

Water has been included in India's Constitution as Entry 17 of the state list. The current institutional arrangement for managing water resources in India involves various government agencies. At the central level, the Ministry of Water Resources (MoWR) is responsible for developing, conserving and managing water as a national resource covering areas as diverse as irrigation, ground water exploitation, drainage and flood control. The MoWR functions through the Central Water Commission, National Water Development Agency and Central Ground Water Board. The Ministry of Environment and Forests (MoEF) is the nodal agency for water quality and environmental matters. Water supply in urban and rural areas is co-ordinated by the Ministries of Urban Affairs and Rural Development, respectively. Besides, water is also a subject of several other ministries and departments such as the Ministry of Agriculture, Power, Health and Family welfare, Surface Transport and the Inland Waterways Authority. Major policies and legislations guiding the management of water resources and its quality and initiatives taken have been discussed.

Map 11.2 Water quality profile of major Indian rivers

- The National Water Policy, 1987, formulated by the Government of India accords top priority to drinking water supply in the allocation of water resources for various beneficial uses. After drinking water, the list includes irrigation, hydropower, navigation and industrial and other uses. The policy also addresses issues such as planning of water resource development projects, maximising water availability, water pricing, water quality, water zoning for proper management of resources and other issues.

- The government explicitly enacted the *Water (Prevention and Control of Pollution) Act, 1974,* with the primary objective of preventing and controlling of water pollution. The Water Act established the Central Pollution Control Board and the state pollution control boards for its implementation. The Water Act empowers the state pollution control boards to lay down and maintain location and source specific standards for discharge of wastewater. The actual provisions for enforcement such as penalties, imprisonment etc. are confined to source-specific standards for individual polluters.
- *The Environment Protection Act, 1986,* is an umbrella act providing for the protection and improvement of environment and for matters connected therewith. It authorises the central government to intervene directly in order to protect the environment and also allows public interest litigation for the same purpose. The nature of penalties under this act is similar to those authorised under the Water Act.
- The government has also introduced, as a supplementary measure, major economic incentives for pollution abatement, besides the 'command and control' regulatory mechanism. The *Water Cess Act* was introduced in 1977, empowering the state pollution control boards to levy a cess on local authorities supplying water to consumers and on consumption of water for certain specified activities. The Act also provides for a rebate on the cess payable if the local authority or industry concerned installs a plant to treat sewage or trade effluent. The cess rates were increased three fold in February 1992. A rebate of 25% on the cess payable has been provided to those industries whose wastewater discharge does not exceed the quantity declared by them and which also comply with the effluent standards prescribed under the Water Act and the Environment Protection Act.
- Under the 1994 EIA notification, an *Environmental Impact Assessment* has been made mandatory for 30 categories of development activities involving investments of more than Rs 500 million and above and environmental clearance for activities is given by the MoEF.
- Under the *National River Action Plan (NRAP),* certain stretches of major rivers with high or intermediate levels of pollution were identified by the CPCB. Sewage collection and treatment works being created to reduce the pollution load to these rivers include schemes for better sewage interception and diversion, construction of sewage treatment plants, provisions for low cost sanitation and other schemes. In the first phase, in the GAP (Ganga action plan), 29 towns were selected along the river and 261 schemes of pollution abatement sanctioned. At present, 156 towns are being considered under the NRAP, out of which about 74 towns are located on the river Ganga, 21 on the river Yamuna, 12 on the Damodar, 6 on the Godavari, 9 on the Cauvery, 4 each on Tungbhadra and Satlej, 3 each on the Subarnarekha, Betwa, Wainganga, Brahmini, Chambal, Gomti, 2 on the Krishna and one each on the Sabarmati, Khan, Kshipra, Narmada, and Mahanadi (MoEF 1999) (Photo 11.3).
- To focus on urban lakes subjected to anthropogenic pressures, the *National Lake Conservation Plan (NLCP), 1993* was prepared. Bhoj Lake of Madhya Pradesh is already getting assistance under funds provided by OECF, Japan.
- Under the World Bank aided Industrial Pollution Control project there is a provision of loan and grant assistance to proposals of construction of Common Effluent Treatment Plants (CETP) for the treatment of effluents from a cluster of industries particularly of small scale (CPCB 1999c).

Besides, there are other acts that have a bearing on the water policy. The Easement Act, 1882 allows rights to use the groundwater by viewing it as an attachment to land. It also provides that all surface water is to be treated as state property. The Transfer of Property Act, 1994 provides that ownership in groundwater can be given to one only if ownership in land overlying is also transferred. Thus groundwater is viewed essentially as an attachment to land (Pachauri and Sridharan 1998).

Policy gaps

- The major bottleneck in an effective policy formulation and implementation is the current institutional set-up involving various government agencies. Further, there is a separation of responsibilities on the basis of water quality and quantity. As many as eight agencies are involved in collecting data on the following water-related parameters: quality of surface water, ground water quality, monitoring of drinking water quality, sanitation and drinking water supply. Such a fragmentary approach, both at the central and state levels, results in duplication and ambiguity of functions and discourages unitary analysis of this scarce resource. For instance, the CPCB monitors the water quality at 507 locations and the CWC separately measures water quality at another 300 locations (TERI 1998). However, co-ordination between the two agencies in fixing the monitoring locations and defining monitoring protocols is missing.
- Water being a state subject, the states are empowered to enact laws or frame policies related to water. Even then, only some of the states have set up organisations for planning and allocating water for various purposes. Though water policy for the country has been prepared by the Ministry of Water Resources (MoWR), only four of the states have their own respective state water policies.
- A proper legal framework for regulating withdrawals of groundwater is not in place. Though efforts have been made to check the overexploitation of groundwater through licensing, credit or electricity restrictions, these restrictions are directed only at the creation of wells. Even the licenses do not monitor or regulate the quantum of water extracted.

Photo 11.3 45 MLD capacity sewage treatment plant under Yamuna Action Plan at Faridabad, Haryana
Source MoEF Annual report 1997-98

- The water cess in industries, is potentially an effective instrument for inducing abatement, but the rates of raw water are so low that the rebate has been as much of an incentive so far. Market-based instruments to encourage resource conservation mainly in the agriculture and domestic sector have not been really tried. This accompanied with the subsidy regime in these sectors has resulted in poor resource usage efficiency.
- It was realised during the later stages of implementation of the Ganga Action Plan, that the local authorities were not able to operate and maintain these assets due to inadequate resources and skills. The level of commitment required from the state agencies was also missing. The pollution arose from a number of diffused sources either urban or rural.

Knowledge/information/data gaps

- Water quality monitoring by CPCB is at present being carried out at 507 locations, as against 77 stations in 1977. The 476 stations at which monitoring was carried out in 1996 and 1997 comprised 407 stations on rivers, 20 on wells, 33 on lakes, 9 on canals, 2 on ponds, 3 on creeks, and 2 on tanks. Water quality monitoring at 383 locations is conducted on a monthly basis, on a quarterly basis at 121 stations and annually for 3 locations through the involvement of several agencies. The maximum, minimum, and mean values of the parameters and the percentage violations for select parameters are reported. However, specific information is not available for water quality in these water bodies for seasons with lean flow. The frequency of monitoring and number of monitoring stations also is not representative of the quality of the water body specifically in the non-monsoon period.
- The CWC also monitors the water quality for 47 parameters at about 300 locations. Though there is a dedicated staff for monitoring the water quality at these three times in a month, published data are not available. Information is available only at the regional office level and that too, on request.
- Information on the availability of groundwater and its quality is limited. Though groundwater availability maps have been prepared for certain locations, extraction rates have not been defined.
- Much of the information—quantitative as well as qualitative, on water supplied, coverage of population, quality of service and sanitation both in the urban and rural areas is not available. Besides, information gaps on water consumption and effluent discharge patterns for industries also exist.

Recommendations

River basin approach

With water being a subject under the state list, the present approach to water-related matters restricts the issue only to political boundaries, involving a number of agencies and ministries with overlapping responsibilities. Instead a river basin or sub-basin-based approach to water management is called for. This would ensure that aspects such as water allocation, pollution control, protection of water resources, and mobilisation of financial resources are not dealt in isolation and decisions on the overall development process and land-use planning flow from this. The administrative mechanisms of these authorities need to be defined and operationalised in coordination with relevant state government departments, the central government, and representatives from the community, ensuring that the delegation of authority from the existing departments is consistent and avoids any overlapping.

Further, for effective co-ordination, apex level bodies need to be created, as in other countries, to coordinate the functioning of different agencies. For instance, the National Water Commission (NWC) in Mexico was established in 1989 as the sole authority with offices in all 31 states and coordinates with the river basin organisations for each of the six basins.

Plug weaknesses in the current policy and legal framework

State-specific water policies need to be prepared for all issues concerning a state. Various individual development projects and proposals, water allocation priorities and guidelines for resource management need to be area-specific and formulated by the states within the framework of such an overall plan. Revision in the National Water Policy, 1987 also needs to be finalised at the earliest. Similarly, weaknesses in the current legal framework, specifically with regard to groundwater regulations, arise from the absence of certain laws and inadequate provisions. Groundwater legislation aiming at equity and sustainability in access to groundwater and its development needs to be enacted in all states. It is important to assess the effectiveness of the various legislative acts and work out measures that improve their applicability and outcomes. Incentives under the Water Cess Act, for instance, have to be made more attractive to make the industries undertake pollution control measures.

Increasing resource availability

The need is to develop surface irrigation sources and undertake measures for rainwater harvesting and preventing water run-offs. With the rivers of the country carrying about 80% of the flow during the monsoon months of June-September and generally in excess of 90% during the period of June-November, the run-off can be tapped by building appropriate water harvesting structures in the lower reaches to trap the water. However constraints associated with rainwater harvesting in terms of the capacity of soil to absorb large quantities of water in a short time frame, quality of the harvested water for drinking water purpose, and the cost involved with building such harvesting structures, need to be looked into, as well.

