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सत्यमेव जयते

State Of Environment Report

India 2009

जहाँ है हरियाली।
वहाँ है खुशहाली॥

Ministry of Environment & Forests
Government of India

State of Environment Report India-2009

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20th July 2009

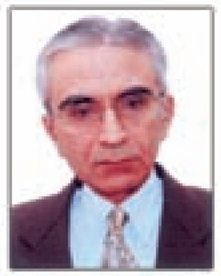
FOREWORD

It gives me great pleasure to introduce this year's edition of the 'State of Environment Report India 2009'. This year has been of particular significance and has seen the phenomenon of climate change come home to India. Not just in terms of effect but in terms of greater awareness and consciousness amongst our citizens. In numerous times in the past our country has been called upon repeatedly to balance economic growth with environmentally sustainable practices, to temper growth with environmental equity, sustainability and social justice. It is in this year that we have answered that call with conclusive steps forward.

It is also in this year that GDP has acquired the alternative and equally meaningful connotation of 'Green' Domestic Product. This exemplifies the need to infuse greater sensitivity towards the environment in our collective conscience. It is vital to maintain a healthy balance between rapid development while conserving our rich bio-diversity and natural resources.

The State of Environment Report works towards providing data on the country's environmental status that is comprehensive and available easily in one compendium. I congratulate all those who were involved in this assignment. I am glad that *Development Alternatives* have participated as equal partners in the production of this national report. I am confident that this report will serve as a useful tool and will find favour as being informative and user friendly by planners, policy makers, academicians, non-governmental organizations, civil society groups and all those interested in becoming more familiar with the state of our country's environment.

(Jairam Ramesh)



विजय शर्मा

Vijai Sharma

सचिव
भारत सरकार
पर्यावरण एवं वन मंत्रालय
Secretary
Government of India
Ministry of Environment and Forests

PREFACE

The State of Environment Report India 2009 presents an overview of the environmental scenario of our country. Its objective is to serve as a baseline document to help assist decision making and policy formulation.

The report has been prepared by Development Alternatives in active collaboration with the Ministry of Environment & Forests. A robust participatory process of consulting a range of stakeholders has been followed. The key environmental issues identified are: climate change, food security, water security, energy security and urban management. I am confident that the report will help all government agencies, NGOs and civil society in planning and policy formulation, and as a useful reference document.

I wish to thank Shri R.H. Khwaja, Dr. S.P. Sharma, Shri Nilkanth Ghosh and Shri Debabrata De, my colleagues in the Ministry, for their hard work in helping to prepare this Report. My appreciation is also due to the project team of Development Alternatives comprising of Shri Anand Kumar, Ms. Neelam Rana, Shri George C Varughese, and Dr. K. Vijaya Lakshmi.

(Vijai Sharma)

CONTENTS

Executive Summary

In the global context of State of the Environment (SoE) Reporting, India is probably unique. Over the last two decades, the Indian SoE reporting experience has ranged from grassroots initiatives like wall posters and citizens reports to media and academic documents and more formal government documents. While the quality of these outputs have been mixed, some of the processes adopted and products developed have been pioneering. Consequently, they have contributed to support policy and decision-making within the country and also for reporting to the global system.

With such a vast range of expertise and experience, Ministry of Environment and Forests, Government of India initiated the SoE reporting process with all State Governments and Union Territories (UTs) through a plan scheme in the Tenth Five Year Plan. The process was initiated in October 2002 and included streamlined data collection and collation systems, cross-sectoral consultative processes, a reporting systems using a range of static and interactive media, and linking SoE Reporting with logical follow-up decision and action.

The basic aim of the scheme is to bring out an overview of the environmental scenario of the States/UTs for mainstreaming environment in policy and decision-making. It is anticipated that through the SoE Reports, State Governments and UT Administrations would be able to integrate environmental dimensions in their socio-economic planning for sustainable development.

The present **National State of Environment (SoE) Report of India-2009** is one of the several reports emanating from the above process. Development Alternatives, the National Host Institute for SoE reporting process in India, has played a crucial role in preparing this report and also carrying out the participatory assessment processes for soliciting inputs from various stakeholders including line ministries, state and central governments, civil society organizations, academic institutions and business groups. The main objective of the SoE Report of India is to bring out an overview of the environmental scenario of India that serves as a baseline document and assists in logical and information-based decision-making. The SoE Report aims to provide policy guidelines and strategies for resource allocation for the coming decades, based on analysis of the state and trends of the environment and provide guidance for national environmental action planning.

The State of the Environment Report for India covers the state and trends of the environment (land, air, water, biodiversity) and five key issues - (1) Climate Change, (2) Food Security, (3) Water Security, (4) Energy Security, and (5) Managing Urbanization. Land degradation is taking place through natural and man-made processes, resulting in the 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 quality in cities is deteriorating due to vehicular growth and a sharp increase in air pollution related diseases. The issue of availability of water, which is going to be one of the critical problems in the coming decades, needs to be addressed on priority basis. Generation of large quantity of hazardous waste from industries, along with the hospital waste has been affecting public health and environment. Climate change and energy security are major concerns which need to be addressed strategically. The SoE Report of India on environmental issues has been prepared, following the PSIR (Pressure-State-Impact-Response) framework.

The report provides an insight on various priority issues for India related to the current status of environment and natural resources, the pressures behind environmental changes and the impacts associated with these changes. The report also assesses the Government's current and proposed policy initiatives or programmes as a response to check and monitor further degradation of environment and also suggests policy options. The report is structured into five sections:

Section – I presents profile of India in brief with characteristics of bio-physical profile, socio-economic and cultural pattern, biodiversity, climate and economic base.

India is one of the oldest civilizations in the world, with kaleidoscopic variety and rich cultural heritage. Geographically, it accounts for a meagre 2.4 per cent of the world's total surface area of 135.79 million sq. km. Yet, India supports and sustains a whopping 16.7 per cent of the world population.

India covers an area of 32,87,263 sq. km., extending from the snow covered Himalayan peaks in the North to the tropical rain forests of the South. India's coast is 7,517 km (4,671 miles) long; of this distance, 5,423 km (3,370 miles) belongs to peninsular India, and 2,094 km (1,301 miles) to the Andaman & Nicobar and Lakshadweep Islands. The rivers of India can be classified into four groups viz., the Himalayan rivers, the Deccan rivers, the coastal rivers, and rivers of the inland drainage basin. The climate of India may be broadly described as tropical monsoonal type. Its climate is affected by two seasonal winds, the North-East monsoon and the South-West monsoon. The North-East monsoon, commonly known as the winter monsoon blows from land to sea, whereas the South-West monsoon, known as the summer monsoon blows from sea to land after crossing the Indian Ocean, the Arabian Sea, and the Bay of Bengal. The South-West monsoon brings most of the rainfall during a year in the country. India, a mega diverse country with only 2.4 per cent of world's land area, accounts for 7-8 per cent of the recorded species of the world, including 45,500 species of plants and 91,000 species of animals. The Constitution of India, the longest and the most exhaustive constitution of any independent nation in the world, came into force on 26 January, 1950. India's diverse economy encompasses traditional village farming, modern agriculture, fisheries, handicrafts, a wide range of modern industries, and a multitude of services.

Section – II presents the state of environment & trends and integrated analyses of four major themes (Land, Air, Water and Biodiversity). The state and trends have been analyzed under the Pressure-State-Impact-Response (PSIR) framework.

Land

India is the seventh largest country in the world, with a total land area of 3,287,263 sq. km. It measures 3,214 km. from North to South and 2,993 km. from East to West. It has a land frontier of 15,200 km. and a coastline of 7,517 km. Out of India's total geographical area of 328.73 Mha., 306 Mha. comprise the reporting area and 146.82 Mha. is degraded land. Land degradation occurring due to the natural and human induced causes, like wind erosion and water logging, is one of the priority concerns in India. The varying degrees and types of degradation stem mainly from unsustainable use and inappropriate land management practices. Loss of vegetation occurs as a result of deforestation, cutting beyond the silviculturally permissible limits, unsustainable fuel-wood 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; non-adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals such as fertilizers and pesticides, improper planning and management of irrigation systems and extraction of groundwater in excess of the recharge capacity. The strategies identified to check land-degradation are as follows:

- Land degradation problem could be tackled to an extent by suitable policies that would internalize the issue into proper decision-making.
- At the macro level, the existing database on land use statistics cannot adequately facilitate the analysis of land degradation and its impact. Changes in the classification of land use statistics are needed in order to study its impact. Advanced technology like Remote Sensing could go a long way in generating vital information on different dimensions of land degradation.
- The information base on which farmers make decisions is incomplete in terms of internalizing rapid changes in soil and water quality variables; hence the need to move towards more sustainable practices such as integrated pest management and land-conserving crop rotations. Research needs to be focused on measures such as integrated crop management. An integrated approach to the problem of degradation, linking agriculture and environment, is yet to be attempted even at the policy level.

Air

Air pollution and the resultant impacts in India could be broadly attributed to the emissions from vehicular, industrial and domestic activities. Air quality has been, therefore, an issue of concern in the backdrop of various developmental activities. Some of the recommendations made to reduce air pollution are as follows:

- Take an integrated approach towards energy conservation and adoption of renewal energy technologies, including hydropower, by appropriately linking efforts to improve conversion, transmission, distribution, and end-use efficiency, and R&D in (and dissemination of) renewable energy technologies. Remove the statutory and regulatory barriers in setting up decentralized generation and distribution system for power and other secondary energy forms, based on local primary energy resources.
- Accelerate the national programmes for disseminating information on improved fuel wood stoves suited to local cooking practices and biomass resources.
- Strengthen the monitoring and enforcement of emission standards and prepare and implement action plans for both point and non-point sources.
- Promote reclamation of wastelands through energy plantations for rural energy, through multi-stakeholder partnerships involving the land owing agencies, local communities, and investors.
- Strengthen efforts for partial substitution of fossil fuels by bio-fuels, through promotion of bio-fuel plantation, promoting relevant research and development, and strengthening regulatory certification of new technologies.

Water

From the East to the West and from the North to the South, water has defined life in the Indian subcontinent for thousands of years. On an average, the combination of rainfall, surface and groundwater resources have been sufficient in providing adequate water to the Indian population. Rise in demand and development pressures are changing the characteristics of water in India. Erosion in the watershed due to the fast growing development and poor land management practices is increasing siltation and changing stream hydraulics. Groundwater reserves are becoming more and more depleted as surface water sources have become too polluted for human use.

The Government of India has formulated the National Water Policy in 1987 to address issues regarding planning, development and allocating groundwater and surface water. It serves as a guideline to help planners and managers in developing country's water resources to its maximum potential.

Biodiversity

India is one of the 17 identified mega diverse countries of the world. Out of all the hot spots in the world, India has two, Eastern Himalaya and Western Ghats. India, with a varied terrain, topography, land use, geographic and climatic factors, can be divided into ten recognizable bio-geographic zones. These zones encompass a variety of ecosystems: mountains, plateaus, rivers, forests, deserts, wetlands, lakes, mangroves, coral reefs, coasts and islands.

Human activities, both directly and indirectly, responsible for current high rates of biodiversity loss are - habitat loss; fragmentation and degradation due to agricultural activities; extraction (including mining, fishing, logging and harvesting); and development (human settlements, industry and associated infrastructure). Habitat loss and fragmentation leads to the formation of isolated, small and scattered populations.

Strategies and actions required to protect the India's rich bio-wealth are as follows:

- Formulate conservation and prudent use strategies for each significant catalogued wetland, with participation from local communities, and other relevant stakeholders.
- Formulate and implement eco-tourism strategies for identified wetlands through multi-stakeholder partnerships involving public agencies, local communities, and investors.
- Integrate wetland conservation, including conservation of village ponds and tanks, into sectoral development plans for poverty alleviation and livelihood improvement, and link efforts for conservation and sustainable use of wetlands with the ongoing rural infrastructure development and employment generation programmes.

Section – III focuses on key environmental issues i.e. *Climate Change, Food Security, Water Security, Energy Security and Urbanization* that threaten to cripple the efforts towards holistic development of India. The issues are again analyzed under the Pressure-State-Impact-Response (PSIR) framework.

Climate Change

India is a large developing country with nearly 700 million rural population directly depending on climate-sensitive sectors (agriculture, forests and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Further, the adaptive capacity of dry land farmers, forest dwellers, fisher folk and nomadic shepherds is very low. Climate change may alter the distribution and quality of India's natural resources and adversely affect the livelihoods of its people. With an economy closely linked to its natural resource base and climatically sensitive sectors such as agriculture, water and forestry, India may face a major threat because of the projected change in climate. With climate change, there would be increasing scarcity of water, reduction in yields of forest biomass, and increased risk to human health. The contribution of India to the cumulative global CO_2 emissions is only five per cent. Thus, historically and at present, India's share in the carbon stock in the atmosphere is relatively miniscule when compared to its distribution over the nation's population.