The concept of watershed development has also to be adopted more rigorously, which will effectively contribute to the revival of local level traditional water control works. Micro-watershed development provides a medium for revival and integration of traditional water control measures. This type of integrated planning helps to make investments far more effective, functionally and economically. But it is also more demanding on both the government and the affected people. Obviously a major effort in public education and training of local people to impart the basic understanding and skills necessary for eliciting such participation is imperative. The government should also consider providing technical and financial support for harvesting rainwater, especially in the rural areas. Photos 11.4 and 11.5 highlight watershed development efforts in the country.

Pricing the resource

Water being a state subject, pricing is done by the state governments and water prices vary from state to state. With water demand in the agricultural sector as high as 95% of total demand and no proportions between the water rates and consumption patterns, water usage efficiency is only 30%–35%. Such poorly targeted subsidies send the wrong signals to users causing a wasteful use of resources and suboptimal choices by consumers. An appropriate tariff structure for water services will encourage wise usage of the resource and generate additional support for the fund-starved service providers as well.

Resource conservation

Together with the measures towards pollution abatement it is imperative to further intensify efforts for conservation of water to prevent overexploitation of existing resources and reduce the quantity of wastewater generated. As water tariffs are very low, the consumer has little incentive to conserve water. There is a need to take a fresh look at the existing water pricing structure. Additionally, there is a need to develop and implement cost-effective water appliances such as low-flow cisterns and faucets and formulate citizen forum groups to encourage and raise awareness on water conservation. Besides the Water Cess Act, efforts have to be made to introduce and implement the Zero discharge concepts, which would enhance recycle and reuse of effluent discharge.

Resource degradation

In order to enhance effective treatment of wastewater, there is a need for better collection and interception of sewage. The existing large number of scattered sources of pollution from high-density low-income communities need to be converted into concentrated point-sources that are easier to monitor and intercept for any further treatment. Many low-cost and effective technologies for waste water treatment, e.g. UASB, duckweed ponds, and horizontal filters have been developed in other parts of the world but are applied to a limited extent in India. There is a need to explore the associated advantages in terms of the negligible amount of energy required, beneficial uses of by-products (sludge as manure and biogas), lower operation and maintenance costs, etc. Adoption of cleaner technologies by the industry would go a long way in safeguarding the quality scarce resources. Policy initiatives can aid the diffusion and implementation of clean technologies by encouraging their procurement by the public sector and other government owned organisations leading to development of a domestic market demand for the product.

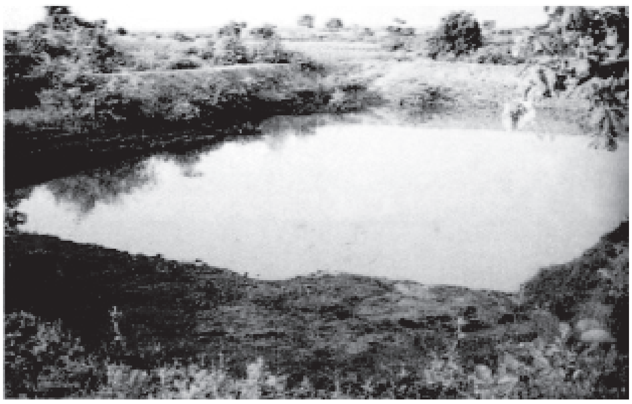


Photo 11.4 Farm pond created in a farmer field in Manoli watershed

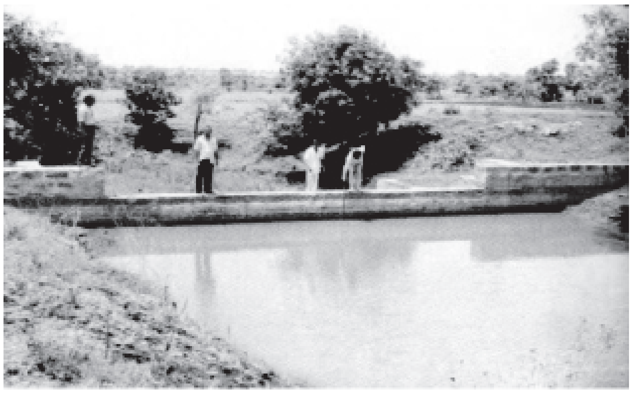


Photo 11.5 Masonry gully control structure having harvested water in Parua Nala watershed

Plugging information gaps

Baseline information—quantitative as well as qualitative—needs to be collected for water supply and sanitation both in the urban and rural areas and then used for formulating strategies to address these and prioritising the action plan. Exercises such as performance measurement of the service provider, specifically in the urban areas need to be undertaken to benchmark operational efficiencies related to water treatment and distribution. This will also help in critically reviewing the various water and wastewater treatment processes and then coming out with some best practice guidelines for operation and maintenance of different types of systems. Similarly, information on water consumption and effluent discharge patterns for industries could be used to benchmark resource consumption and increase the productivity levels per unit of water consumed.

A basin-wise analysis of the availability of utilisable resources, demand levels and consumption patterns needs to be made. This will help in identifying pockets or states over-using water, basins that have poor water utilisation rates and prioritise an action plan for implementing projects like watershed management to increase the resource availability. Such an analysis would also assist in developing a Water Zoning Atlas to guide decisions related to the siting of industries and other economic activities.

Community management

Community management is the key to the successful overall performance of the water sector. It has been amply demonstrated that projects with community inputs are more successful in reaching the greatest number of affected people with long lasting services. Other benefits include lower costs, greater acceptance of the technology, and better maintenance of the facilities by the users. In order to regulate pollution, changes in government policies are required and community participation is also necessary to ensure the success of NRAP.

However, one needs to maintain some degree of caution while adopting either 'community participation' or 'community management' approaches. Community-based management goes one step beyond just simple involvement of the people in the process—it empowers the community to control its systems. This would require a number of committed volunteers and trained staff to carry out the tasks. At the micro-level, the delegation of integrated water resources development and management procedures to the lowest appropriate levels would lead to redressal of the problems of the affected people within their own social and regional domains. The NGOs can provide a very important link between the community and government institutions. The NGOs can offer their services in capacity building of the relevant stakeholders, R&D for low-cost and effective water supply and sanitation facilities, and timely enforcement of policies.

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12 Hazardous waste: special reference to municipal solid waste management

Introduction

Detection of traces of toxic chemicals in drinking water supplies, in polar ice caps, groundwater sources and episodes such as those in Minamata Bay, Japan and Love Canal, USA have focussed the attention of the public worldwide on the risks posed by the inappropriate disposal of hazardous waste and accidental release of toxic chemicals into the environment. In India regulations to control and manage air and water related pollution were in place as early as 1974 and 1981 when the Water Act and Air Acts, were respectively, introduced in country. However, the concern and need to manage the hazardous waste generated in the country in a scientific manner was felt only in the mid-eighties after the occurrence of the (in) famous Bhopal gas tragedy on 2/3 December 1984. The Government's attention was then drawn towards environmental damage and the casualties that hazardous chemical substances and toxic wastes can cause. In order to cover the environment in toto, the MoEF (Ministry of Environment and Forests) enacted an umbrella act i.e., the Environment (Protection) Act in 1986. Subsequent to this Act, in order to prevent indiscriminate disposal of hazardous waste, the MoEF promulgated the Hazardous Wastes (Management and Handling) Rules in 1989, and efforts to inventorise hazardous waste generation were initiated. Though the hazardous waste rules were introduced in 1989, the response towards their implementation has remained very poor. Also, due to the liberalised policy the pace of industrialisation has been accelerated, which has resulted in increasing amounts of hazardous wastes every year. This along with a growing amount of municipal solid waste due to rapid urbanisation and hospital waste due inadequate policy and technological measures continues to remain a daunting issue of environmental concern to India.

Pressure

Industrial and hazardous waste

Sources of hazardous waste include those from industrial processes, mining extraction, tailings from pesticide based agricultural practices, etc. Industrial operations lead to considerable generation of hazardous waste and in a rapidly industrialising country such as India the contribution to hazardous waste from industries is largest. Hazardous waste generation from industries is also critical due to their large geographical spread in the country, leading to region wide impacts. The annual growth in hazardous waste generation can be directly linked to industrial growth in the country.

States such as Gujarat, Maharashtra, Tamil Nadu, and Andhra Pradesh, which are relatively more industrialised, face problems of toxic and hazardous waste disposal far more acutely than less developed states. The major hazardous waste-generating industries in India include petrochemicals, pharmaceuticals, pesticides, paint and dye, petroleum, fertilisers, asbestos, caustic soda, inorganic chemicals and general engineering industries.

During the last 30 years, the industrial sector in India has quadrupled in size. The main source of hazardous waste and cause of an adverse impact on the environment has been the Indian chemical industry. Hazardous wastes from the industrial sectors mentioned above contain heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals which are toxic, flammable, reactive, corrosive or have explosive properties.

Municipal solid wastes

There has been a significant increase in the generation of MSW (municipal solid wastes) in India over the last few decades. This is largely a result of rapid population growth in the country. The daily per capita generation of municipal solid waste in India ranges from about 100 g in small towns to 500 g in large towns. Although national level data do not exist for municipal solid waste generation, collection and disposal, for the lack of a nation wide inventory, the growth of solid waste generation over the years can be studied for a few selected urban centres. The population of Mumbai increased from around 8.2 millions in 1981, to 12.3 millions in 1991, a growth of around 49%. The municipal waste generation however grew from 3,200 tonnes per day to 5,355 tonnes per day in the same period, a growth of around 67%. This clearly indicates that the growth in municipal waste generation in our urban centres has outpaced the growth in population in recent years. The reasons for this trend could be our changing lifestyles, food habits and changes in the standard of living. MSW in cities is collected by the municipalities and transported to designated disposal sites normally a low lying area on the outskirts of the city for disposal. The choice of a disposal site is more a matter of what is available than what is suitable.