India released its National Action Plan on Climate Change (NAPCC) on 30th June, 2008 to outline its strategy to meet the Climate Change challenge. The National Action Plan advocates a strategy that promotes, firstly, the adaptation to Climate Change and secondly, further enhancement of the ecological sustainability of India's development path. India's National Action Plan stresses that maintaining a high growth rate is essential for increasing the living standards of the vast majority of people of India and reducing their vulnerability to the impacts of climate change. Accordingly, the Action Plan identifies measures that promote the objectives of sustainable development of India while also yielding to benefits for addressing climate change. Eight National Missions, which form the core of the National Action Plan, represent multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. The focus is on promoting understanding of Climate Change, adaptation and mitigation, energy efficiency and natural resource conservation.

Food Security

Today, there are marketable surpluses of food grains in India; the prevalence of widespread hunger is not due to the non-availability of food in the market but due to lack of adequate purchasing power among the rural and urban poor. Inadequate purchasing power, in turn, is due to insufficient opportunities for gainful employment. The famines of jobs and of purchasing power are becoming the primary causes for the famines of food in the households of the poor. Poverty, increased food consumption, land degradation, climate change are some of the pressures of food insecurity.

Some of the measures to secure food security are as follows:

- The National Food Security Mission has been launched recently as a centrally sponsored scheme. The objective is to increase production and productivity of wheat, rice and pulses on a sustainable basis so as to ensure food security of the country.
- Boosting agricultural science and technology.
- Sustainable intensification and diversification of farming systems and value-addition.
- Promotion of organic farming – a solution to ensure economically sustainable agriculture.

Water Security

Water security is emerging as an increasingly important and vital issue for India. Many Indian cities are beginning to experience moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. These shortages would be further aggravated by receding of glaciers and dwindling fresh water resources. Population stress, irrigation requirements and industrialization are the major pressures for water insecurity.

The environmental challenges of water resource development and management in India are expected to manifest themselves more explicitly and rapidly in the coming years. These environmental challenges may be addressed through four broad approaches:

- Improving efficiencies and minimizing losses
- Recharging groundwater aquifers
- Abatement and treatment of water pollution
- Reuse and recycling of wastewater

Energy Security

India is a developing country facing the critical challenge of meeting its rapidly increasing demand for energy. With over a billion people, India ranks sixth in the world in terms of energy demands. India's economy is projected to grow seven to eight per cent over the next two decades, spurring a substantial increase in demand for oil to fuel land, sea, and air transportation. While India has significant reserves of coal, it is relatively poor in oil and gas resources. India's oil reserves amount to 0.5 per cent of the global reserves.

In recent years, India's energy consumption has been increasing at one of the fastest rates in the world owing to population growth and economic development.

In the recent years, the Government of India has recognized the energy security concerns and more importance is being placed on energy independence. Some of the strategies for energy security are as follows:

- Power Generation Strategy will focus on low cost generation, optimization of capacity utilization, controlling the input cost, optimization of fuel mix, Technology upgradation and utilization of non-conventional energy sources.
- Transmission strategy will focus on development of National Grid including Inter-state connections, technology upgradation and optimization of transmission cost.
- Distribution strategy (to achieve distribution reforms) will focus on system upgradation, loss reduction, theft control, consumer service orientation, quality power supply commercialization, decentralized distributed generation and supply for rural areas.
- Conservation strategy (to optimize the utilization of electricity) will focus on demand side management, load management and technology upgradation to provide energy efficient equipment / gadgets.

Managing Urbanization

Due to an uncontrolled urbanization in India, environmental degradation has been occurring very rapidly and causing shortages of housing, worsening of water quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes. The situation in metropolises like Mumbai, Kolkata, Chennai, Delhi and Bangalore, is becoming worse year by year. Some of the strategies to manage urbanization are as follows:

- Redirection of migration flow is required. Since the mega cities have reached the saturation level for employment generation and to avoid over-crowding into the over congested slums of mega cities like Mumbai, Kolkata, Delhi and Chennai, there is a dire need to build a strong economic sector (Kundu and Basu, 1998) in the urban economy. Growth efforts and investments should be directed towards small cities which have been neglected so far so that functional base of urban economy is strengthened. Then, the redirection of migration to this desirable destination will be possible.
- Policy should also relate to proper urban planning where city-planning will consist of operational, developmental and restorative planning.

Section – IV provides the Policy and Institutional Options to cater the emerging environmental challenges. To address these challenges, it is essential to focus on diverse response options and instruments for possible solutions. Emphasis must be placed on increasing stakeholders responsibility and accountability and promoting more cooperative efforts for ensuring a healthy environment.

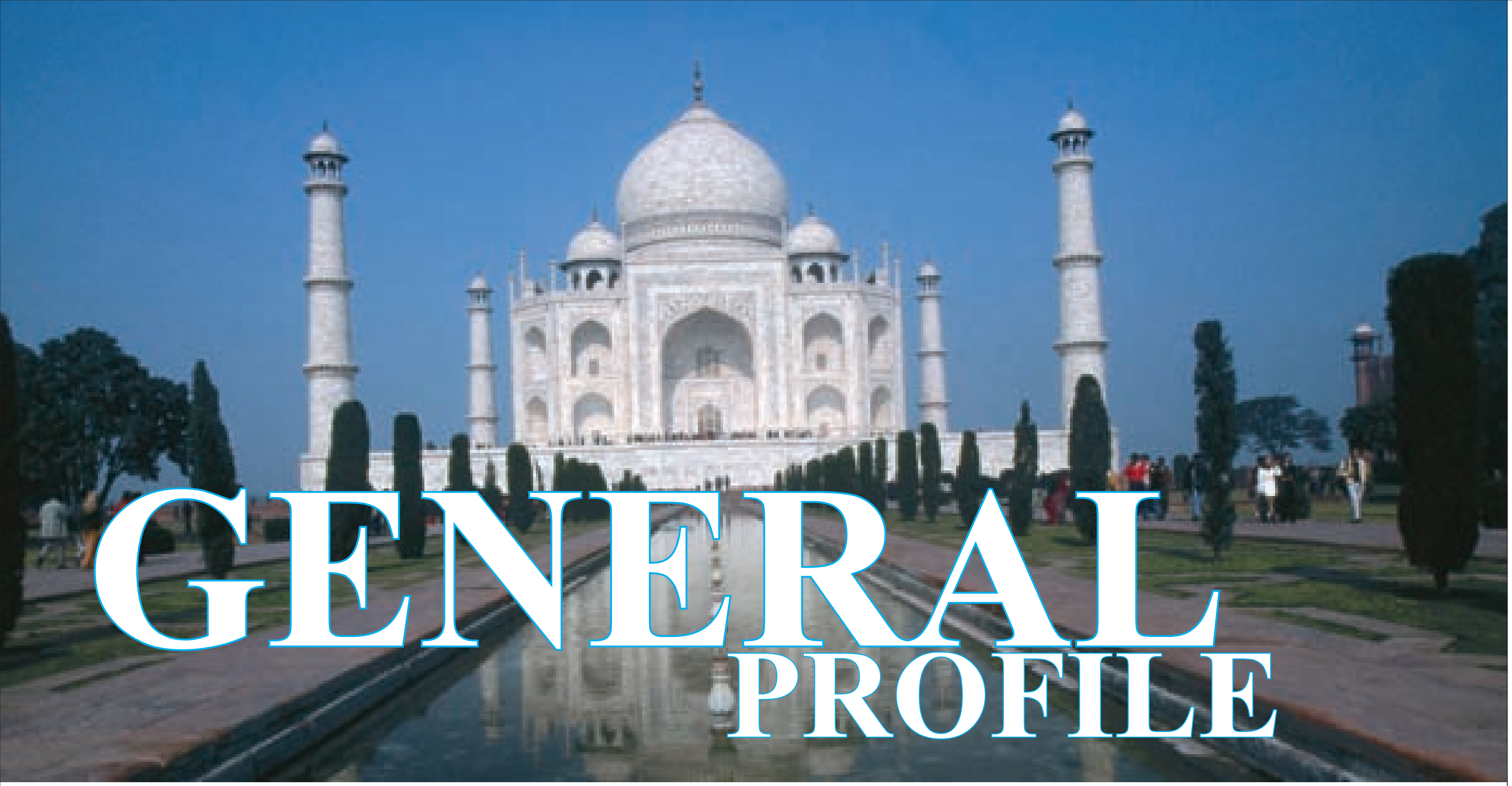
Spreading awareness and empowering people to take decisions, at the local level, is an effective way of dealing with the environmental problems of India. Their decisions will enable initiatives that will benefit them as well as the local environment. It has been seen that solutions always emerge whenever governments involve people, using a participatory approach to solve problems.

Community-based natural resource management initiatives, coupled with policy reforms, can prove to be an effective mechanism for improving access to, and improving productivity of, natural resources. The success of joint forest management and irrigation user groups in India, provide enough evidence that social capital and participatory processes are as crucial to environmental protection as financial resources and development programmes.

Section – V provides the list of annexures.

CHAPTER - 1

OVERVIEW

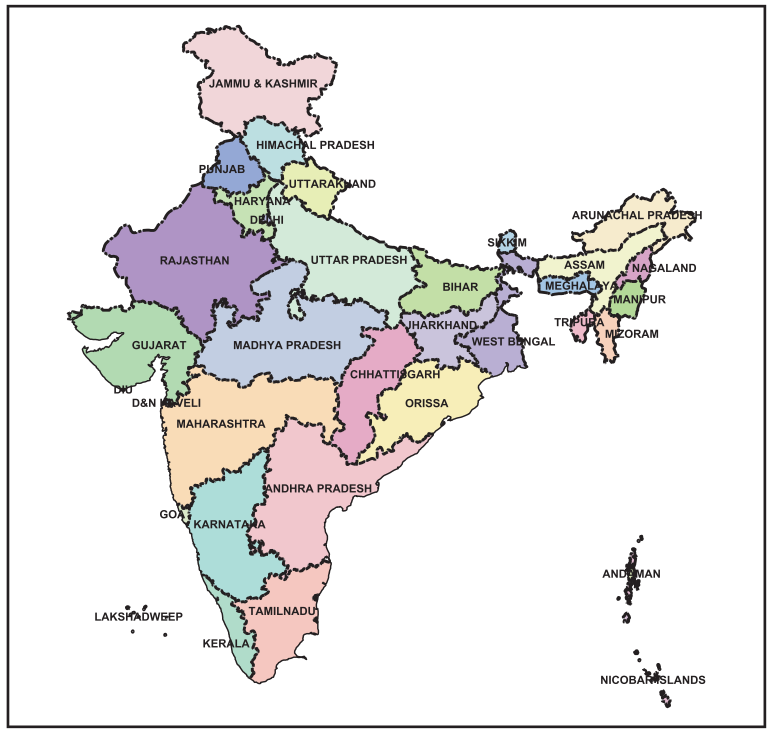


GENERAL PROFILE

India is one of the oldest civilizations in the world with a kaleidoscopic variety and rich cultural heritage. It has achieved multifaceted socio-economic progress during the last sixty-one years of its independence. India has become self-sufficient in agricultural production, and is now the tenth most industrialized country in the world and the sixth nation to have gone into outer space. India's population as on 1st March, 2001, was 1,028 million (532.1 million males and 496.4 million females). India accounts for a meagre 2.4 per cent of the world surface area of 135.79 million sq. km. Yet, it supports and sustains a whopping 16.7 per cent of the world population.

It covers an area of 3,287,263 sq. km., extending from the snow-covered Himalayan heights in the North to the tropical rain forests of the South (Figure 1.1). As the seventh largest country in the world, India stands apart from the rest of Asia, marked off as it is by mountains and the sea, which give the country a distinct geographical entity. Bounded by the Great Himalaya in the North, it stretches southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal in the East and the Arabian Sea in the West. India has a land frontier of about 15,200 km. The total length of the coastline, including the mainland, Lakshadweep Islands, and the Andaman and Nicobar Islands is 7, 517 km.

Figure 1.1 : Administrative Map of India



Source: State of Environment Atlas of India 2007, MoEF

PHYSIOGRAPHY & RELIEF

Countries sharing a common border with India are Afghanistan and Pakistan in the North-West, China, Bhutan and Nepal in the North and Myanmar and Bangladesh in the East. Sri Lanka is separated from India by a narrow channel of sea formed by the Palk Strait and the Gulf of Mannar.

The mainland comprises of four regions, namely, the Great Mountain Zone, the Indo-Gangetic Plains, the Desert Region and the Southern Peninsula.

Valley of flowers

The **Himalaya** comprises of three near parallel ranges interspersed with large plateaus and valleys, some of which, like the Kashmir and Kullu valleys, are fertile, extensive and of great scenic beauty. Some of the highest peaks in the world are found in these ranges. In the East, between India and Myanmar, and India and Bangladesh, the hill ranges are much lower. The Garo, Khasi, Jaintia and Naga hills, running almost East-West, join the chain of the Mizo and Arakan hills running North-South.

The **Indo-Gangetic Plains**, about 2,400 km long and ranging from 240 to 320 km in width, are formed by the basins of three distinct river systems - the Indus, the Ganga and the Brahmaputra. They are one of the world's greatest stretches of flat alluvium and also one of the most densely populated areas on Earth.

The **Desert Region** can be divided into two parts - the great Thar desert and the 'little desert'. The great Thar desert extends from the edge of the Rann of Kutch beyond the Luni River northwards. The whole of Rajasthan-Sind frontier runs through this. The 'little desert' extends from the Luni between Jaisalmer and Jodhpur up to the Northern West. Between the great Thar desert and the little desert, lies a zone of absolutely sterile country, consisting of rocky land cut by limestone ridges.