State

Industrial and hazardous waste

The first few attempts to quantify hazardous waste generation in the country remain limited to indirect estimations. For instance, using the correlation between economic activity and hazardous waste generation established by the Organisation for Economic Cooperation and Development (OECD), the reported generation of hazardous waste was about 0.3 million tonnes per annum in 1984. World Bank estimates place this at approximately 4 million tonnes annually for the year 1995. These scattered inventories were not very useful in designing hazardous waste strategies for the country since hazardous waste generation is very dynamic owing to the intense growth in industrial activities taking place. In order to generate an updated inventory for hazardous waste in the country, an exercise in different states of India was initiated by the CPCB (Central Pollution Control Board) in the year 1993. The present information on total hazardous waste generated from industries and facilities available for its disposal in Indian states has been collected by the MoEF through the respective SPCBs (state pollution control boards). Table 12.1 gives the state-wise status of number of units generating hazardous waste as well as the quantity of waste generated till 24 March 2000, for recyclable, incinerable and disposable waste types. In total, at present, around 7.2 million tonnes of hazardous waste is generated in the country of which 1.4 million tonnes is recyclable, 0.1 million tonnes is incinerable and 5.2 million tonnes is destined for disposal on land (MoEF 2000).

As per the information provided by the MoEF, there are 323 hazardous waste recycling units in India, and of these 303 recycling units use indigenous raw material while 20 depend on imported recyclable wastes. The status of hazardous waste imported for recycling and recovery of mostly metallic constituents in country is presented in Box 1. The major types of hazardous waste imported by the country include battery scrap, lead and zinc dross, ash, skimmings and residues and galvanised zinc.

Table 12.1 Status of hazardous waste generation

State	No. of Units Generating HW	Quantity of Waste Generated (Waste Type) TPA			
		Recyclable	Incinerable	Disposable	Total[a]
Andhra Pradesh	501	61820	5425	43853	111098
Assam	18	-	-	166008	166008
Bihar	42	2151	75	24351	26577
Chandigarh	47	-	-	305	305
Delhi	-	-	-	-	59423
Goa	25	873	2000	3725	8742
Gujarat	2984	26000	19953	150062	430030
Haryana	309	-	-	31046	32559
Himachal Pradesh	116	-	63	2096	2159
Karnataka	454	47330	3328	52585	103243
Kerala	151	84932	5069	690014	780015
Maharashtra	3953	847436	5012	1155398	200784
Madhya Pradesh	183	89593	1309	107767	198669
Orissa	163	2841	-	338303	341144
Jammu and Kashmir	57	-	-	-	1221
Pondicherry	15	8730	120	43	8893
Punjab	700	9348	1128	12233	22745
Rajasthan	306	9487	19866	2242683	227203
Tamil Nadu	1100	193507	4699	196002	401073
Uttar Pradesh	1020	-	-	-	140146
West Bengal	440	45233	50894	33699	129826
Total	12584	1429281	118941	5250173	7243750

[a] Total of recyclable, incinerable and disposable will not add up due to waste sold or otherwise disposed

The contents of Box 1 indicate that the import of hazardous waste into the country for recycling purposes clearly needs guidelines to regulate it so that India does not become dumping ground. The MoEF has taken a few initiatives in this regard to regularise and track the hazardous waste imported. These are explained in more detail in the response section of the chapter.

The major generators of non-hazardous industrial solid wastes in India are thermal power stations producing coal ash, steel mills producing blast furnace slag and steel melting slag, non-ferrous industries such as aluminium, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime sludge and fertiliser and allied industries producing gypsum. Since these wastes are generated in huge quantities in the country (147 million tonnes per annum as per a 1999 estimate), the recycle/reuse potential of these wastes should be explored, otherwise a huge land area would be required for disposal. The quantities of industrial waste produced per annum from these industrial sources are presented in Table 12.2.

Municipal solid wastes

As stated earlier, the daily per capita generation of MSW in India ranges from about 100 g in small towns to 500 g in large towns. The recyclable content of waste ranges from 13% to 20% (CPCB 1994/95). A primary survey in

Box 1 Dumping of hazardous waste in India

India has become the dumping ground for hazardous waste (Anjello and Ranawana 1996, Agarwal 1998). Cheap labour, poor environmental standards, a sieve-like import regime and a growing market for cheap raw materials are all here. Ignoring its law courts, India is helping rich nations beat an international ban on the dumping of toxic industrial waste in developing countries (Greenpeace 1997). Thousands of tonnes of toxic waste are being illegally shipped to India for recycling or dumping, despite a New Delhi court order banning imports of toxic materials. Every Indian port is a floodgate standing open for hazardous waste. Of course, Indian government is keeping a tight rein on hazardous waste imports by licensing only five companies to accept metallic waste and letting only three companies export such waste to India for recycling. In fact, 151 different importing companies have imported nearly 73,000 tonnes of toxic zinc and lead residues from 49 countries. In 1995, Australia exported more than 1,450 tonnes of hazardous waste like scrap lead batteries, zinc and copper ash to India. Huge quantities of PVC waste is still exported to Asia despite an international agreement (Greenpeace 1998). A Greenpeace analysis of India's foreign trade data found that at least 1,127 tonnes of zinc ash were imported mainly from the United States since May 1996. Some 569 tonnes of lead battery waste were brought in through the main seaport of Bombay between October 1996 and January 1997. About 40,000 tonnes of broken lead batteries were imported during 1996. While lead acid batteries are in the Basel Ban List, India's Directorate General of Foreign Trade last year allowed free imports of lead battery plates and terminals. Some 150 companies and trading houses are importing toxic waste into India though only seven are licensed to do so.

Table 12.2 Sources and quantum of waste generated from major industrial sources

	Quantities MTPA		*Source/origin*
Waste	*1990*	*1999*	
Steel and blast furnace slag	35.0	7.5	Conversion of pig iron to steel and manufacture of iron
Brine mud	0.02	-	Caustic soda industry
Copper slag	0.02	-	By-product from smelting of copper
Fly ash	30.0	58.0	Coal based thermal power plants
Kiln dust	1.6	-	Cement plants
Lime sludge	3.0	4.8	Sugar, paper, fertiliser, tanneries, soda ash, calcium carbide
Phosphogypsum	4.5	11.0	Phosphoric acid plant, ammonium phosphate
Red mud/bauxite	3.0	4.0-4.5	Mining and extraction of alumina from bauxite
Lime stone	-	50.0	-
Iron tailings	-	11.25	-
Total	77.14	147.05	

Source National Waste Management Council - Ministry of Environment and Forests

1971 estimated that the urban population generated 374 g/capita/day of solid waste (Bhide and Sundersan 1983). In another survey conducted by NEERI the quantity of waste produced has been found to vary from 200 to 600 g/capita/day. A survey in 1981 places this figure at 432 g/capita/day (Nath 1984) and yet another survey in 1995 at 456 g/capita/day (EPTRI 1995). A survey conducted by ORG in 1989 places total MSW generation for 33 Indian cities at 14,934 tonnes a day. The EPTRI estimates of the survey in 1995 for 23 Indian cities places it around 11 million tonnes a year. The survey conducted by CPCB puts total municipal waste generation from class I and II cities to around 18 million tonnes in 1997 (CPCB 2000a). The present annual solid waste generated in Indian cities has increased from 6 million tonnes in 1947 to 48 million tonnes in

Photo 12.1 Secured landfill for disposal of hazardous waste under construction
Source Parivesh Newsletter, June 1998, Vol. 5 (I), Central Pollution Control Board, Delhi

Table 12.3 Physico-chemical characteristics of MSW

Component	% of wet weight 1971-73[a] (40 cities)	1995[b] (23 cities)
Paper	4.14	5.78
Plastics	0.69	3.90
Metals	0.50	1.90
Glass	0.40	2.10
Rags	3.83	3.50
Ash and fine earth	49.20	40.30
Total compostable matter	41.24	41.80
Calorific value (kcal/kg)	800-1100	<1500
Carbon-nitrogen ratio	20-30	25-40

[a] Bhide and Sundaresan 1983; [b] EPTRI 1995

1997 and is expected to increase to 300 million tonnes per annum by 2047 (CPCB 2000a).

The characteristics of MSW collected from any area depends on a number of factors such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc. Table 12.3 presents the changes in the characteristics of waste over the past two decades. The data show the changes in the relative share of different constituents of waste in the past several decades. Table 12.3 shows that the percentage of recyclable waste is increasing in the municipal waste streams. This can be largely attributed to changing lifestyles and increasing consumerism. Photo 12.2 shows disposal of plastic bags along with other types of waste streams. The strategy to deal with municipal solid waste in the country, should therefore target maximising recycling/reuse efforts so that dependence on landfills for final waste disposal can be minimised.

Only few cities follow such good practice of waste disposal as tipping of waste using mechanised equipment for levelling and compacting and placing a daily cover of soil on top of it before compacting it further. Some municipalities also practise composting the organic fraction of the waste. Photos 12.3 and 12.4 show compacting of municipal waste and vermi-composting being practiced at one of the dumpsites, respectively.

However, overall, the average waste collection efficiency of the total generation in Indian cities is around 72% (NIUA 1989) and 70% of Indian cities do not have adequate waste transportation facilities. Lots of littering usually takes place while waste is stored in collections centres and also during its transport. Photos 12.5 and 12.6 show primary waste collection centre and transportation of municipal solid waste in the country.

In addition, till date, biomedical waste generated from clinics, hospitals, nursing homes, pathological laboratories, blood banks and veterinary centres, in absence of any legislation till very recently, and a lack of awareness of impacts due to its indiscriminate disposal, was also being disposed alongwith municipal waste in dumpsites. Photo 12.7 shows co-disposal of biomedical waste at municipal waste collection centre.