The **Peninsular Plateau** is marked off from the plains of river Ganga and the Indus by a mass of mountain and hill ranges, varying from 460 to 1,220 meters in height. Prominent among these are the Aravali, Vindhya, Satpura, Maikala and Ajanta. The Peninsula is flanked on one side by the Eastern Ghats with an average elevation of about 610 meters, and on the other by the Western Ghats where the average elevation varies between 915 to 1,220 meters, rising in places to over 2,440 meters. The southern point of the plateau, where the Eastern and the Western Ghats meet is formed by the Nilgiri Hills. The Cardamom Hills lying beyond may be regarded as a continuation of the Western Ghats.

COASTAL AREA

India's coast is 7,517 km (4,671 miles) long; of this distance, 5,423 km (3,370 miles) belongs to peninsular India, and 2,094 km (1,301 miles) to the Andaman, Nicobar, and Lakshadweep Islands. According to the Indian naval hydrographic charts, the mainland coast consists of the following: 43 per cent sandy beaches, 11 per cent rocky coast including cliffs, and 46 per cent mud flats or marshy coast. Notable coastal features of India comprise the marshy Rann of Kutch in the West and the alluvial Sundarbans Delta in the East, which India shares with Bangladesh. India has two archipelagos - the Lakshadweep, coral atolls beyond India's South-Western coast, and the Andaman and Nicobar Islands, a volcanic island chain in the Andaman Sea.

RIVERS OF INDIA

The rivers of India can be classified into four groups viz., the **Himalayan rivers,** the **Deccan rivers,** the **coastal rivers,** and **rivers of the inland drainage basin.**

The main **Himalayan River System** includes the Indus and the Ganga-Brahmaputra-Meghna system. The Indus originates near Mansarovar in Tibet, flows through India and Pakistan, and finally falls into the Arabian Sea near Karachi. Its important tributaries flowing through Indian territory are Sutlej (originating in Tibet), Beas, Ravi, Chenab and Jhelum. The Ganga-Brahmaputra-Meghna river system creates principal sub-basins of the Bhagirathi and the Alaknanda, which join at Dev Prayag to form the Ganga. It then traverses through Uttarakhand, Uttar Pradesh, Bihar, and West Bengal. Below the Rajmahal hills, Bhagirathi, which used to be the main course in the past, takes off, while Padma continues eastwards and enters Bangladesh. The Yamuna, Ramganga, Ghaghra, Gandak, Kosi, Mahananda and Sone are the important tributaries of Ganga. Rivers Chambal and Betwa are the important sub-tributaries, which join Yamuna before it merges with Ganga. The Padma and the Brahmaputra join in Bangladesh, and continue to flow as River Padma or Ganga. The Brahmaputra rises in Tibet, where it is known as Tsangpo and runs a long distance till it crosses over into India in Arunachal Pradesh under the name of Dihang. Near Passighat, Debang and Lohit join river Brahmaputra and together run all along Assam in a narrow valley. It crosses Bangladesh as a downstream of Dhubri.

In the **Deccan region,** most of the major river systems flow in the eastern direction and fall into the Bay of Bengal. The major East-flowing rivers are Godavari, Krishna, Cauvery and Mahanadi. Narmada and Tapti are the major West-flowing rivers.

River Godavari in the Southern peninsula forms the second largest river basin, covering ten per cent of the total area of the country, while the Mahanadi has the third largest basin. River basin of the Narmada in the uplands of the Deccan, flowing into the Arabian Sea, and of Cauvery in the south, falling into the Bay of Bengal is about the same size, though with different character and shape.

There are numerous coastal rivers, which are comparatively smaller. While only a handful of such rivers drain into the sea along the East Coast, there are as many as 600 such rivers on the West Coast.

CLIMATE

The climate of India may be broadly described as tropical monsoonal type. There are four seasons:

(i) Winter (January-February)
(ii) Hot weather summer (March-May)
(iii) Rainy South-Western monsoon (June-September) and
(iv) Post-monsoon, also known as North-East monsoon in the southern Peninsula (October-December)

India's climate is affected by two seasonal winds - the North-East monsoon and the South-West monsoon. The North-East monsoon, commonly known as the winter monsoon blows from land to sea, whereas the South-West monsoon, known as the summer monsoon blows from sea to land after crossing the Indian Ocean, the Arabian Sea, and the Bay of Bengal. The South-West monsoon brings most of the rainfall during a year in the country.

BIODIVERSITY

India, a megadiverse country with only 2.4 per cent of the land area, accounts for 7-8 per cent of the recorded species of the world, including over 45,500 species of plants and 91,000 species of animals.

India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms, which display significant biodiversity. Being one of the 17 identified megadiverse countries, it is home to 8.58 per cent of mammalians, 13.66 per cent of avians, 7.91 per cent of reptilians, 4.66 per cent of amphibians, 11.72 per cent of fish, and 11.80 per cent of plant species documented so far.

Swamp Deer in their natural habitat

India's forest cover ranges from the tropical rainforest of the Andaman Islands, Western Ghats, and North-Eastern India to the coniferous forest of the Himalayas. Between these extremes lie the Sal-dominated moist deciduous forest of Eastern India, the Teak-dominated dry deciduous forest of Central and Southern India, and the Babul-dominated thorn forest of Central Deccan and Western Gangetic plains. Important Indian trees include Neem, widely used in traditional Indian herbal remedies.

Among species found in India, only 12.6 per cent of mammals and 4.5 per cent of birds are endemic, as against 45.8 per cent of reptiles and 55.8 per cent of amphibians. Notable endemics are the Nilgiri Leaf Monkey and the Brown and Carmine Beddome's Toad of the Western Ghats. India contains 172 (2.9 per cent) of the IUCN designated threatened species. These include the Asiatic Lion, the Bengal Tiger, and the Indian White-Rumped Vulture, which suffered near-extinction situation from feeding on the carrion of diclofenac-treated cattle.

SOCIO - ECONOMIC & CULTURAL PATTERN

Indian culture is marked by a high degree of syncretism and cultural pluralism. It has managed to preserve established traditions while absorbing new customs, traditions, and ideas from invaders and immigrants and spreading its cultural influence to other parts of Asia.

All the five major ethnic groups - Australoid, Mongoloid, Europoid, Caucasian, and Negroid find representation among the people of India. According to the 2001 census, out of the total population of 1,028 million in the country, Hindus constituted the majority with 80.5 per cent, Muslims were second at 13.4 per cent, followed by Christians, Sikhs, Buddhists, Jains, and others.

Twenty two National Languages that have been recognized by the Constitution of India, of which Hindi is the official union language. Besides these, there are 844 different dialects spoken in various parts of the country.

Architecture is one area that truly represents the diversity of Indian culture. Much of it, including notable monuments and heritage buildings such as the Taj Mahal, Red Fort of Agra, Ajanta and Ellora Caves, Purana Quila, Qutub Minar, Elephanta Caves, Jaisalmer Fort, Jantar Mantar, India Gate, Gateway of India etc., comprises a blend of ancient and varied local traditions from several parts of the country and abroad. Vernacular architecture also displays notable regional variation.

Indian dance has diverse *folk* and *classical* forms. Among the well-known folk dances are the *bhangra* of Punjab, the *bihu* of Assam, the *chhau* of West Bengal, Jharkhand and Orissa and the *ghoomar* of Rajasthan. Eight dance forms, many with narrative forms and mythological elements, have been accorded the 'classical dance' status by India's *National Academy of Music, Dance, and Drama*. These are: *bharatanatyam* of Tamil Nadu, *kathak* of Uttar Pradesh, *kathakali* and *mohiniyattam* of Kerala, *kuchipudi* of Andhra Pradesh, *manipuri* of Manipur, *odissi* of Orissa and *sattriya* of Assam.

India Gate

Indian cuisine is characterized by a wide variety of regional styles and the use of herbs and spices. The staple food in the region is rice (especially in the South and the East) and wheat (predominantly in the North). Spices that are native to the Indian subcontinent are now consumed worldwide, for instance black pepper. Indian cuisine is season specific and is based on scientific combination of the medicinal and digestive properties of various vegetables, pulses and spices duly balancing their positive and negative effects on the body and digestive system. Turmeric, saffron and other herbs for body care and Amla, Ritha, Neem etc. for hair care and medicinal purposes have been traditionally used for ages in India.

Traditional Indian dresses vary across the regions in their materials, colours and styles and depend on various factors, including climate. Popular dress-styles include draped garments such as sari for women and dhoti or lungi for men. In addition, stitched clothes such as salwar-kameez for women and kurta-pyjama and European-style trousers and shirts for men, are also popular.

Many Indian festivals are religious in origin, although several are celebrated irrespective of caste and creed. Some popular festivals are Diwali, Ganesh Chaturthi, Ugadi, Thai Pongal, Holi, Onam, Vijayadasami, Durga Puja, Eid-ul-Fitr, Bakr-Id, Christmas, Buddha Jayanti and Baisakhi. Religious practices are an integral part of everyday life and are a public affair. Most festivals are related to crop harvesting or with change of seasons and as such are secular in nature.

POLITICAL & GOVERNANCE STRUCTURE

The Constitution of India, the longest and the most exhaustive constitution of any independent nation in the world, came into force on 26 January, 1950.

The President of India is the Head of the State, elected indirectly by an electoral college for a five year term. The Prime Minister is the head of the government and exercises most executive powers. The Prime Minister is appointed by the President and, by

Parliament House

convention, is the candidate supported by the party or political alliance holding the majority seats in the lower house of Parliament.

The legislature of India is a bicameral Parliament, which consists of the upper house called the Rajya Sabha and the lower house called the Lok Sabha. The Rajya Sabha, a permanent body, has 245 members serving staggered six year terms. Most are elected indirectly by the State and territorial legislatures in proportion to the State's population. 543 of the Lok Sabha's 545 members are directly elected by popular vote to represent individual constituencies for a five year term. The other two members are nominated by the President from the Anglo-Indian community if, the President is of the opinion that the community is not adequately represented.

India has a unitary three-tier judiciary, consisting of the Supreme Court, headed by the Chief Justice of India, twenty-one High Courts, and a large number of trial courts. The Supreme Court has original jurisdiction over cases involving fundamental rights and disputes between states and the Centre, and appellate jurisdiction over the High Courts. It is judicially independent, and has the power to declare the law and to strike down union or state laws which contravene the Constitution. The role as the ultimate interpreter of the Constitution is one of the most important functions of the Supreme Court.

ECONOMIC BASE

India's diverse economy encompasses traditional village farming, modern agriculture, fisheries, handicrafts, a wide range of modern industries, and a multitude of services.

The structure of the Indian economy has undergone considerable change in the last decade.

Table 1.1: Rate of growth at factor cost at 1999-2000 prices (per cent)

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Agriculture, forestry & fishing	10.0	0.0	5.8	4.0	4.9	1.6
Mining & quarrying	3.1	8.2	4.9	8.8	3.3	3.6
Manufacturing	6.6	8.7	9.1	11.8	8.2	2.4
Electricity, gas & water supply	4.8	7.9	5.1	5.3	5.3	3.4
Construction	12.0	16.1	16.2	11.8	10.1	7.2
Trade, hotels & restaurants	10.1	7.7	10.3	10.4	10.1	*
Transport, storage & communication	15.3	15.6	14.9	16.3	15.5	*
Financing, insurance, real estate & business services	5.6	8.7	11.4	13.8	11.7	7.8
Community, social & personal services	5.4	6.8	7.1	5.7	6.8	13.1
Total GDP at factor cost	8.5	7.5	9.5	9.7	9.0	6.7
* Trade, hotels & restaurants, transport & communication (together) grew at 9 per cent, 2008-09						

Source: Economic Survey of India, 2008-09, Ministry of Finance

These include increasing importance of external trade and of external capital flows. The services sector has become a major contributor to the economy with GDP share of over 50 per cent and the country becoming an important hub for exporting IT services. The share of merchandise trade to GDP increased to over 35 per cent in 2007-08 from 23.7 per cent in 2003-04. If the trade in services is included, the trade ratio is 47 per cent of GDP for 2007-08.

The overall growth of GDP at factor cost at constant prices in 2008-09, as per revised estimates released by the Central Statistical Organization (CSO) (May 29, 2009) was 6.7 per cent. This represented a decline of 2.1 per cent from the average growth rate of 8.8 per cent in the previous five years (2003-04 to 2007-08).

The growth of GDP at factor cost (at constant 1999-2000 prices) at 6.7 per cent in 2008-09 nevertheless represents a deceleration from high growth of 9.0 per cent and 9.7 per cent in 2007-08 and 2006-07 respectively (Table 1.1)

The deceleration of growth in 2008-09 was spread across all sectors except mining & quarrying and community, social and personal services. The growth in agriculture and allied activities decelerated from 4.9 per cent in 2007-08 to 1.6 per cent in 2008-09, mainly on account of the high base effect of 2007- 08 and due to a fall in the production of non-food crops including oilseeds, cotton, sugarcane and jute. The production of wheat was also marginally lower than in 2007-08.