Assuming a waste generation factor of 250 g/bed/day for infectious biomedical waste, the Directorate General of Health Services

Photo 12.2 Disposal of plastic bags
Source Parivesh Newsletter, September 1998, Vol. 5 (II), Central Pollution Control Board, Delhi

Photo 12.3 Municipal waste being compacted at the dumpsite
Source Parivesh Newsletter, Highlights 1998, December 1998, Central Pollution Control Board, Delhi

Photo 12.4 Vermi Compost plant for treatment of solid waste
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

has estimated the total infectious biomedical waste generated from different states in India at 54 404 tonnes per annum as on 1 January 1993 (CPCB 2000b). A WHO study on health care waste has estimated that of the total waste generated in health care facilities, about 85% of the waste is non-infectious, 10% infectious but non-hazardous and 5% hazardous (CPCB 2000b). Based on these estimates, the total health care waste

Photo 12.5 Primary municipal waste collection centre
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

Photo 12.6 Transportation of municipal solid waste
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

Photo 12.7 Co-disposal of biomedical waste with municipal waste
Source Parivesh-Highlights 1999, Central Pollution Control Board, Delhi

generated as per the 1993 data in the country can be taken as 544 040 tonnes per annum and hazardous waste generation from health care facilities can be taken as 27,202 tonnes per annum. A proper waste segregation scheme for separating hospital waste into infectious and non-infectious categories is therefore desired. This should be coupled with separate and dedicated treatment facilities for infectious waste categories so that co-disposal of infectious waste with municipal waste can be avoided. Photo 12.8 shows a medical waste incinerator installed at Safdarjung Hospital in Delhi.

Impact

Industrial and hazardous waste

Improper storage, handling, transportation, treatment and disposal of hazardous waste results in adverse impact on ecosystems including the human environment. When discharged on land, heavy metals and certain organic compounds are phytotoxic and at relatively low levels can adversely affect soil productivity for extended period of times. For

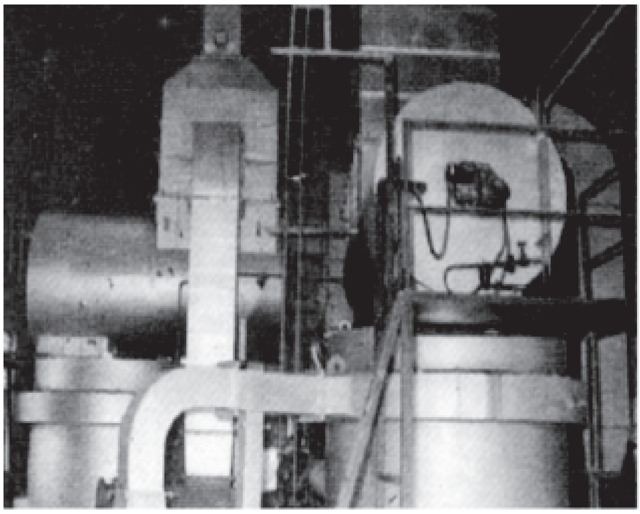

Photo 12.8 Hospital waste incinerator at Safdarjung hospital
Source Parivesh Newsletter, Highlights 1998, December 1998, Central Pollution Control Board, Delhi

example, uncontrolled release of chromium contaminated wastewater and sludge resulted in contamination of aquifers in the North Arcot area of Tamil Nadu. These aquifers can no longer be used as sources of freshwater.

Discharge of acidic and alkaline waste affects the natural buffering capacity of surface waters and soils and may result in the reduction of a number of species. The Boxes 2 to 4, provide illustrations of contamination due to improper management of hazardous wastes in Gujarat, the Thane-Belapur Industrial Area, and the Delhi- Rajasthan area, respectively.

Municipal solid wastes

At presently most of the MSW in the country is disposed off unscientifically (no 'sanitary landfill' exists) (Pachauri and Sridharan 1998). This has adverse impacts on not only the ecosystem but also on the human environment. Unscientific disposal practices leave waste unattended at the disposal sites, which attracts birds, rodents, fleas, etc. to the waste and creates unhygienic conditions (odour, release of airborne pathogens, etc.). The plastic content of the municipal waste is picked up by rag pickers for recycling either at primary collection centres or at dumpsites. Plastic are recycled mostly in factories, which do not have adequate technologies to process them in a safe manner. This exposes the workers to toxic fumes and unhygienic conditions. Moreover, since the ragpicking sector is not formalised, not all the recyclables, particularly plastic bags, get picked up and are found littered everywhere, reaching the drains and water bodies ultimately and choking them. Policy intervention to strengthen administrative structures can help in mitigating the adverse impacts of the waste on public health. The efforts of the Surat Municipal Corporation after the plague epidemic in 1994 have resulted in a complete metamorphosis of the city. This successful example has streamlined the management of solid waste and has

Box 2 Case Studies from Gujarat illustrating adverse impact of hazardous wastes

The Ahmedabad-Vadodara-Surat industrial belt has over 2 000 industrial units in the organised sector and more than 63 000 small scale units manufacturing chemicals like soda ash, dyes, yarns and fertilisers. Vapi in Valsad district has around 1 800 units of which 450 fall in category of polluting industries. Industries in all these areas usually dump their wastes in low lying areas within 2 km radius. As a result, a major illegal dump yard has sprung up on the banks of river Daman Ganga. Indian Petrochemical Corporation Limited (IPCL) at Vadodara dumps 1 800 tonnes of hazardous wastes every month at a site near Nandesari. The IPCL dumpsite is on hill. During rainy season, the hazardous constituents of these wastes are washed down into the river.

Source (Shankar, Martin, Bhatt, and Erkman 1994)

Box 3 Case Studies from Maharashtra illustrating adverse impact of hazardous wastes

The Thane-Belapur industrial area, in Maharashtra where about 1200 industrial units are housed on a 20 km stretch close to New Mumbai creates more than 100 tonnes of solid waste every day. About 85% of this waste is either acidic or alkaline in nature. The area also produces 5 tonnes of waste every day, which is difficult to treat because of its halogen content. The bulk of hazardous waste in this area is co-disposed with municipal waste in municipal waste dumpsites. The water bodies in the vicinity of this industrial area are polluted. The sediment in the Ulhas river has registered high levels of mercury and arsenic. Ulhas river empties into Thane Creek at its northern end. As a result, Thane Creek is one of the most polluted seawaters in the country.

Source (Shankar, Martin, Bhatt and Erkman 1994)

Box 4 Case Studies from Delhi and Rajasthan illustrating adverse impact of hazardous wastes

In the Wazirpur Industrial Estate and Shahadara-Maujpur Industrial Estate as well as along the Grand Trunk road in Delhi, small and tiny scale industries processing non- ferrous metals such as copper, brass, aluminium as well as steel rolling mills and pickling factories were dumping their heavy metal rich effluent and acids into open cess pools or drains. This had led to permeation of effluent into water table and has contaminated groundwater, which is used by local residents as potable water supply.

During 1988-89, M/s Silver Chemicals and Jyoti Chemicals located at Village Bichhri in Rajasthan were engaged in production of around 375 tonnes and 20 tonnes of H-acid (a naphthalene sulphonic acid based azo dye) respectively. This resulted in some 8 250 cu m of wastewater and some 2 400–2 500 tonnes of process sludge. The toxic wastewater was let out without treatment and the process sludge was dumped in the plant premises. The wastewater flowed through Udaisagar canal across the entire region while rainwater washed the sludge across the soil into the groundwater. An official survey indicates that groundwater up to 70 feet below the ground level had been contaminated over an area of 7 sq km affecting 8 000 people in seven villages. The NEERI report to study the extent of contamination in this area says that an amount of Rs 4 crore will be needed to reverse the process of soil and groundwater contamination.

Sources Bhattacharya and Shrivastava 1994; Sharma and Bannerji 1996

helped in creating an atmosphere where the urban local bodies and citizens can discuss the gravity of the problem and share responsibilities with a more positive attitude (Box 5).

Most biomedical waste generated from health care facilities are at present, collected without segregation into infectious and non-infectious categories and are disposed in municipal bins located either inside or outside the facility premises. Sanitary workers pick this waste from here along with other MSW and transport and dispose it at municipal dumpsites. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot

Box 5 Surat: a success story

The plague outbreak in Surat in 1994 was a stern reminder of what negligence in the area of solid waste management can lead to. After that disaster the city diligently tried to improve its living conditions. Institutional changes were the first thing to happen when the city began its journey from a city ridden with plague to the second cleanest city in the country, a status it achieved in a short span of 18 months. The city was divided into six zones to decentralise the responsibilities for all civic functions. A commissioner was appointed for each zone with additional powers; the officials responsible for solid waste management were made accountable for their work; and field visits were made mandatory for them each day. The solid waste management department and other related departments were made to work in concert and cooperate with one another. Indeed, these are some of the very basic changes that need to be introduced in the functioning of all urban local bodies. Community participation played a key role in the rapid implementation of decisions taken by the corporation. People were issued grievance redressal cards, which they could fill in and drop at the zonal office to register their complaints. The complaint was attended within 24 hours and the card returned to the citizen. In addition to the administrative changes, the changed laws had an important role to play in improving the conditions by also making the citizens aware of and responsible for certain preventive actions. Initially, the Gujarat Municipal Act did not have the provision of imposing a penalty for littering, which was introduced later as a fine of Rs 50 for every offence of littering and the fine was doubled for every subsequent offence. The corporation, in an appreciable attempt, has now engaged private sweepers to cover different inner areas of the town. Private contractors are also actively involved in the transport, collection, and disposal of solid waste.

infectious in adverse environmental conditions. Moreover, biomedical waste also contains sharp objects (scalpels, needles, broken glasses/ampoules, etc.) the disposal of which poses a risk of injury and exposure to infection to sanitary workers and rag pickers working at these dumpsites. Since most of these dumpsites are unscientifically managed, the chances of pathogens contained in infectious waste becoming airborne and getting released to nearby water bodies or affecting the local resident population cannot be ruled out.