The performance of the agricultural sector influences the growth of the Indian economy. Agriculture (including allied activities) accounted for 17.8 per cent of the GDP in 2007-08 as compared to 21.7 per cent in 2003-04. Notwithstanding the fact that the share of the agricultural sector in GDP has been declining over the years, its role remains critical as it accounts for about 52 per cent of the employment in the country. Apart from being the provider of food and fodder, its importance also stems from the raw materials that it provides to industry. The prosperity of the rural economy is also closely linked to agriculture and allied activities. Agricultural sector contributed 12.2 per cent of national exports in 2007-08.

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Gloriosa superba - an ornamental orchid of Himalaya

CHAPTER - 2

STATE & TRENDS OF THE ENVIRONMENT

LAND

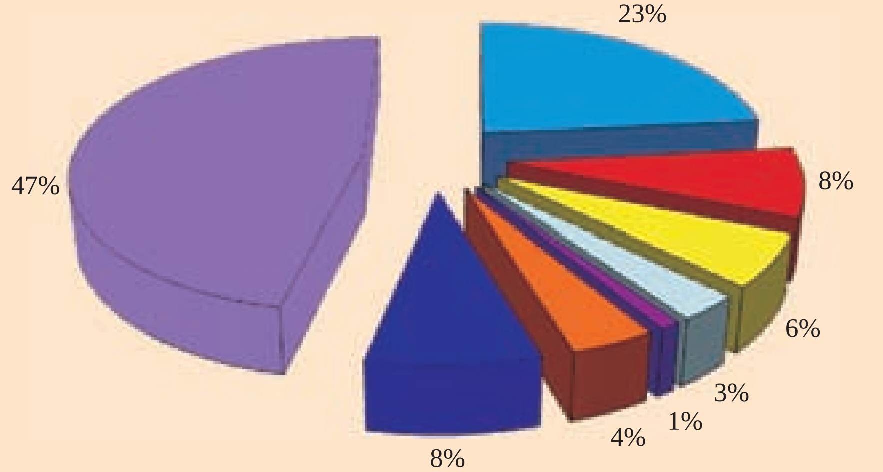
India is the seventh largest country in the world, with a total land area of 3,287,263 sq. km. (1,269,219 sq. miles). It measures 3,214 km (1,997 miles) from North to South and 2,993 km (1,860 miles) from East to West. It has a land frontier of 15,200 km (9,445 miles) and a coastline of 7,517 km (4,671 miles). Ever-growing population and urbanization is creeping into its forests and agricultural lands.

Although India occupies only 2.4 per cent of the world's total land area, it supports over 16.7 per cent of the entire global population. Of the total geographical area of 328.73 Mha., 306 Mha. comprise the reporting area and 146.82 Mha. land is degraded land.

LAND DEGRADATION STATUS

In India, an estimated 146.82 Mha. area suffers from various forms of land degradation due to water and wind erosion and other complex problems like alkalinity/salinity and soil acidity due to water logging (Figure 2.1.2).

Figure 2.1.1 : Land Use Classification in India (2005-2006)



- Net Area Sown
- Barren and Unculturable Land
- Miscellaneous Tree Crops and Groves
- Fallow Land
- Non Agricultural Uses
- Permanent Pastures and Other Grazing Land
- Culturable Wasteland
- Forests

Source: Agricultural Statistics at a Glance 2008, Ministry of Agriculture

Table 2.1.1: Land Use Classification in India, (2005-2006)

(Area in Mha)

Classification	2000-01	2001-02 (P)	2002-03 (P)	2003-04 (P)	2004-05 (P)	2005-06 (P)
1	2	3	4	5	6	7
I. Geographical Area	328.73	328.73	328.73	328.73	328.73	328.73
II. Reporting Area for Land Utilisation Statistics (1 to 5)	305.08	305.01	305.24	305.32	305.23	305.27
1. Forests	69.62	69.51	69.64	69.67	69.67	69.79
2. Not Available for Cultivation (a+b)	41.55	41.78	42.08	42.23	42.30	42.51
(a) Non Agricultural Uses	23.81	24.07	24.28	24.66	24.72	25.03
(b) Barren and Unculturable Land	17.74	17.71	17.80	17.57	17.58	17.48
3. Other Uncultivated Land excluding fallow Land(a+b+c)	27.71	27.37	27.41	26.98	27.00	26.92
(a) Permanent Pastures and Other Grazing Land	10.83	10.59	10.51	10.45	10.43	10.42
(b) Land Under Miscellaneous Tree Crops and Groves not Included in Net Area Sown	3.32	3.37	3.36	3.39	3.38	3.38
(c) Culturable Wasteland	13.56	13.41	13.54	13.14	13.19	13.12
4. Fallow Land (a+b)	25.03	24.94	33.46	25.48	24.94	24.17
(a) Fallow Land Other Than Current Fallows	10.19	10.30	11.76	11.20	10.72	10.50
(b) Current Fallows	14.84	14.64	21.70	14.28	14.22	13.67
5. Net Area Sown (6-7)	141.16	141.42	132.66	140.95	141.32	141.89
6. Gross Cropped Area	185.70	189.75	175.66	190.37	190.91	192.80
7. Area Sown More Than Once	44.54	48.33	43.00	49.42	49.59	50.90
8. Cropping Intensity*	131.60	134.20	132.40	135.10	135.10	135.90
III. Net Irrigated Area	54.84	56.30	53.88	56.00	58.54	60.20
IV. Gross Irrigated Area	75.82	78.07	72.89	77.11	79.51	82.63

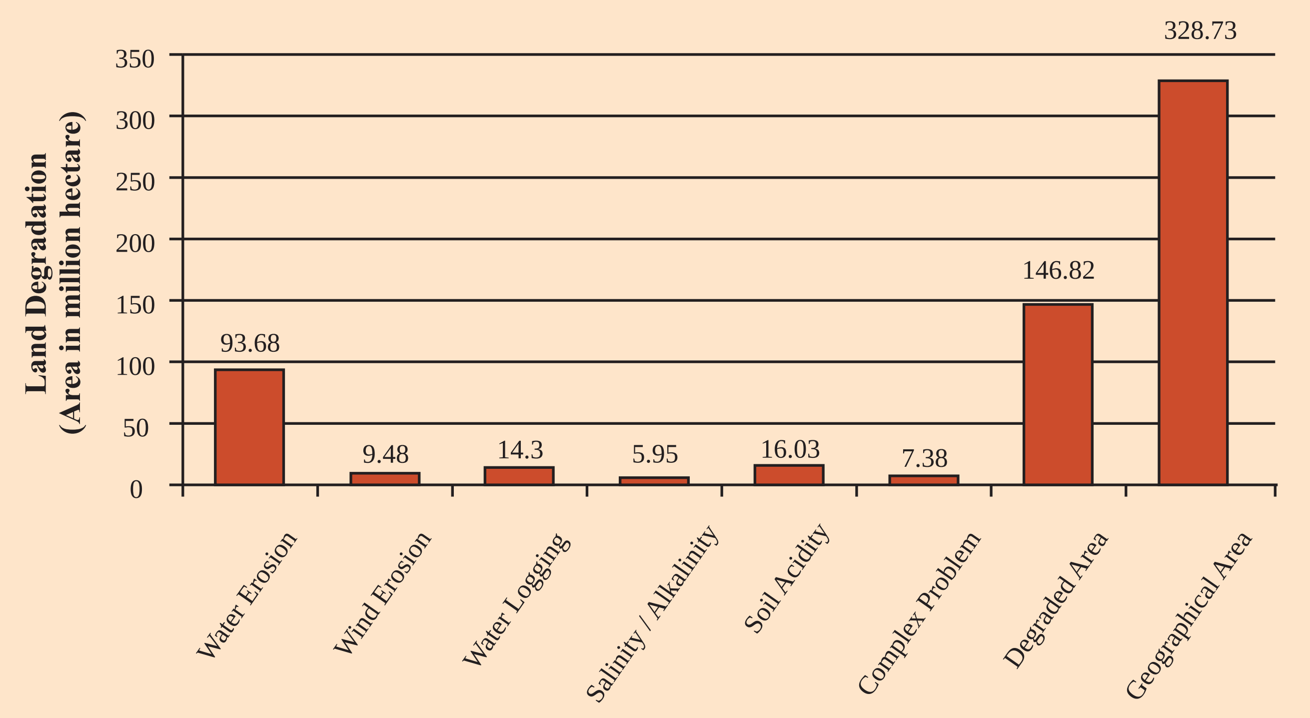
P : Provisional

** : Cropping Intensity is obtained by dividing the gross cropped area by the net area sown.*

Note : The decline in net area sown in 2002-03 reflects the impact of the severe drought of 2002-03 on agriculture operations.

Source: Agricultural Statistics at a Glance 2008, Ministry of Agriculture

Figure 2.1.2 : Extent of Various Kinds of Land Degradation in India



Source: National Bureau of Soil Survey and Land Use Planning, 2005

The varying degrees and types of degradation, stem mainly from unstable use and inappropriate land management practices. Loss of vegetation occurs as a result of deforestation, cutting beyond the silviculturally permissible limits, unsustainable fuel-wood 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 fertilizers and pesticides, improper planning and management of irrigation systems and extraction of groundwater 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, for the degradation of land.

DRIVERS OF CHANGE

Agricultural Practices

Out of India's total geographical area (328.7 million hectares) 141.89 million hectares is the net sown area, while 192.80 million hectares is the gross cropped area. The net irrigated area is 60.20 million hectares and the cropping intensity is 135.90 per cent (Table 2.1.1).

A change in land use pattern implies variation in the proportion of area under different land uses at a point in two or more time periods. Over the past fifty years, while India's total population increased by about three times, the total area of land under cultivation increased by only 20.2 per cent (from 118.75 Mha. in 1951 to 141.89 Mha. in 2005-06). Most of this expansion has taken place at the expense of forest and grazing land. Despite fast expansion of the area under cultivation, less agricultural land is available on per capita basis.

Direct consequences of agricultural development on the environment arise from intensive farming activities, which contribute to soil erosion, land salination and loss of nutrients. The introduction of Green Revolution in the country has been accompanied by over-exploitation of land and water resources and excessive usage of fertilizers and pesticides. Shifting cultivation (or *Jhum* cultivation) has also been a major factor responsible for land degradation in hilly areas. Leaching due to extensive use of pesticides and fertilizers is a major source of contamination of water bodies.

The extent of agricultural intensification and extensification is characterized by an increase in cropping and irrigation intensity and the imbalanced use of chemical fertilizers, pesticides and insecticides. It has also led to land degradation, over-exploitation of underground water resources and increased use of chemical fertilizers, leading to eutrophication and water pollution in some regions.

Enhanced intensification and extensification also leads to salination, alkalization and water logging in irrigated areas, along with eutrophication of water bodies and ill health of oceans, leading to loss of biodiversity. For achieving and maintaining food security and sustainable forestry, controlling of land/soil erosion is extremely vital.

It is essential to control soil erosion in order to attain and maintain food security, sustainable forestry and agricultural and rural development. Statistics reveal that only 23 per cent of the applied fertilizer is consumed by plants, the remaining 77 per cent is either leached out beyond the root zone or lost by volatilization.

Shifting Cultivation

The current practice of shifting cultivation in the eastern and north-eastern regions of India is an extravagant and unscientific form of land use. According to a recent estimate, an area of 18765.86 sq. km. (0.59 percent of the total geographical area) is under shifting cultivation. The effects of shifting cultivation are devastating and far-reaching in degrading the environment and ecology of these regions. The earlier 15–20 years cycle of shifting cultivation on a particular land has reduced to two or three years now. This has resulted in large-scale deforestation, soil and nutrient loss, and invasion by weeds and other species. The indigenous biodiversity has been affected to a large extent. As per the statistics, Orissa accounts for the largest area under shifting cultivation in India.

Forest fire caused by jhum burning

Excessive Chemical Usage

Per hectare consumption of fertilizers has increased from 69.8 kg in 1991-92 to 113.3 kg in 2006-07, at an average rate of 3.3 per cent. There is excessive use of urea and a bias against micronutrients. As against the desirable NPK proportion of 4:2:1, the average use of urea now is 6:2 and 4:1. The Steering Committee of the Planning Commission has observed that "because nitrogenous fertilizers are subsidised more than potassic and phosphatic fertilizers, the subsidy tends to benefit the crops and regions which require higher use of nitrogenous fertilizers as compared to crops and regions which require higher application of P and K." The excessive use of urea has also affected the soil profile adversely (Table 2.1.2)

Table 2.1.2: All India Consumption of Fertilizers in Terms of Nutrients (N, P & K)

				(1000 tonnes)
Year	**N**	**P**	**K**	**Total**
2000-01	10920.2	4214.6	1567.5	16702.3
2001-02	11310.2	4382.4	1667.1	17359.7
2002-03	10474.1	4018.8	1601.2	16094.1
2003-04	11077.0	4124.3	1597.9	16799.1
2004-05	11713.9	4623.8	2060.6	18398.3
2005-06	12723.3	5203.7	2413.3	20340.3
2006-07	13772.9	5543.3	2334.8	21651.0

Source: Agriculture Statistics at a Glance, 2006-07, Ministry of Agriculture

Agricultural Waste Residue Burning

Burning of wheat and rice straw and other agricultural residue has also contributed to loss of soil fertility, apart from causing air pollution. Open field burning of straw after combine harvesting is a common practice in states like Punjab, Haryana and Uttar Pradesh in order to ensure early preparation of fields for the next crop. Punjab alone produces around 23 million tonnes of rice straw and 17 million tonnes of wheat straw, annually. This straw is rich in nitrogen, phosphorus and potassium. However, instead of recycling it back into the soil by mulching, it is burnt in the fields. This raises the temperature of the soil in the top three inches to such a high degree that the carbon: nitrogen equilibrium in soil changes rapidly. The carbon as CO_2 is lost to the atmosphere, while nitrogen is converted into a nitrate. This leads to a loss of about 0.824 million tonnes of NPK from the soil. This is about 50 per cent of the total fertilizer consumption in the state. Considering that 90 per cent of rice straw and 30 per cent of the wheat straw is available for recycling, it will be equivalent to recycling of 0.56 million tonnes of nutrients worth Rs. 4 billion. Moreover, agriculture experts also maintain that fire in the fields kills friendly fauna and bacteria.