Projections

Industrial and hazardous wastes

As stated earlier, the present hazardous waste generation in the country is around 7.2 million tonnes out of which 1.4 million metric tonnes is recyclable, 0.1 million tonnes is incinerable and 5.2 million tonnes are destined for disposal on land. This indicates that discounting the recyclable fraction of hazardous waste, total of around 5.3 million tonnes of hazardous waste requires some treatment and disposal. Taking the unit average cost of treatment and disposal of hazardous waste at Rs 3,000 per tonne of the waste, this requires an investment of around Rs 15,900 million every year for treatment and disposal of the hazardous waste in a scientific way.

The land required to dispose this waste in an engineered landfill, assuming the average density of waste to be around 1.2 tonnes/m^3 and the depth of the landfill 4 m, would be around 1.08 km^2 every year. This data can be applied to future waste projections to arrive at future land requirements for the disposal of hazardous waste.

In addition to hazardous waste, industries also generate around 147 million tonnes of non-hazardous (high volume-low hazard) wastes every year at present (NWMC 1999) which is mostly disposed on open, low lying land.

Municipal solid wastes

A study conducted by the CPCB on management of municipal solid waste in the country estimates that waste generation from the present 48 million tonnes is expected to increase to 300 million tonnes per year by the year 2047 (490 g per capita to 945 g per capita). The estimated requirement of land for disposal would be 169.6 sq km in 2047 as against 20.2 sq km in 1997 (CPCB 2000a).

Response

Existing policy responses

Industrial and hazardous waste

The MoEF, Government of India is the nodal agency at the central level for planning, promoting and co-ordinating environmental programmes, apart from policy formulation. The executive responsibilities for industrial pollution prevention, and control, are primarily executed by the CPCB at the central level, which is a statutory authority, attached to the MoEF. The CPCB was constituted in September 1974, for implementing provisions of the Water (Prevention and Control of) Pollution Act, 1974. The State Departments of Environment and SPCBs and Pollution Control Committees (PCCs) are the agencies designated to perform these functions at the state and union territory level.

Policies for hazardous waste management

The Hazardous Wastes (Management and Handling) Rules, 1989 was introduced under Sections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as HWM Rules 1989). The HWM Rules, 1989 provide for control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules. Implementation of these rules is done through the SPCBs and pollution control committees in respective states and union territories.

Besides these rules, in 1991, the MoEF issued Guidelines for Management and Handling of Hazardous Wastes for (a) generators, (b) transport of hazardous waste, and (c) owners/operators of hazardous waste storage, treatment and disposal facility. These guidelines also established the mechanisms for the development of a reporting system for the movement of hazardous waste (the manifest system) and for the first time established procedures for closure and post-closure requirements for landfills. In 1995, these were followed by publication of Guidelines for Safe Road Transport of Hazardous Chemicals that established basic rules for Hazardous Goods Transport and provided for the establishment of a Transport Emergency Plan and for provisions on Identification and Assessment of Hazards.

In addition to these direct rules dealing with issues of hazardous waste management, the Government has moved to enact into legislation, additional incentives for industries to comply with environmental provisions and bring market forces out into the business of environment. In this vein, the Public Liability Act 1991 was adopted to require industries dealing with hazards to ensure against accidents or damages caused by release of pollutants. The National Environmental Tribunal Act 1995 provides provisions for expeditious remedies to parties injured by environmental crimes. Legislation on a Community Right to Know 1996 has been adopted to provide more access to information regarding potential hazards from industrial operations. India is also a signatory to the Basel Convention, 1989 on control of transboundary movement of hazardous wastes and their disposal. There were few inherent limitations observed in implementation of HWM Rules, 1989. To remove these limitations, the MoEF notified Hazardous Wastes (Management and Handling) Amendment Rules in January 2000.

Initiatives taken for hazardous waste management

Emerging policy directions in the field of hazardous waste management emphasise the need for scientific disposal of waste and policies to encourage waste minimisation and adoption of cleaner technologies. Various activities initiated by the Government of India to meet these objectives are listed and discussed below:

- MoEF has initiated task of hazardous waste inventory in various states to gather updated information
- State governments are in the process of identifying hazardous waste disposal sites based on EIA of the potential sites
- The CPCB has prepared a ready reckoner in 1998 providing technical information on sources of hazardous wastes, their characteristics, and the methods for recycling and disposal
- Training programmes have been organised for concerned personnel in ports and customs and in pollution control boards so as to familiarise them with precautionary measures and testing methodologies for hazardous waste constituents.
- It has been decided to impose a ban on import of hazardous wastes containing beryllium, selenium, chromium (hexavalent), thallium, pesticides, herbicides and their intermediates/residues based on recommendations by an Expert Committee constituted at the national level for advising in matters related to hazardous wastes
- In order to control movement of Basel Wastes, cyanide wastes and mercury- and arsenic-bearing wastes have been prohibited for export and import from December 1996.
- Import of waste oil and metal bearing wastes such as zinc ash, skimmings, brass dross and lead acid batteries for processing to recover resources would be regulated by MoEF and allowed only by environmentally acceptable technologies

In addition to these initiatives, various projects to regulate storage, treatment and disposal of hazardous wastes have been initiated in the country. These projects are discussed below.

Australian-Aid project

An Australian Aided Hyderabad Waste Management Project was initiated with a total cost of 8.4 million Australian Dollars in 1996 to develop a common treatment, storage and disposal facility for hazardous waste generated from industries located in Medak, Hyderabad, and Ranga Reddy districts. The SPCB is also receiving technical assistance through this Aus-Aid project for training in hazardous waste management.

German project

A German Technical Co-operation Project (GTZ) for assisting Karnataka in development of hazardous waste management infrastructure has been initiated in 1995 at an estimated cost of DM 3 million for creation of a hazardous waste disposal facility and DM 3 million for technical co-operation. In this project, the work completed includes a hazardous waste inventory, status of existing disposal system, and evaluation of waste disposal alternatives with focus on incineration and landfilling. The study has recommended setting up one single centralised landfill and development of one cement kiln in the state to incinerator status.

Municipal solid wastes

At the central level the responsibility of dealing with municipal solid waste lies with the MoUAE (Ministry of Urban Affairs and Employment). The other ministries involved are the MoEF and MNES (Ministry of Non-conventional Energy Sources). The MoUAE plays a coordinating and monitoring role, sponsors research and development projects, and organises training courses and workshops on issues related to solid waste management. After the MoUAE the second most important ministry involved in waste management is the MoEF. The MNES is currently implementing projects in areas related to waste and energy. At the local level it is urban local bodies like municipal authorities or corporations, which ensures waste collection, transportation and disposal. The collection, transportation and disposal of municipal solid waste is regulated and controlled by Municipal Acts in each municipality. These Acts also deal with environmental pollution caused by improper disposal of municipal solid waste.

Policies for municipal solid waste management

The MoEF, Government of India has now issued the Municipal Solid Wastes (Management and Handling) Rules in the year 2000. These rules identify the CPCB as the agency that will monitor the implementation of these rules and municipalities will be required to submit annual reports regarding municipal waste management in their areas to the CPCB. For management of biomedical waste, the MoEF has notified Bio-Medical Waste (Management and Handling) Rules in 1998 under sections 6, 8 and 25 of Environment (Protection) Act of 1986.

Initiatives taken for municipal solid waste management

Apart from notification of rules for management of municipal solid wastes in 2000 by the MoEF, several attempts are underway to improve the management of municipal solid waste. Some of the initiatives taken at the national level and efforts made by various ministries at the central level are as follows:

- NWMC (National Waste Management Council). The NWMC was constituted in 1990 and one of its objectives was municipal solid waste management. The council is at present engaged in a survey of 22 municipalities to estimate the quantity of recyclable waste and its fate during waste collection, transportation, and disposal. NWMC in 1993 constituted a national plastic waste management task force to suggest measures to minimise the adverse environmental and health impacts arising out of plastic recycling. Based on the recommendations of this task force, the MoEF in 1998, came out with draft Recycled Plastic Usage Rules, 1998 which bans storing, carrying and packing of food items in recycled plastic bags. It also specifies the quality standards for manufacturing recycled plastic bags.

- Strategy Paper. The MoUAE engaged NEERI (National Environmental Engineering Research Institute) for formulating a strategy paper on municipal waste management and also for preparing a manual on solid waste management. These documents highlight various critical issues relating to the management of solid wastes and have offered a number of suggestions for improving management practices.
- Policy Paper. The CPHEEO (Central Public Health Environmental Engineering Organisation) of MoUAE has prepared a policy paper on promoting the integrated provisions of water, sanitation, solid waste management and drainage utilities in India.
- Master Plan for MSW. The MoEF and CPCB organised an interaction meet on March 1995 with municipal authorities and other concerned ministers to evolve a strategy for the management of municipal solid wastes. CPCB also formulated guidelines for safe disposal of hospital wastes.
- Realising the potential and the need for proper treatment of wastes and resultant recovery of energy, the MNES, in June 1995, launched a National Programme on Energy Recovery from urban – municipal and industrial wastes, with a view to promoting the adoption of appropriate technologies. Various fiscal and financial incentives are offered by the MNES under this programme for energy recovery from wastes.
- High Powered Committees: A high powered committee on urban waste was constituted by the Government of India during 1975. The committee, in its report made 76 recommendations, covering eight important areas of waste management. Another high powered committee was constituted in 1995. The committee has given number of recommendations covering issues like segregation, door-to-door collection, proper handling and transportation, waste composting and treatment and use of appropriate technologies for waste treatment and disposal.

Judicial interventions

Failure in implementation of existing legislation to check the environmental damage caused by non-conforming industrial units has resulted in issue of directions in the year 1996 from Supreme Court (SC) of India ordering closure/shifting of industrial units using hazardous processes and hazardous chemicals from Delhi region to regions identified by government in the National Capital Region. In addition, SC has ordered closure of 200 tanneries in Tamil Nadu, and 35 foundries in Bengal.

Policy gaps

Hazardous waste management

- The rules promulgated by the MoEF in the year 2000 dealing with hazardous waste management fail to provide any incentive for waste reduction/minimisation efforts. Industries are therefore reluctant to adopt such measures.
- In absence of standards for clean up of contaminated sites and limits for disposal of waste on land, those industries which are causing contamination of land and water bodies through inappropriate waste disposal are not legally bound to clean the site unless ordered by judicial intervention to do so (refer to Box 4 – groundwater contamination at Village Bichchri).

Municipal waste management

- Though draft rules for the management of municipal waste were notified as early as 1998, the final rules could be notified only in the year 2000. These rules along with rules for biomedical waste management do not clearly identify the role and responsibilities to be undertaken by the CPCB and SPCBs.

Knowledge/information/data gaps

Hazardous waste management

- The hazardous waste inventory carried out by different states has been a one-time exercise. But since the growth of the industrial sector is dynamic in the country, there is a need to constantly update this waste inventory so that appropriate waste management strategies can be incorporated in waste management plans.
- In absence of a reliable waste inventory, there is very little practice at present for using tools such as EIA for hazardous waste problems. This has led to very little research on exploring the risks and health impacts of hazardous waste disposal on surrounding ecosystem and communities.
- Apart from some dedicated facilities at large chemical industries, India lacks the sort of infrastructure that is required for proper treatment and disposal of hazardous waste largely due to the inability of regulatory authorities to achieve strict enforcement of rules. This is also partly due to inadequate infrastructure including staff in different SPCBs assigned for hazardous waste management in the state.

Municipal waste management

- Although attempts have been made at the city level in some selected pockets of the country to identify and quantify municipal waste and biomedical waste, there are no state/nation-wide waste inventories available in both the cases. It becomes very difficult in the absence of such an inventory to prepare waste management plans.
- Most of the waste whether municipal or biomedical, is at present dumped in open low lying areas with no provisions for liners, leachate collection and treatment system or gas collection system.
- In absence of segregation of waste at source, waste treatment alternatives such as recycling, waste-to-energy projects and or composting become uneconomical to operate.
- Most infectious biomedical waste segregated at the source of generation gets disposed at municipal waste dumpsites in absence of dedicated waste disposal facilities for biomedical waste generators.

Policy recommendations

Industrial and hazardous waste management

- The strategy required to ensure scientific management of hazardous waste, which is expected to increase over the years due to our liberalised economic policies and related growth in industry should encompass all the aspects of waste management cycles starting from generation of waste to its handling, segregation, transportation, treatment, and disposal.
- In addition, the strategy should also target waste minimisation/ reduction as its primary focus. This becomes particularly important in view of stricter environmental standards being enforced on industries. This results in increased cost of treatment and disposal to meet the stricter standards. Any waste minimisation/reduction effort would thus result in less waste generation and lesser waste to be managed thus reducing the cost of waste management. In addition, any recycle/reuse effort may in fact earn net revenue on the waste generation.
- Although the Government of India recognises the localised nature of hazardous waste generators and while significant progress has been made in identifying large concentrations of hazardous waste, further

efforts are required to quantify and characterise the volume of waste residues generated by industries. As discussed above, there is need to constantly upgrade this waste inventory so that appropriate waste management strategies can be incorporated in waste management plans.

- Although substantial progress has been made in imparting training and capacity building to SPCB officials, additional capacity at SPCB is needed to deal with analytical and monitoring requirements regarding tracking of hazardous waste movement and management. In addition training is also required for critical industrial sectors generating hazardous waste to address their responsibility in handling, storage, transportation, treatment and disposal of hazardous waste. This becomes particularly important in light of new amended hazardous waste rules introduced in country in January 2000. The amended hazardous waste rules expand the definition of hazardous waste from previous one incorporating the hazardous waste streams identified in Basel Convention.
- It is suggested to incorporate comprehensive approaches such as EIA to carry out environmental and social assessments of hazardous waste management operations. This will help us assessing the risks and health impacts of inappropriate disposal of hazardous waste on surrounding ecosystem and communities.
- Environmental emergencies and accidental spillage or indiscriminate disposal of chemicals or waste on land causes contamination of soil and groundwater. Use of any treatment or cleanup option requires cleaning of soil and groundwater to some acceptable level of contaminants. Most of the time, in dealing with contaminated soil or groundwater, it is neither economically nor technologically feasible to achieve the zero level of cleanup. It is, therefore, necessary for the Government to set standards not only for disposal of waste on land but also for clean up of contaminated soils and groundwater.
- Apart from some dedicated facilities at large chemical industries, India lacks the sort of infrastructure that is required for proper treatment and disposal of hazardous waste. Opportunity of setting such facility at the state level, addressing the willingness-to-pay issue by participating industries, type of ownership, financial mechanisms to finance such ventures and extent of private sector participation need to be addressed/explored to ensure that such facilities come into existence.

Municipal solid waste management

In order to have a satisfactory, efficient, and a sustainable system of solid waste management, proper planning, implementation, and management systems must be incorporated in framing the national policy for solid waste management for the country. Present and future ways to manage solid waste stream need consideration of the following aspects.

- Setting targets for waste reduction. Reduction at source can be accomplished in three ways (1) fees and tax incentives to promote market mechanisms to effect source reduction, (2) mandatory standards and regulation, and (3) education and voluntary compliance with policies by business and consumers, (Marcin, Durbak, and Ince 1994). However, these strategies need to be sensitive to the concerns of possible loss of business and jobs in affected industries. Reduction in the quantity of municipal solid waste could affect employment, taxes/revenues, and economic activity in unpredictable ways (Marcin, Durbak, and Ince 1994).
- Technological interventions. India has lagged behind in adopting technologies for solid waste management. In particular, three technical components, collection, transportation, and treatment and disposal of waste need urgent attention.

- Collection of waste. One immediate measure to revamp the existing collection service structure is to provide community waste bins conveniently placed for the people to deposit domestic waste. As a first step, this will ensure that people do not throw their garbage on the roads and hence do not create open dumpsites. The second measure should entail separation of waste at source into biodegradable and non-biodegradable components.
- Transportation of waste. Waste should be carried in covered vehicles. For the narrow lanes in the congested Old City where a dumper placer cannot move and where the waste has to be carried longer than 1 km to the nearest municipal bin, small, covered vehicles built over a three-wheeler scooter, preferably with a tipping arrangement, may be used. Infectious and hazardous waste from health care facilities should be carried strictly in separate covered vehicles. Hospital waste of some categories, e.g. biomedical waste consisting of human body parts, body fluids, etc., has to be incinerated but for other categories of waste, methods like microwaving and autoclaving are possible.
- Treatment and disposal. Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightaway transported to recycling units, which, in turn, would pay the corporations for it, thereby adding to their income. The organic matter could be disposed of either by aerobic composting, anaerobic digestion or sanitary landfilling. Depending upon land availability and financial resources, either of these methods could be adopted. However, it appears that landfilling would continue to be the most widely adopted practice in India in the coming few years, in which case certain improvements will have to be done to ensure that it is sanitary landfilling and not merely dumping of waste.

- Institutional and regulatory reforms. The municipalities are the primary institutions responsible for solid waste management in India, but most of the urban local bodies, barring a few progressive ones, are unable to provide the desirable level of conservancy services. The 12th Schedule in 74th Amendment Act 1992, (Entry 6 in Schedule 12 (Article 243-W) empowers the local bodies by giving them independence, authority, and power to impose taxes, duties, tolls, and fees for services including public health, sanitation, conservancy, and solid waste management.

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Part IV Conclusions

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13 Conclusions and recommendations

India has made remarkable progress in the areas of food production, industrial development, energy generation, socio-economic conditions and other fields, since it gained independence in 1947. On the socio-economic front, life expectancy improved, the infant mortality rate declined, and literacy rate improved. India is a biomass-based country where about two-thirds of the population depends on agriculture for subsistence. India is self sufficient in food. India has a place among the ten most industrialised nations of the world. Rapid population growth has been exerting heavy pressure on India's finite natural resources. While the annual growth rate of the population is a major concern, rapid economic growth has led to many undesirable consequences and unanticipated environmental problems.

The chapter includes the conclusions and recommendations for each priority issue. The major policy, knowledge and information gaps are discussed and policy recommendations made are also included in the chapter.

Land degradation

Policy/ knowledge/information gaps

- There is no well-defined integrated land use policy. This lacuna has largely been responsible for the current phase of land degradation.
- There is no rural fuel wood as well as grazing and fodder policy that results grazing far beyond the carrying capacity and extraction of fuel and fodder from forests far beyond the sustainable limits, creating enormous negative impacts on the forest and land.
- Information on severity of area affected by various forms of degradation is limited, highly variable, and sketchy.

Policy recommendations

- A well-defined integrated land use policy should be developed. Rural fuel wood and grazing and fodder policies are to be developed to guide management of land and forest scientifically and sustainably.
- A National Land Use Commission should be instituted to lay down such policies, implementation strategies and monitoring guidelines with support from the existing All-India Soil and Land Use Survey, National Bureau of Soil Survey and Land Use Planning and the Forest Survey of India under the stewardship of the Planning Commission to address most land-related issues.
- A Land Capability Classification should be developed for Indian conditions to ensure that land is put under the right kind of use according to its capability.
- A correct assessment of the nature and extent of the existing degraded land needs to be carried out using remote sensing techniques and GIS with scientifically sound criteria and indicators.
- Application of soil nutrient results in serious soil health and ecological problems, which needs urgent attention. Integrated Plant Nutrient Supply (IPNS), have to be adopted to improve fertiliser use efficiency and reduce the potential danger of pollution from higher nutrient use in agriculture.