Soil Erosion

Soil is a unique non-renewable natural resource that supports life on planet Earth. It is estimated that one-sixth of the world's soil has already been degraded by water and wind erosion. In India, approximately 130 Mha. of land area (or 45 percent of the total geographical area) is affected by serious soil erosion through ravines and gullies, shifting cultivation, cultivated wastelands, sandy areas, deserts and water logging (Govt. of India, 1989). Excessive soil erosion with consequent high rate of sedimentation in the reservoirs and decreased fertility has created serious environmental problems with disastrous economic consequences.

In India, the Ganga, Brahmaputra and Kosi rivers carry huge amounts of eroded soil in the form of heavy silt, which deposits as sediments on the river bed. While soil erosion by rain and river in hilli areas causes landslides and floods, deforestation, overgrazing, traditional agricultural practices, mining and incorrect siting of development projects in forested areas have resulted in exposing the green cover to severe soil erosion. Ravines and gullies account for 4 Mha. of land erosion. The area subjected to shifting cultivation reported 4.9 Mha. of eroded land.

In India, erosion rates range from 5 to 20 tonnes per hectare, sometimes going up to 100 tonnes per hectare. Nearly 93.68 million hectares are affected by water erosion and another 9.48 million hectares are affected by wind erosion annually in India. Thus, erosion leads to impoverished soil on one hand, and silting up of reservoirs and water tanks on the other.

Apart from checking soil erosion, the problem of conserving soil moisture is also of immense importance in the extensive regions of low and uncertain rainfall, forming parts of Punjab, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka. These tracts are characterized by scanty, ill-distributed and highly erosive rains, undulating topography, high wind velocity and generally shallow soils. The period of heavy downpour from August to October is also the period of severe erosion in these regions. About 76 per cent of Rajasthan's arid region is affected by wind erosion of different intensities, and 13 per cent by water erosion. In fact, 4 per cent of Rajasthan's arid area is affected by water logging and salinity or alkalinity.

In India, very little area is free from the hazard of soil erosion. It is estimated that out of 305.9 million hectares of reported area, 146 million hectares is in dire need of conservation measures.

Change in Forest Cover

Forests are not just trees, but part of an ecosystem that underpins life, economies and societies. Forests provide a wide range of services which include prevention of soil erosion, floods, landslides, maintenance of soil fertility, and fixing carbon from the atmosphere as biomass and soil-organic carbon.

The total forest cover of the country, as per the 2005 assessment, is 677,088 sq. km. which constitutes 20.60 per cent of the geographic area of the country (Table 2.1.3 and Figure 2.1.4).

Dry Deciduous Forests of the Melghat Tiger Reserve

The total tree cover of the country has been estimated as 91,663 sq. km. or about 2.79 per cent of the country's geographical area (State of Forest Report, 2005).

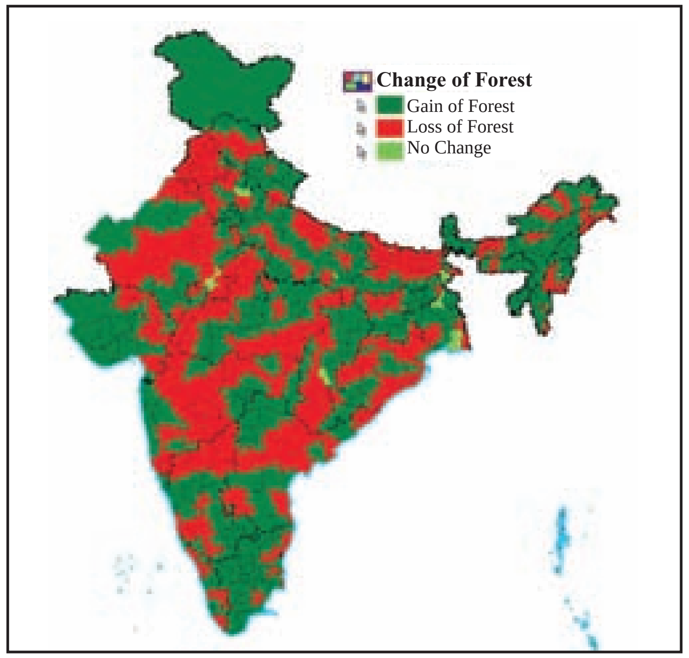
Table 2.1.3: Status of Forest Cover in India, 2005

Class	Area (sq. km.)	Percentage of Geographical Area
1	2	3
Forest Cover		
Very Dense Forest	54569	1.66
Moderately Dense Forest	332647	10.12
Open Forest	289872	8.82
Total Forest Cover	**677088**	**20.60**
Non-Forest Cover		
Scrub	38475	1.17
Non-Forest	2571700	78.23
Total Geographical Area	**3287263**	**100.00**

Source: Compendium of Environment Statistics - India, 2007

Between 2003 and 2005, the total forest cover had decreased slightly by 728 sq. km. The states, which have shown a decline in the forest covers, are Nagaland (296 sq. km), Manipur (173 sq. km), Madhya Pradesh (132 sq. km) and Chhattisgarh (129 sq. km). There has been a significant loss of forest cover in the Andaman and Nicobar Islands (178 sq. km) because of the Tsunami, whereas the states of Tamil Nadu (41 sq. km) and Tripura (32 sq. km) have shown a marginal increase in the forest cover, with Arunachal Pradesh (85 sq. km) showing significant increase in the total forest cover (Figure 2.1.3).

Figure 2.1.3 : Change in the Forest Cover of India



Source: State of Environment Atlas of India 2007, MoEF

Mining

India is rich in a variety of natural resources. Along with 56 per cent arable land, it has a significant number of sources of coal, iron ore, manganese, mica, bauxite, titanium ore, chromite, natural gas, diamonds, petroleum and limestone. India is self-sufficient in thorium, which is mined along the shores of Kerala, comprising 24 per cent of the world's known and economically available thorium.

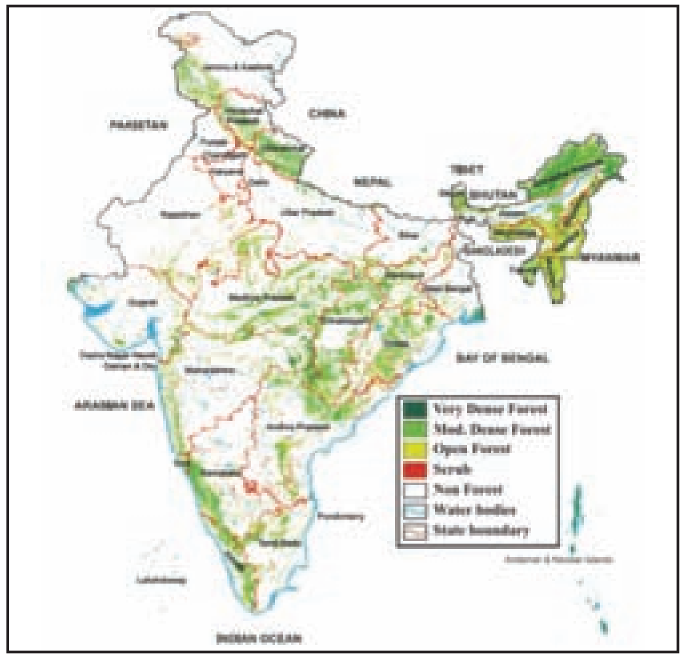
Land degradation is considered to be unavoidable by-product of mining and has reached alarming proportions, mainly due to over-exploitation and mismanagement of natural resources. Mining activity often leads to environmental problems like land degradation, particularly in opencast mining and land subsidence in underground mining. Open-cast mining in areas with forest cover causes deforestation.

Mining complexes, as estimated recently, occupy around 0.06 per cent of the total land area of the country.

Flooding

The increasing frequency of floods in India is largely due to deforestation in the catchment areas, destruction of surface vegetation, change in land-use, increased urbanization and other developmental activities. The main reason, however, is the increased sedimentation and reduced capacity of drainage systems. Consequently, streams and rivers overflow their banks, flooding the downstream areas. These are of frequent occurrence in many parts of India, especially in hilly terrains, causing a disruption of normal life and considerable damage to the productive land system. The problem of human-induced water logging in India is more common in canal command areas (surface irrigation) because irrigation facilities are often introduced without adequate provision for drainage.

Figure 2.1.4: Forest Cover Map of India



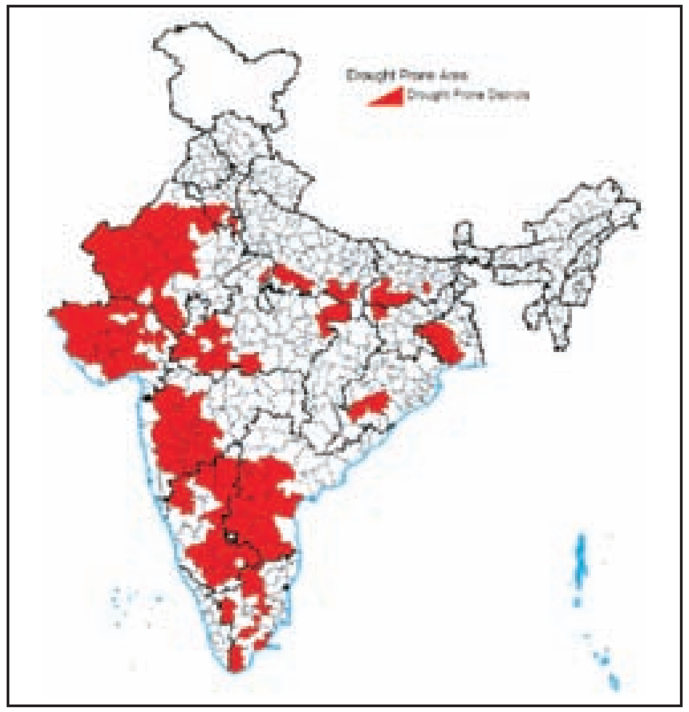
Source: Forest Survey of India, 2005

Box 2.1.1: Drivers and Pressures Affecting Forest Ecosystems
Population pressure, poverty and weak institutional framework have often been viewed as the predominant underlying causes of forest depletion and degradation in developing countries. Excessive population and livestock pressure and the requirements of forest products for essential development generate pressure on forest resources like fuel-wood, fodder, timber, lumber, paper, which in turn triggers deforestation. Over-exploitation of the forest resources, as compared to its incremental and regenerative capacities, escalates the forest depletion and degradation process. India has witnessed a spurt of large projects from big dams and thermal power projects to huge mines and massive industrial complexes. About 92 per cent area in arid Rajasthan is affected by desertification (30 per cent slightly, 41 per cent moderately and 21 per cent severely). In the neighbouring arid Gujarat, about 93 per cent area is affected by desertification.

Desertification

In India, 228.3 Mha. of geographical area comprises arid (50.8 Mha.), semi-arid (123.4 Mha.) and dry sub-humid regions (54.1 Mha.). Western parts of Rajasthan and Kutch are chronically drought affected. As a matter of fact, droughts occur frequently in the areas affected by desertification (Figure 2.1.5).

Figure 2.1.5: Drought Prone Areas of India



Source: State of Environment Atlas of India 2007, MoEF

Pollution

Soil pollution from heavy metals due to improper disposal of industrial effluents, along with the excessive use of pesticides and mismanagement of domestic and municipal wastes, is becoming a major concern. Though no reliable estimates are available to depict the exact extent and degree of this type of land degradation, it is believed that the problem is extensive and its effects are significant. Some commercial fertilizers also contain appreciable quantities of heavy metals, which have undesirable effects on the environment. The indiscriminate use of agro-chemicals, such as fertilizers and pesticides, is often responsible for land degradation. Soil texture, infiltration and permeability characteristics are affected adversely to a considerable extent due to excessive grazing, fire and mismanagement of land under cultivation.

RESPONSE

1. 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. IWDP (Integrated Watershed Development Programme) was launched in the year 1989-90 to develop the wastelands on watershed basis, to strengthen the natural resource base and to promote the overall economic development of the resource-poor and disadvantaged sections of people inhabiting the programme areas.
2. The National Bureau of Soil Survey and Land Use Planning, the Central Soil and Water Conservation Research and Training Institute and the Indian Council of Agricultural Research (ICAR), have jointly initiated the preparation of maps of soil erosion affected areas in different states using the components of Universal Soil Loss Equation. Similar assessments needs to be carried out for other degradation 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

Wasteland reclamation through Dhaincha plantation 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.