- A systematic monitoring mechanism needs to be developed to assess the balance between input and withdrawal of nutrients to guard against possible nutrient depletion. There is a need also to define the threshold values for such additions and for promoting a balance in the use of organic manure, chemical fertilisers, bio-fertilisers and agrochemical to ensure sustainability and increased production.
- A multi-level stakeholder approach for the planning process is essential to ensure improvements in sustainable land use and development. In a multi-stakeholder approach, three principles must converge—good land husbandry, sustainable land use, and an enabling institutional environment. Local knowledge systems, norms and values must be given due importance while developing any such planning.
- The major challenge in the agriculture sector is checking fragmentation of land holdings, which can be achieved by providing security of land rights and land tenure, encouraging efficient use of marginal lands, developing areas of untapped potential thereby correcting uneven utilisation of land, and using the irrigation potential efficiently.
- The agricultural extension system of the country needs revamping to make it more efficient. Multidisciplinary technical information, viable land use options and alternatives identified for various agro-ecological and socio-economic units and crop combinations and crop rotations need to be passed on to land users for achieving effective land management results.

Bio diversity

Policy/information/knowledge gaps

- Lack of policies for protection of wetland grasslands, sacred groves and other areas significant from the point of view of biodiversity.
- Lacunae in the economic policy, institutional and governance systems is also responsible for the loss of biodiversity in India.
- Inadequate implementation of existing laws and various schemes
- Poor implementation of Wildlife Protection Act 1972 as amended in 1991 and inadequate implementation of eco-development programmes are policy gaps resulting in the destruction of biodiversity.
- Inadequate participation of NGOs in the process of completion of various schemes of the government
- The financial outlay provided in the budget for forestry sector is minimal. There is a need to enhance the financial outlay for forestry and biodiversity sector for preservation of valuable biodiversity in the country.
- Documentation of biodiversity is an urgent requirement as the latest statistics and data on floral and faunal biodiversity of India have not been compiled and documented.
- Lack of knowledge of the magnitude, patterns, causes and rates of deforestation and biodiversity laws at the ecosystem and landscape level.
- Information on poaching trade and trade routes is sketchy and current wildlife protection and law enforcement measures are inadequate and inefficient.
- Biodiversity Act /Bill should not override the provisions of Wildlife Protection Act.

Policy recommendations

- Most of the legal provisions are focussed on use and exploitation of biological resources, than their conservation. Even Wild Life Protection Act 1972, have focussed on protection rather than conservation. Hence a greater thrust should be given to the conservation aspect in the rules pertaining to biodiversity.
- A comprehensive legislation on biodiversity conservation and uses should be promulgated

- There is a need for formulation of policies for protection of wetlands, grasslands, and sacred groves significant from the point of view of biodiversity.
- Biodiversity bill should be passed on immediate basis.
- The presence of a biodiversity Cell in all development departments impinging on land and water
- There is a need to document biodiversity
- Increase allocation of financial resources for conservation of biodiversity
- Integrating conservation with development
- Incentives and disincentives for improper use of biodiversity
- Biodiversity Act/Bill should not override the provisions of Wildlife Protection act.
- There should be continuous monitoring of biodiversity use for review of results of implementation of policies and programmes.

Air pollution with special reference to vehicular pollution

Policy/information/knowledge gaps

- Lack of land use planning and its implementation are leading to unplanned settlements and industrial growth in cities and towns, in turn, affecting public health.
- No separate transport policy exists at the national and state levels. No well-defined policy laid out to promote private participation in public transport. Also there is a lack of coordination between various government agencies to improve the transport services leading to rapid increase of personal vehicles in cities and towns.
- Monitoring at problem areas, hotspots and traffic intersections is lacking; more stations to be established and frequency of monitoring to be increased.
- There is a need to monitor additional air quality parameters such as ozone, benzene, PAH, $PM_{2.5}$, dry deposition of sulphates and nitrates
- Lack of private/community participation in monitoring activity
- Emission factors relevant for India are not available for various activities
- Mapping for emission loads for various pollutants is not available
- Air pollution modelling as a tool can be applied for forecasting and urban planning
- Effectiveness and impacts of various policy measures are not assessed
- Strengthening of information on number of vehicles on road, vehicle usage, etc.

Policy recommendations

- Vehicular pollution control in metropolitan cities and other cities deserves top priority. A practical strategy should be devised that reduces both emissions and congestion. Various strategies need to be adopted including augmentation of public transport system, promotion of mass rapid transport system, traffic planning and management, taxes on fuels, and vehicles, further tightening of emission norms and fuel quality specifications, promotion and use of alternative fuels like CNG/LPG/propane/ battery operated vehicles, replacement of two-stroke engines, and strengthening of an inspection and maintenance (I & M) system.
- Thrust also should be given to the control of industrial pollution through measures including promotion of cleaner technologies, strengthening of emission standards, introducing economic incentives, and strengthening of monitoring and reporting system. Emphasise should be given to waste minimisation and waste utilisation. Appropriate siting of industries will help minimise the impacts of activities on ecosystem and human health.
- Emission standards for various categories of industries need to be strengthened. In addition to concentration based standards, load based standards also should be developed.

- A comprehensive urban air quality management strategy should be formulated that includes information related to urban planning, ambient air quality, emission inventory, and air quality dispersion models. Strengthening of the monitoring network and institutional capabilities would facilitate an improvement of the enforcement mechanism.
- Use of cleaner fuels like LPG in households would reduce indoor air pollution.
- Air quality standards should be developed based on local dose-response relationships for which appropriate environmental epidemiological studies should be undertaken.
- Development of land use planning incorporating environmental considerations and strictly adhere to the planning need to be given priority to safeguard human health in urban areas.
- Economic instruments need to be put in place to encourage industries to adopt cleaner technology and other conservation practices and to discourage over utilisation of natural resources.
- Promotion of renewable energy sources such as hydro, wind, and solar
- The monitoring network requires a massive quality control programme and expansion of its operations to cover new stations as well as more pollutants (e.g., RPM_{10}, $RPM_{2.5}$, O_3, Pb, CO, and hydrocarbons such as benzene and PAHs) on a regular basis. Smaller cities should also be covered so that preventive measures can be taken before the pollution problem becomes acute.

Fresh water management

Policy/information/knowledge gaps

- Lack of institutional mechanism and overlapping of responsibilities are the major bottleneck in the effective management of water resources in India. As many as eight agencies are involved in collecting water related data, which results in duplication and ambiguity of functions and discourages.
- States are empowered to frame water policies. Many states do not have water policies though the Ministry of Water Resources (MoWR) has prepared water policy for the country.
- A proper legal framework for regulating withdrawals of groundwater is not in place. Though efforts have been made to check the overexploitation of groundwater through licensing, credit or electricity restrictions, these restrictions are directed only at the creation of wells. Even the licenses do not monitor or regulate the quantum of water extracted.
- Water cess has not been very effective in inducing abatement since the rates of raw water are so low. Market based instruments to encourage resource conservation mainly in the agriculture and domestic sector have not been really tried. This accompanied with the subsidy regime in these sectors has resulted in poor resource usage efficiency.
- It was realised during the later stages of implementation of the Ganga Action Plan, that the local authorities were not able to operate and maintain these assets due to inadequate resources and skills. The level of commitment required from the state agencies was also missing. The pollution resulted from a number of diffused sources either urban or rural.
- Water quality monitoring by CPCB reports the maximum, minimum, and mean value of the parameter and the percentage violations for select parameters. However, specific information is not available for water quality in these water bodies for seasons with lean flow. The frequency of monitoring and number of monitoring stations also is not representative of the quality of water body specifically in the non-monsoon period.

- The CWC monitors the water quality for 47 parameters three times in a month but published information is not available. Information is available only at the regional office levels and that too, on request.
- Information on availability of groundwater and its quality is limited. Though groundwater availability maps have been prepared for certain locations, extraction rates have not been defined.
- Much of information—quantitative as well as qualitative—on water supplied, coverage of population, quality of service and sanitation both in the urban and rural areas is not available. Besides information gaps on water consumption and effluent discharge patterns for industries also exist.

Policy recommendations

- A river basin approach or sub-basin-based approach is suitable to integrate all aspect of water management namely water allocation, pollution control, protection of water resources, and mobilisation of financial resources. An apex level body can be created to coordinate the functioning of different agencies.
- State-specific water policies need to be prepared. Revision in the National Water Policy, 1987 also needs to be finalised at the earliest. Groundwater legislation needs to be promulgated in all states to promote sustainable water uses and development. Incentives under the Water Cess Act, for instance, have to be made more attractive to make the industries undertake pollution control measures.
- Emphasis should be given to developing surface irrigation sources and take measures for rainwater harvesting to increase water resource availability. The concept of watershed development has also to be adopted more rigorously. Micro-watershed development provides a medium for revival and integration of traditional water control measures. People's participation is the essential prerequisite for water shed development and to this end, public education and training to local people is to be given.
- Appropriate tariff structure for water services will have to be evolved to encourage wise usage of the resource and generate additional support for the fund-starved service providers as well. There is a need to have a fresh look at the existing water pricing structure. There is also a need to develop and implement cost-effective water appliances such as low-flow cisterns and faucets and formulate citizen forum groups to encourage and raise awareness on water conservation.
- Technological intervention is required to enhance effective treatment of wastewater. Many low-cost and effective technologies for waste water treatment, e.g. UASB, duckweed ponds, and horizontal filters have been developed in other parts of the world but their application is to a limited extent in India. Adoption of cleaner technologies by the industry would help to safeguard surface water bodies.
- Data on water supply and sanitation for both urban and rural areas needs to be collected to formulating strategies and prioritising the action plan. Performance measurement of the service provider, specifically in the urban areas need to be undertaken to benchmark operational efficiencies related to water treatment and distribution. Similarly, information on water consumption and effluent discharge patterns for industries could be used to benchmark resource consumption and increase the productivity levels per unit of water consumed.
- A basin-wise analysis of the availability of utilisable water resources, demand levels and consumption patterns needs to be made. Such an analysis would help in developing a Water Zoning Atlas to guide decisions related to siting of industries and other economic activities.