3. Joint Forest Management Programme: In India, Joint Forest Management (JFM) has emerged as an important intervention in management of forest resources. It recognizes the livelihood and sustenance needs of the people through the principle of 'care and share'. The concept of JFM has been interpreted in various ways but the basic element in this concept is to establish grassroots community based institutions for protection and management of forests. The programme aims at empowering local people for their active participation as partners in the management of forest resources and sharing the benefits derived from its protection and management. The JFM approach optimizes the returns, minimizes conflicts and links the forestry development works with the overall development of land based resources. It also aims at building technical and managerial capability at the grassroots level.
4. Soil conservation in arid, semi-arid and dry sub-humid areas was included as one of the themes in the 'International Convention on Combating Desertification' held in December 1996. India participated and ratified its commitments. The objective was to curtail wide scale deforestation and watershed degradation through appropriate corrective measures.

Slope stabilization for soil conservation

5. Drought Prone Areas Programme (DPAP): The Rural Works Programme (RWP) initiated in 1970-71 was re-designated as Drought Prone Areas Programme (DPAP) in 1973-74 to focus solely on problems of drought prone areas. At present, DPAP is under implementation in 972 Blocks of 185 Districts in 16 States (Table 2.1.4).

Table 2.1.4: States under Drought Prone Area Programme

Sl. No.	States	No. of Districts	No. of Blocks	Area in Sq. Km.
1	Andhra Pradesh	11	94	99,218
2	Bihar	6	30	9,533
3	Chhattisgarh	8	29	21,801
4	Gujarat	14	67	43,938
5	Himachal Pradesh	3	10	3,319
6	Jammu & Kashmir	2	22	14,705
7	Jharkhand	15	100	34,843
8	Karnataka	15	81	84,332
9	Madhya Pradesh	24	105	89,101
10	Maharashtra	25	149	1,94,473
11	Orissa	8	47	26,178
12	Rajasthan	11	32	31,969
13	Tamil Nadu	17	80	29,416
14	Uttar Pradesh	15	60	35, 698
15	Uttrakhand	7	30	15,796
16	West Bengal	4	36	11,594
	Total	**185**	**972**	**7,45,914**

Source: Annual Report 2007-2008, Ministry of Rural Development

6. Desert Development Programme (DDP): The Desert Development Programme (DDP) was started both in hot desert areas of Rajasthan, Gujarat and Haryana and the cold deserts of Jammu & Kashmir and Himachal Pradesh in 1977-78. From 1995-96, the coverage has been extended to a few more districts in Andhra Pradesh and Karnataka.

   DDP was launched to tackle special problems of desert areas. The basic objective of this programme is to minimize the adverse effect of drought, and to control desertification through rejuvenation of the natural resource base of the identified desert areas. The programme also aims at promoting overall economic development and improving the socio-economic conditions of the resource - poor and disadvantaged sections of people inhabiting the programme areas. DDP is under implementation in 235 blocks of 40 districts in seven states having the coverage of about 45.7 Mha.
7. The National Land Use & Conservation Board's (NLCB) objective is to serve as a policy planning, coordinating and monitoring agency at the national level for issues concerning the health and scientific management of land resources of the country.
8. The Programme for Reclamation of Alkali Soil (RAS) was launched in the Seventh Five Year Plan for reclamation of soils, which are suffering from alkalinity. About 7 Mha. area in the country is affected by the salt problem, out of which about 3.58 Mha. area suffers from alkalinity. Such alkali soils are largely located in 11 states, namely- Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh.

   The main objectives of the programme are:-
   - Reclamation of the lands affected by alkalinity and improving land productivity by growing salt tolerant crops and horticulture plantations;
   - Increase the production of fuel- wood and fodder;
   - Improve capacity of extension personnel and beneficiaries in various aspects of alkali land reclamation technology;
   - Generate employment opportunities, thereby reducing rural-urban migration.

   Since the inception of the programme, till its end in 2004-05, an area of 6.59 lakh ha. had been reclaimed under this programme.
9. Watershed Development Project in Shifting Cultivation Areas (WDPSCA) is basically a central assistance to states with an objective of overall development of jhum areas on watershed basis, reclaiming the land affected by shifting cultivation and socio-economic upgradation of jhumia families so as to encourage them for settled agriculture. The scheme is being implemented since 1994-95.
10. The Programme on Soil Conservation for Enhancing the Productivity of Degraded Lands in the Catchments of River Valley Project and Flood Prone River (RVP and FPR): Presently, this programme is being implemented in 53 catchments having a total catchment area of 110.11 Mha. falling in 27 states namely - Assam, Andhra Pradesh, Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Mizoram, Meghalaya, Manipur, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttaranchal and West Bengal.

    The major objectives of the programme are:
    - Prevention of land degradation by adoption of a multi–disciplinary integrated approach of soil conservation and watershed management in catchment areas;
    - Improvement of land capability and moisture regime in the watersheds;
    - Promotion of land use to match the land capability; and
    - Prevention of soil loss from the catchments to reduce siltation of multipurpose reservoirs and enhance the *in-situ* moisture conservation and surface rainwater storage in the catchments to reduce flood peaks and the volume of run-off.

    From the inception of the programme, till the end of the IX Plan (2005-06), an area of 62.58 lakh ha. had been treated.
11. Several initiatives for proper management of agricultural waste have also been taken up for promoting alternative uses of straw instead of burning it in the fields. The Department of Science, Technology & Environment, Government of Punjab constituted a task force in September, 2006 for formulation of a policy to mitigate the problem generated due to severity of burning of agricultural waste in the open fields after harvesting, and its consequent effects on soil, ambient air and health of living organisms. The task force has suggested promotion of agronomic practices and technological measures for better utilization of agricultural waste. These include use of *happy seeder*, developed by Punjab Agricultural University in collaboration with Australian Centre for International Agriculture Research (ACIAR) and use of paddy straw for power generation. The *happy seeder*,

Bihar : A Flood Prone State

A view of Annamalai forest

machine is compact and lightweight, and is tractor-mounted. It consists of two separate units, a straw management unit and a sowing unit. The *happy seeder* cuts, lifts and throws the standing stubble and loose straw and sows in one operational pass of the field while retaining the rice residue as surface mulch. It has thus the capability of managing the total loose straw and cutting rice residue in strips, which are thrown in front of each furrow opener.

Consequently, burning of paddy and wheat straw in the fields has been banned in the state of Punjab.

POLICY SUGGESTIONS

- Land degradation problem can be tackled to an extent by suitable policies that would internalize degradation into proper decision-making, wherever possible. Inappropriate policy choices in the Indian context like free or highly subsidized pricing of electricity for tube well irrigation, heavily subsidized surface water for irrigation and subsidized chemical inputs have aggravated the problem. For example, overuse of poor quality tube well water has led to soil salinity. Economic instruments in the form of balanced incentives will be a cost-effective measure to encourage farmers to adopt soil conservation practices. For problems regarding over-application of chemical inputs, in the long run, conjunctive use of chemical inputs with bio-inputs along with farm residue is the only answer.
- At the macro level, the existing database on land use statistics cannot adequately facilitate the analysis of land degradation and its impact. Modifications in the classification of land use statistics are needed in order to study its environmental impacts. Advanced technology like Remote Sensing can go a long way in helping generate better information on the different dimensions of land degradation.
- The information base on which farmers make decisions is incomplete with respect to internalizing rapid changes in soil and water quality variables, by moving towards more sustainable practices such as integrated pest management and land-conserving crop rotations. Research needs to be focused on measures such as integrated crop management. An integrated approach to the problem of degradation, linking agriculture and environment, is yet to be attempted even at the policy level.
- Farm research should address the issue of balancing the external inputs usage and the internal sources of nutrients. Thus from a policy perspective, there is a need for public and private initiative on several fronts - increased investment in resource management, research and extension; research to develop suitable and more sustainable cropping patterns and rotations; correction of price distortions on key inputs, especially water and electricity; and special incentives to invest in bio-inputs and also inputs like gypsum, which helps in reclamation of salt-affected soil. Such policy interventions may be rewarding if they can counteract the environmentally perverse land use. However, costs of such interventions have to be considered against their potential benefits, before making definite policy prescriptions.
- Develop and implement viable models of public-private partnerships for setting up and operating secure landfills, incinerators, and other appropriate techniques for the treatment and disposal of toxic and hazardous waste, both industrial and biomedical, on payment by users, taking the concerns of local communities into account.
- Develop and implement strategies for cleaning up toxic and hazardous waste dump legacies, particularly in industrial areas, and abandoned mines, and work towards reclamation of such lands for future sustainable use.

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Prevention of coastal erosion at Kanya Kumari

AIR

In India, air pollution is proving to be an issue of concern. India's ongoing population explosion along with rapid urbanization and industrialization has placed significant pressure on its infrastructure and natural resources. While industrial development has contributed significantly to economic growth in India, it has done so at considerable cost to the environment. Air pollution and its resultant impacts can be attributed to emissions from vehicular, industrial and domestic activities. The air quality has been, therefore, an issue of social concern in the backdrop of various developmental activities.

Industrial emissions : A major cause of air pollution

There has been unbalanced industrial growth, unplanned urbanization and deforestation. According to reports, India's urban air quality ranks amongst the world's worst. Of the three million premature deaths in the world that occur each year due to outdoor and indoor air pollution, the highest numbers are assessed to occur in India. Some cities in India have witnessed decline in air pollution levels due to various measures taken by the Governments. In fact, according to a World Bank study, Delhi, Mumbai, Kolkata, Ahmedabad and Hyderabad have seen about 13,000 less premature deaths from air pollution related diseases.

PRESSURES AFFECTING AIR QUALITY

Population Growth

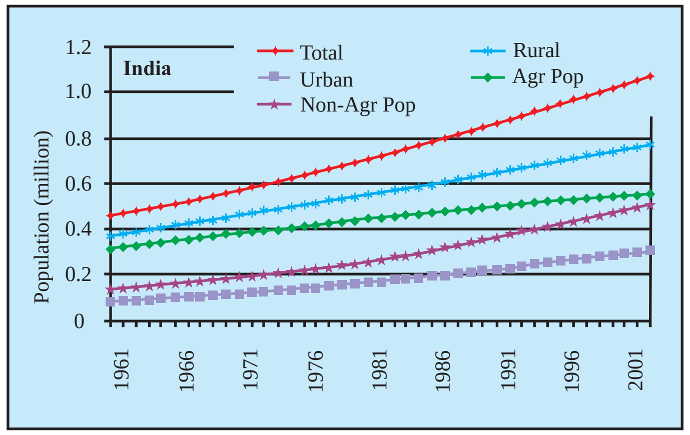
India has witnessed an explosive growth of population (0.3 billion in the year 1950 to 1.04 billion in the year 2002) accompanied by unplanned urbanization over the last five decades (Figure 2.2.1).

The total population of India is expected to exceed 1.6 billion by the year 2050 (Oldenburg 2005). The population growth has mainly centered on cities with large scale migration of rural population in search of livelihoods. In addition, high population growth rates especially in the Indo-Gangetic (IG) basin has resulted in unbalanced human concentration. The result is that IG basin is one of the most densely populated regions in the world.

This rapidly expanding population, especially in urban areas, is one of the main reasons for environmental concerns in the country. This problem can be narrowed down to many of the large cities in India. Between 1997 and 2020, the population of India's second largest city (Delhi) is expected to grow 1.9 times, i.e. almost double (Bose 1997). The increase in population has been hinting towards an alarming situation. India sustains 16.7 per cent of the world's population on 2.4 per cent of its land area, exerting tremendous pressure on its natural resources. In fact, the growing air pollution menace is deadly for the urban poor in India, 50-60 per cent of whom live in slums.

Following the trends of urbanization and population growth in Indian cities, people buying more vehicles for personal use have perpetuated an increase in vehicles that contribute to vehicular emissions containing pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, lead, ozone, benzene, and hydrocarbons (Goyal 2005).

Figure 2.2.1: Total Rural, Urban, Agricultural Population Growth (Agr Pop) and Non- Agricultural Population (Non-Agr Pop)) for India, Since 1961



Source: Census, 2001

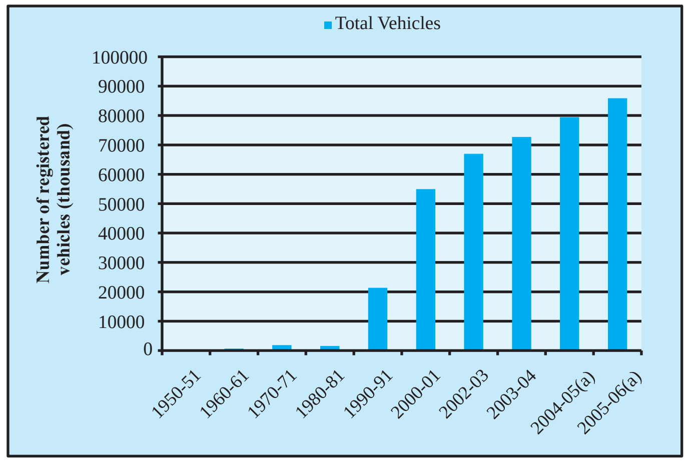
Vehicular Emission Load

As a result of urbanization in India, pressure on urban transport is likely to increase substantially in this new millennium. Total vehicle population of India is more than 85 million (about 1 per cent share of the world) (Figure 2.2.2). The increase in vehicles, as well as the presence of other motorized forms of transportation (taxis, autos, trains, buses, etc.), will contribute to the already existent large amount of vehicular emissions. The worst thing about vehicular pollution is that it cannot be avoided as the vehicular emissions are emitted at near-ground level.