Hazardous waste management

Policy/information/knowledge

Hazardous waste management

- Provision of incentives for waste reduction/minimisation efforts are missing in the rules promulgated by the MoEF in the year 2000
- No standards for clean up of contaminated sites and no limits for disposal of waste on land.
- Inventory of hazardous waste carried out by various states needs to be constantly updated to devise appropriate waste management strategies.
- System to assess the impacts of hazardous waste on human health, and ecosystem is missing.
- There is lack of infrastructure facilities for proper treatment and disposal of hazardous waste in India largely due to lack of enforcement mechanism.

Municipal waste management

- Rules on management of municipal waste and biomedical waste do not clearly identify the role and responsibilities of the CPCB and SPCBs.
- No state/nation-wide waste inventories available at the city levels to identify and quantify municipal waste and biomedical waste except for a few places. Preparation of waste management plan becomes difficult without such inventories.
- Most of the municipal or biomedical waste are currently dumped on open low lying areas with no provisions for liners, leachate collection and treatment system or gas collection system.
- In absence of segregation of waste at source, waste treatment alternatives such as recycling, waste-to-energy projects and or composting become uneconomical to operate. Most infectious biomedical waste is disposed at municipal waste dumpsites in absence of dedicated waste disposal facilities for biomedical waste.

Policy recommendations

Industrial and hazardous waste management

- Strategies need to be developed to ensure scientific management of hazardous waste encompassing all the aspects of waste management cycles starting from generation of waste to its handling, segregation, transportation, treatment and disposal. In addition, the strategy should target waste minimisation/reduction as its primary focus.
- Efforts are required to quantify and characterise the volume of waste residues generated by industries and the information needs to be constantly upgraded.
- Capacity building for SPCBs to deal with analytical and monitoring requirements regarding tracking of hazardous waste movement and management. Training for critical industrial sectors generating hazardous waste to address their responsibility in its handling, storage, transportation, treatment, and disposal.
- EIA tool can be introduced to carry out environmental and social assessments of hazardous waste management operations to assess the risks and health impacts of inappropriate disposal of hazardous waste on surrounding ecosystem and communities.
- It is necessary for the government to set up standards not only for disposal of waste on land but also for clean up of contaminated soils and groundwater.
- Ways and means to be worked out to create facilities and infrastructure for proper treatment and disposal of hazardous waste. Issues need to be addressed are willingness-to-pay issue by participating industries, type of ownership, financial mechanisms to finance such ventures and extent of private sector participation.

Municipal solid waste management

In order to achieve a satisfactory, efficient, and a sustainable system of solid waste management, the following aspects to be covered.

- Setting targets for waste reduction. Reduction at source can be accomplished in three ways (1) fees and tax incentives to promote market mechanisms to effect source reduction, (2) mandatory standards and regulation, and (3) education and voluntary compliance with policies by business and consumers
- Technological interventions. Two technical components need urgent consideration, namely collection of waste and treatment and disposal of waste.
- Collection of waste. One immediate measure to revamp the existing collection service structure is to provide community waste bins conveniently placed for the people to deposit domestic waste. The second measure should entail separation of waste at source into biodegradable and non-biodegradable components.
- Transportation of waste. Waste should be carried in covered vehicles. Infectious and hazardous waste from health care facilities should be carried strictly in separate covered vehicles. Hospital waste of some categories, e.g. biomedical waste consisting of human parts, body fluids, etc., has to be incinerated but for other categories of waste, methods such as microwaving and autoclaving are possible.
- Treatment and disposal. Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightaway transported to recycling units, which, in turn, would pay. The organic matter could be disposed of either by aerobic composting, anaerobic digestion or sanitary landfilling.
- Institutional and regulatory reforms. The 74th Constitutional Amendment empowered the local bodies to apply power to impose taxes, duties, tolls, and fees for services including public health, sanitation, conservancy, and solid waste management.

Part V Annexes

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I Acronyms and abbreviations

Acronyms	Abbreviations
ADM	Administrative Pricing Mechanism
AEQM	Area-wide Environment Quality Management
AEZ	Agro Ecological Zone
ARWSP	Accelerated Rural Water Supply Programme
BCM	Billion Cubic Metres
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BPC	British Petroleum Company
BSI	Botanical Survey of India
CETP	Common Effluent Treatment Plants
CGWB	Central Ground Water Board
CIER	Centre for Industrial and Economic Research
CII	Confederation of Indian Industry
CMIE	Centre for Monitoring the Indian Economy Pvt. Ltd
CNG	Compressed Natural Gas
CNH	Central National Herbarium
CO	Carbon dioxide
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health Environmental Engineering Organization
CRSP	Centrally Sponsored Rural Sanitation Programme
CSD	Commission on Sustainable Development
CSE	Centre for Science and Environment
CSO	Central Statistical Organization
CSWCRTI	Central Soil and Water Conservation Research and Training Institute
CZA	Central Zoo Authority
DM	Dutch Marks
DoAC	Department of Agriculture and Co-operation
DoFW	Department of Family Welfare
DoT	Department of Tourism
EIA	Environmental Impact Assessment
EMS	Environmental Management System

Acronyms	Abbreviations
ENVIS	Environmental Information System
EPA	Environment Protection Act
EPTRI	Environmental Protection Training and Research Institute
ESCAP	Economic and Social Council for Asia and the Pacific
FAO	Food and Agricultural Organization
FBC	Fluidized Bed Combustion
FSI	Forest Survey of India
FYP	Five Year Plan
GAP	Ganga Action Plan
GDP	Gross Domestic Product
GEMS	Global Environmental Monitoring Systems
GIS	Geographical Information System
GLASOD	Global Assessment of Human-induced Soil Degradation
GoI	Government of India
GTZ	German Technical Co-operation
HDI	Human Development Index
HSD	High-Speed Diesel
HUDCO	Housing and Urban Development Cooperation
IAA	Impact Assessment Agency
ICAR	Indian Council of Agricultural Research
ICFRE	Indian Council of Forestry Research and Education
ICPC	Indian Centre for Promotion of Cleaner Technologies
IDRC	International Development Research Centre
IFA	Indian Forest Act
IGCC	Integrated Gasification Combined Cycle
IIP	Index of Industrial Production
IMD	Indian Meteorological Department
IPCL	Indian Petrochemical Corporation Limited

Acronyms	Abbreviations
IPM	Integrated Pest Management
IPNS	Integrated Plant Nutrient Supply
JFM	Joint Forest Management
JNU	Jawaharlal Nehru University
kWh	Kilo Watt Hour
LPCD	Litres Per Capita Per Day
LPG	Liquefied Petroleum Gas
MHA	Million Hectare
MINARS	Monitoring of Indian National Aquatic Resources
MNES	Ministry of Non-conventional Energy Sources
MoA	Ministry of Agriculture
MODVAT	Modified Value Added Tax
MoEF	Ministry of Environment and Forests
MoF	Ministry of Finance
MoI & B	Ministry of Information and Broadcasting
MoPNG	Ministry of Petroleum and Natural Gas
MoRD	Ministry of Rural Development
MoST	Ministry of Surface and Transport
MoUAE	Ministry of Urban Affairs and Employment
MoWR	Ministry of Water Resources
MRTP	Monopolies and Restrictive Trade Practices Act
MSW	Municipal Solid Wastes
MT	Million Tonnes
MTOE	Million Tonnes of Oil Equivalent
MW	Mega Watt
NAAQM	National Ambient Air Quality Monitoring Network
NAEB	National Afforestation and Eco-development Board
NBSAP	National Biodiversity Strategy and Action Plan
NCERT	National Council of Educational Research and Training
NCR	National Capital Region
NCT-Delhi	National Capital Territory-Delhi
NEAA	National Environmental Appellate Authority
NEERI	National Environmental Engineering Research Institute
NGOs	Non-Governmental Organizations
NIP	New Industrial Policy

Acronyms	Abbreviations
NIUA	National Institute of Urban Affairs
NLCP	National Lake Conservation Plan
NO_x	Nitrogen dioxide
NRAP	National River Action Plan
NRSA	National Remote Sensing Agency
NSSO	National Sample Survey Organization
NWC	National Water Commission
NWMC	National Waste Management Council
NZC	National Zoological Collection
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCCs	Pollution Control Committees
PKM	Passenger Kilo Meter
RGNDWM	Rajiv Gandhi National Drinking Water Mission
RPM	Respirable Particulate Matter
SC	Supreme Court
SDNP	Sustainable Development Networking Programme
SIAM	Society of Indian Automobile Manufacturers
SII	Sanders International Incorporation
SO_2	Sulphur dioxide
SOM	Soil Organic Matter
SOTER	Soil and Terrain Database
SPCBs	State Pollution Control Boards
SPM	Suspended Particulate Matter
TERI	Tata Energy Research Institute
TKM	Tonne Kilo Meter
TPPs	Thermal Power Plants
TRYSEM	Training of Rural Youth for Self-Employment
TSDF	Treatment, Storage, and Disposal Facility
TWh	Trillion Watt-hour
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization
WII	Wildlife Institute of India
WTTC	World Travel and Tourism Council
YAP	Yamuna Action Plan
ZSI	Zoological Survey of India

II Components of the National SoE

Part I Executive summary

Part II Overview

- Human development
- An overview of energy sector
- Industry
- Agriculture
- Tourism in India
- Natural disasters
- Institutional mechanism and environmental policy

Part III Priority issues

- Land degradation
- Biodiversity
- Air pollution with special reference to vehicular pollution in urban cities
- Management of fresh waters
- Hazardous waste: special reference – municipal solid waste management

Part IV Conclusions

- Policy / knowledge / information gaps
- Policy recommendations

Part V Annexes

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