Following the trend of Delhi's urbanization and the lack of appropriate mass transport system, people buying more vehicles for personal use have perpetuated an increase in vehicles. The amount of registered vehicles in Delhi has increased fifty-one times over a thirty year period. Unbelievably, as much as 17 per cent of the cars in India run in Delhi alone. It has more cars than the total numbers of cars in the individual states of Maharashtra, Tamil Nadu, Gujarat and West Bengal. The vehicle stock in Delhi is expected to almost quadruple by the year 2020.

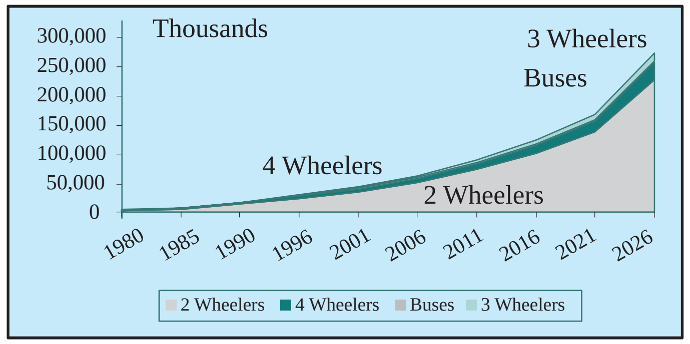
However, there are several ways by which government, industry, and the public can significantly contribute to the twin goals of reducing our dependence on motor vehicles and consequently

Figure 2.2.2 : Total Registered Motor Vehicles in India



Note :(a) provisional
Source: Economic Survey of India, 2007-2008, Ministry of Finance

Figure 2.2.3: Vehicular Growth in India



Source: Transportation economics and environmental issues that influence product strategy, TERI 2003

reducing harmful emissions. A vigilant, informed, and active citizenry will help ensure that air pollution concerns are factored into the way we plan our cities, towns, and transportation systems.

Industrial Sector Growth

Growth of India's economy is led by a robust performance of the industrial sector (Table 2.2.1 & 2.2.2). The development of a diversified industrial structure, based on a combination of large and small-scale industries, along with growing population has contributed to the growing incidence of air pollution. Impressive growth in manufacturing (7.4 per cent average over the past 10 years) is a reflection of growth trends in the fields of electronics and information technology, textiles, pharmaceuticals, basic chemicals etc. These industries, belong to the 'red category' of major polluting processes designated by the Central Pollution Control Board (CPCB), and have significant environmental consequences in terms of air emissions. The economic boom has also led to an increase in investments and activities in the construction, mining, and iron and steel sectors. This in turn, is causing a significant increase in brick making units, sponge iron plants and steel re-rolling mills that involve highly polluting processes.

Air borne emissions emitted from various industries are a cause of major concern. These emissions are of two forms, viz. solid particles (SPM) and gaseous emissions (SO_2, NO_2, CO, etc.). Heavy polluting industries were identified which are included under the 17 categories of highly polluting industries for the purpose of monitoring and regulating pollution from them. The Ministry of Environment and Forests has developed standards for regulating emissions for various industries including thermal power stations, iron and steel plants, cement plants, fertilizer plants, oil refineries, pulp and paper, petrochemicals, sugar, distilleries and tanneries.

Table 2.2.1 : Annual Growth Rates (Per Cent) For Industries

Period	Mining	Manufacturing	Electricity	General
(weights)	(10.47)	(79.36)	(10.17)	(100.00)
1995-96	9.7	14.1	8.1	13.0
2000-01	2.8	5.3	4.0	5.0
2001-02	1.2	2.9	3.1	2.7
2002-03	5.8	6.0	3.2	5.7
2003-04	5.2	7.4	5.1	7.0
2004-05	4.4	9.2	5.2	8.4
2005-06	1.0	9.1	5.2	8.2
2006-07	5.4	12.5	7.2	11.6
2007-08 (Apr-Nov)	4.9 (4.2[b])	9.8 (11.8[b])	7.0 (7.3[b])	9.2 (10.9[b])

(a): based on Index of industrial production.
Base 1993-94=100; figure for April-Nov 2006-07

Source: Economical Survey of India, 2007-2008, Ministry of Finance

The industrial units in India are largely located in the states of Gujarat, Maharashtra, Uttar Pradesh, Bihar, West Bengal and Madhya Pradesh. The highest concentration of sulphur dioxide and oxides of nitrogen is, therefore, often found in cities located in these states. Some other industrial states in Delhi, Punjab, Rajasthan and Andhra Pradesh are also becoming critical.

Power Sector

The power sector is a major consumer of coal, using about 78 per cent of the country's coal production. Coal-fired thermal units account for around 62.2 per cent of total power generation in the country. Coal is a major energy source catering to India's growing energy needs. It meets about 51 per cent of the country's commercial energy needs, and about 70 per cent of the electricity produced in India comes from coal. Thus, coal continues to be the mainstay for the Indian power sector.

India's heavy reliance on coal explains the country's relatively high carbon intensity level. Coal production through opencast mining, its supply to and consumption in power stations, and industrial boilers leads to particulate and gaseous pollution. Radioactive emissions from nuclear power plants are of grave concern as they can cause serious impact both in terms of spatial and inter-generational effects.

Table 2.2.2: Sectoral Growth Rates

(at Factor Cost, 1999-2000 prices)

Year	Agriculture	Industry	Services	Total
2002-03	-7.2	7.1	7.4	3.8
2003-04	10.0	7.4	8.5	8.5
2004-05	0.0	9.8	9.6	7.5
2005-06 (QE)	6.0	9.6	9.8	9.0
2006-07 (RE)	2.7	10.9	11.0	9.4
Average: Tenth Plan	2.1	8.9	9.3	7.6

Note: QE – Quick Estimates ; RE – Revised Estimates

Source: Annual Report, 2007-2008, Planning Commission

In 2006-07, India had encountered 495.54 million tonne/year of total absolute emissions of CO_2 from the power sector (Table 2.2.3). However, the contribution of India to the cumulative global CO_2 emissions is only 5 per cent. Thus historically, and at present, India's share in the carbon stock in the atmosphere is relatively very small when compared to its population. With high capital costs associated with replacing existing coal-fired plants and the long time required to introduce advanced coal technologies, many of India's highly polluting coal-fired power plants are expected to remain in operation for the next couple of decades, thereby keeping India's carbon emissions on the rise.

Table 2.2.3: Total Absolute Emissions of CO_2 (Million Tonnes/Year) From the Power Sector by Region for 2000-01 to 2006-2007

Region	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
1	2	3	4	5	6	7	8
North	97.87	102.74	106.81	110.00	112.21	120.10	129.55
East	58.03	61.43	66.59	75.51	83.96	92.52	93.36
South	89.02	92.18	105.24	108.12	105.60	101.76	109.25
West	135.19	141.60	148.56	144.13	157.78	153.93	157.72
North-East	2.21	2.16	2.29	2.46	2.47	2.53	2.65
India	**382.31**	**4000.11**	**429.48**	**440.22**	**462.02**	**470.85**	**495.54**

Source: Compendium of Environment Statistics - India, 2007

Agricultural Waste Burning

Almost all the leading newspapers of northern India published reports on the incident of a thick cloud of smog that enveloped many parts of Punjab and Haryana on 15 October, 2005. People experienced reduced visibility, besides irritation in the eyes and throat. This smog was attributed to the large scale burning of rice straw by farmers.

Punjab alone produces around 23 million tonnes of rice straw and 17 million tonnes of wheat straw annually. More than 80 per cent of paddy straw (18.4 million tonnes) and almost 50 per cent wheat straw (8.5 million tonnes) produced in the state is being burnt in fields every year.

Apart from affecting the soil fertility, this also causes air pollution due to emission of large amounts of suspended particulate matter, besides gases like CH_4, CO, NO_2, SO_2, etc., leading to various health hazards like respiratory, skin and eye diseases. Intensive agriculture is also a contributor to greenhouse gases (GHG) like carbon dioxide, methane and nitrous oxide, causing climate change. At an all India level, emissions from the agriculture sector are reported to be 28 per cent of the aggregate national emissions. These include emissions from enteric fermentation in livestock, manure management, rice cultivation and burning of agricultural crop residues.

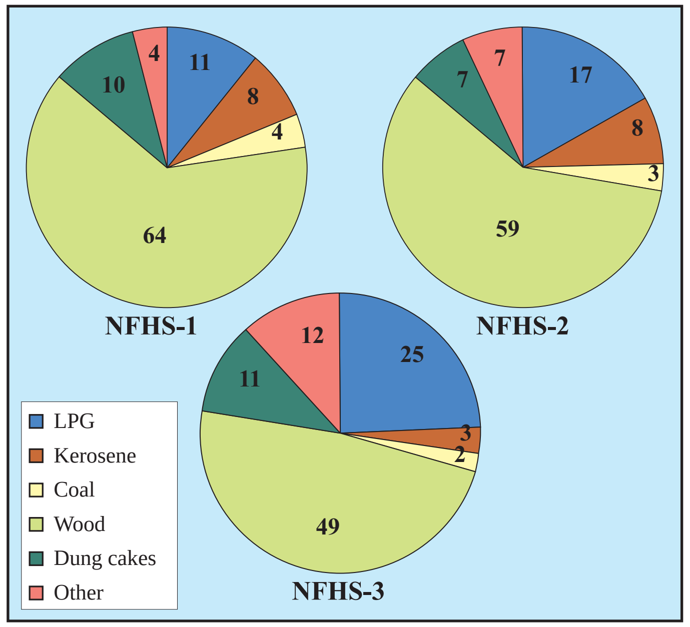
The National Remote Sensing Agency (NRSA), Hyderabad (Badrinath *et al.,* 2006) conducted a study to calculate the total emissions produced from straw-burning during the harvesting season in Punjab. The calculated total emissions suggested that wheat crop residue burning contributed to about 113 Gg (Giga gram: 10 billion gram or 10 million kg) of CO, 8.6 Gg of NO_x, 1.33 Gg of CH_4, 13 Gg PM_{10} (smoke) and 12 Gg of $PM_{2.5}$ during May 2005.

The extent of paddy crop residue burning in Punjab only during October 2005 had been estimated to be in an area of 12,685 sq. km., which is much higher than the wheat crop residue burning that occurs during the month of May each year. Emissions from burning paddy fields were estimated to be 261 Gg of CO, 19.8 Gg of NO_x, 3 Gg of CH_4, 30 Gg of PM_{10} and 28.3 Gg of $PM_{2.5}$ during October 2005.

Domestic Sector - Indoor Air Pollution

A considerable amount of air pollution results from burning of fossil fuels. The household sector is the second largest consumer of energy in India after the industrial sector. National Family Health Survey-3 (NFHS-3) found that 71 per cent of India's households use solid fuels for cooking and that 91 per cent of rural households also do the same. According to National Family Health Survey-3, more than 60 per cent of Indian households depend on traditional sources of energy like fuel-wood, dung and crop residue for meeting their cooking and heating needs (Figure 2.2.4). Burning of traditional fuels introduces large quantities of CO_2 in the atmosphere, when the combustion is complete, but if there is an incomplete combustion followed by oxidation, then CO is produced, in addition to hydrocarbons.

Figure 2.2.4: Proportion of Households by Type of Fuel Usage



Source: National Family Health Survey-3, 2005-2006

STATEWISE AIR QUALITY TRENDS

CPCB has identified a list of polluted cities in which the prescribed National Ambient Air Quality Standards (NAAQS) are violated. Action plans are being formulated and 88 of them are being implemented to control air pollution in non- attainment cities by respective states.

Ambient Air Quality Trends

Central Pollution Control Board is executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of 342 monitoring stations covering 127 cities/towns in 26 States and 4 Union Territories of the country.

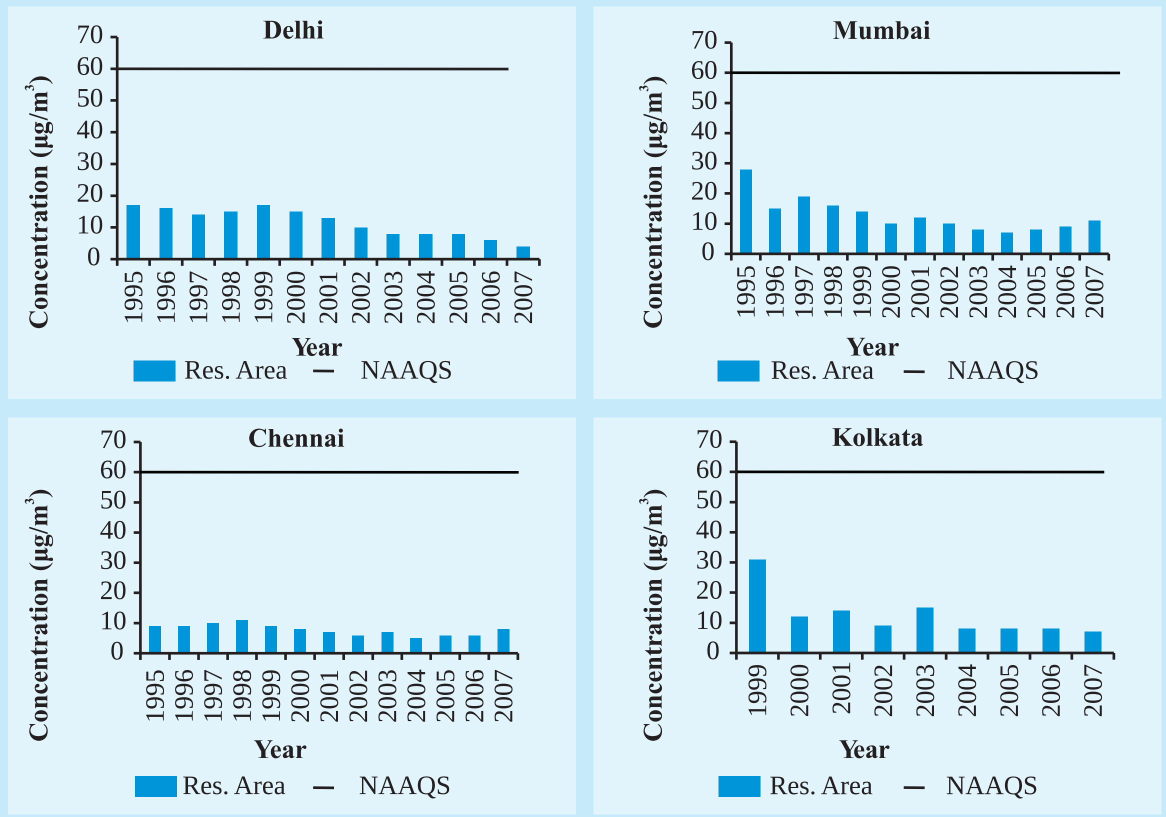
The country-wide ambient air quality monitoring carried out by CPCB at 201 monitoring stations revealed that National Ambient Air Quality Standards (NAAQS) for Respirable Suspended Particulate Matter (RSPM), the main air pollutant of public health concern, were violated at most of the monitoring stations (MoEF, 2005). The estimated annual economic cost of damage to public health from increased air pollution, based on RSPM measurements for 50 cities with the total population of 110 million, reached USD 3 billion (Rs.15,000 crores) in 2004.

Air quality data and trends highlight an emerging phenomenon of conflicting trends for different categories of cities, similar to that experienced by many other countries, thereby reflecting the complex forces behind the impact of growth on environmental action and outcome.

Sulphur Dioxide (SO_2)

Annual average concentration of SO_2 levels are within the prescribed National Ambient Air Quality Standards (NAAQS) at almost all the locations as per the reports of the Central / State Pollution Control Board. A decreasing trend has been observed in SO_2 levels in many cities like Delhi and Mumbai, during the last few years. This trend may be due to various measures taken, such as reduction of sulphur in diesel etc. and use of LPG instead of coal as a domestic fuel (Figure 2.2.5).

Figure 2.2.5: Trends in Annual Average Concentration of SO_2 in Residential Areas of Delhi, Mumbai, Chennai and Kolkata



Remark: Data for 2007 for Chennai, Kolkata and Mumbai is the avarage of data available as on date

Source: Central Pollution Control Board, 2008

Table 2.2.4 : Top Ten Locations with respect to SO_2 Emissions During 2007 in Residential Areas

	Residential Area		
Sl. No.	**Location**	**State**	**Annual Average conc.(µg/m^3)**
1	Nashik Municipal Council Building, Nashik	Maharashtra	49
2	Ahirpara, Khurja	Uttar Pradesh	43
3	Gram Panchayat Ghugus, Chandrapur	Maharashtra	39
4	RTO Colony Tank, Nashik	Maharashtra	36
5	Nagar Parishad, Chandrapur	Maharashtra	34
6	Fisheries College, Tuticorin	Tamil Nadu	29
7	AVM Jewellery Building, Tuticorin	Tamil Nadu	28
8	Clock Tower, Dehradun	Uttranchal	27
9	Elbert Ekka Chowk, Ranchi	Jharkhand	22
10	Vishak Hostel, Bhilai	Chhattisgarh	21
Note: Annual average national standard is 60 ì g/m^3			

Source: Central Pollution Control Board, 2008

Table 2.2.5: Top Ten Locations with respect to SO_2 Emissions During 2007 in Industrial Areas

	Industrial Area		
Sl. No.	**Location**	**State**	**Annual Average Conc. (µg/m^3)**
1	CGCRI, Khurja	Uttar Pradesh	47
2	VIP Industrial Area, Nashik	Maharashtra	44
3	MIDC, Chandrapur	Maharashtra	41
4	Bistupur Vehicle Testing Center, Jamshedpur	Jharkhand	39
5	Golmuri Vehicle Testing Center, Jamshedpur	Jharkhand	37
6	Dombivali MIDC Phase-II	Maharashtra	32
7	Ambernath Muncipal Council Office	Maharashtra	29
8	Chemical Div. Labour Club, Nagda	Madhya Pradesh	28
9	Raunag Auto Limited, Gajraula	Uttar Pradesh	28
10	Raja Agencies, Tuticorin	Tamil Nadu	28
Note: Annual average national standard is 80 ì g/m^3			

Source: Central Pollution Control Board, 2008

The highest concentration amongst all residential areas was observed at the monitoring station located in Nashik Municipal Corporation Building, Nashik and the highest concentration from the industrial areas was observed at the monitoring station located at CGCRI, Khurja, U.P. during 2007, although SO_2 levels at none of the monitoring stations exceeded the NAAQS (Table 2.2.4 & 2.2.5).

Nitrogen Dioxide (NO_2)

During the last few years, a decreasing trend has been observed in nitrogen dioxide levels due to various measures taken for vehicular pollution control such as stricter vehicular emission norms. Vehicles are one of the major sources of NO_2 in the country. However, Delhi observed an increasing trend in the past few years, especially after the introduction of CNG. This alternative fuel is known to emit, comparatively, more NO_2 than diesel and petrol (Figure 2.2.6).

During 2007, the highest concentration of NO_2 among all residential areas was observed at Town Hall, Delhi and from the industrial areas, at Bandhaghat, Howrah. Nonetheless, NO_2 levels at 81 per cent of the monitoring stations in industrial areas and 70 per cent of the monitoring stations in residential areas were found to be lower than the NAAQS (Table 2.2.6 & 2.2.7).

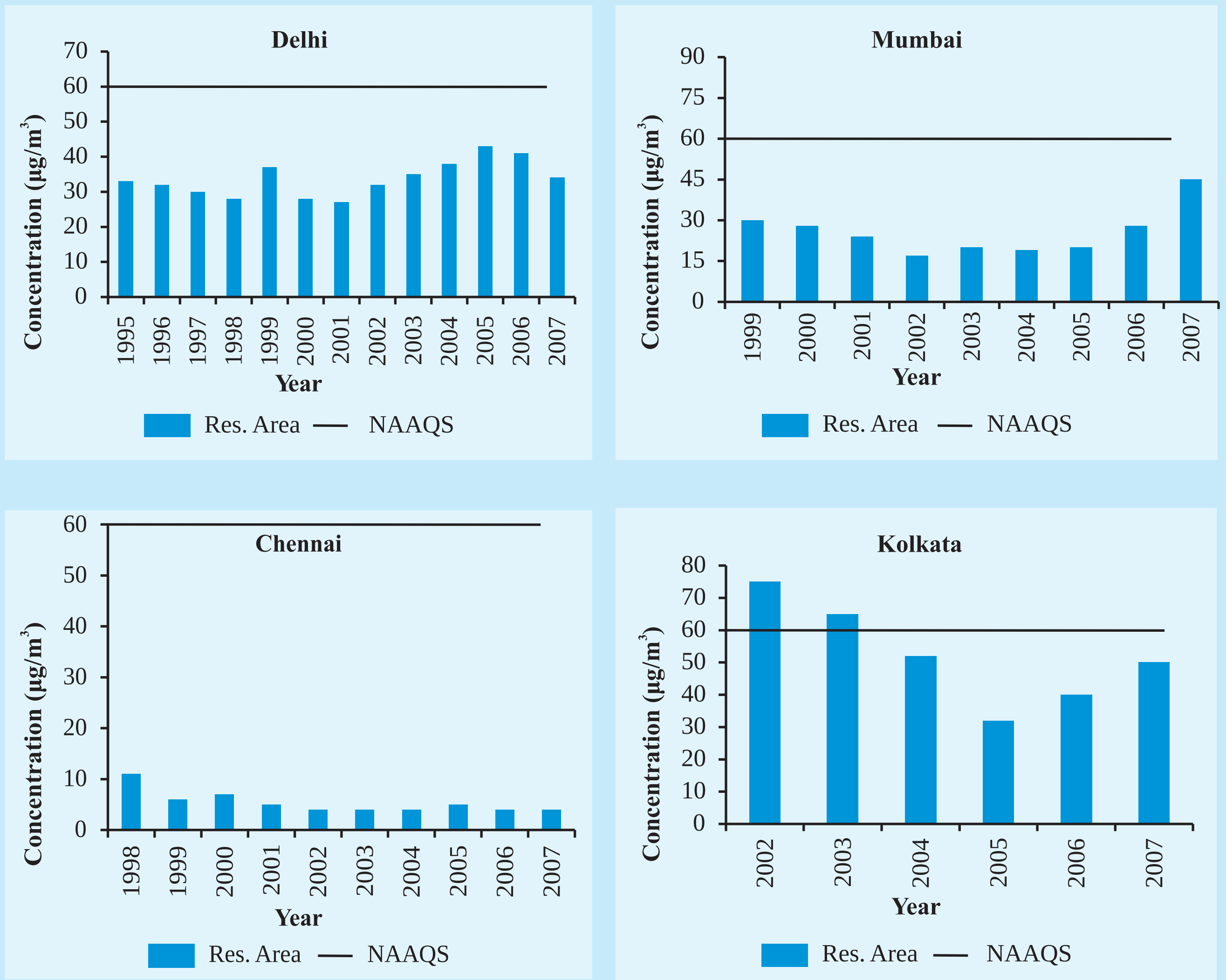
Particulate Matter

Annual average concentrations of Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM) exceeded the NAAQS in most of the cities. In cities like Delhi, this is due to engine gensets, small scale industries, biomass incineration, boilers and emission from power plants, re-suspension of traffic dust and commercial and domestic use of fuels (Figure 2.2.7). A decreasing trend in RSPM however, has been observed in cities like Solapur and Lucknow during the last few years. The probable reason could be corrective measures, like reduction of sulphur in diesel, use of premix 2-T oil dispensor and stringent standard for particulate matter in diesel vehicles. Lower levels of RSPM and SPM are also found to be governed by factors like presence of excellent ventilation effects owing to sea and land breeze, in coastal cities and wet deposition in the month of monsoon.

The highest concentration from residential areas was observed at a monitoring station located at M/s Modi Oil & General Mills, Gobindgarh and in case of industrial areas at Sub-divisional Office, Satna. RSPM level at 51 per cent of the monitoring stations in residential areas and 14 per cent of the monitoring stations in industrial areas, was critical (Table 2.2.8 & 2.2.9).

As far as SPM is concerned, highest concentrations were observed at Town Hall, Delhi and Regional Office, Udaipur from the residential and industrial areas, respectively. The percentage violation of NAAQS (24 hourly avg.) was less than two per cent at 68 monitoring stations of industrial and 30 monitoring stations of residential areas. In the remaining stations, it was two per cent or more (Table 2.2.10 & 2.2.11).

Figure 2.2.6: Trends in Annual Average Concentration of NO_2 in Residential Areas of Delhi, Mumbai, Chennai and Kolkata



Remark: Data for 2007 for Chennai, Kolkata and Mumbai is the average of data available as on date

Source: Central Pollution Control Board, 2008

It is well-known that particulate matter less than 2.5 micron (PM 2.5) is the most harmful particle as it reaches the alveolar region (i.e. blood and gas exchange region) of the respiratory tract, causing various respiratory and cardiovascular ailments. It has also been established that fine particles are more prone to get enriched with toxic and carcinogenic substances than the coarse particles.

Recognizing its importance, CPCB has initiated the monitoring of $PM_{2.5}$ in some major cities.

Particulate matter with size less than 2.5 micrometre ($PM_{2.5}$) was measured at BSZ Marg (ITO), New Delhi using continuous analyzers (Figure 2.2.8). The annual average concentration of $PM_{2.5}$ was found to be 102 ì g/m^3 during 2007. The monthly average concentration of $PM_{2.5}$ varied from 34 ì g/m^3 to 198 ì g/m^3, change in climatic conditions being a decisive factor. Presence of lesser volume of troposphere in the winter season, aided easy mixing resulting in higher concentrations. Similarly, lower concentrations were observed in monsoon months as particulate matter is washed out due to wet deposition.

NOISE POLLUTION

Of late, noise has been recognized as a pollutant which until recently was considered only a nuisance. The Central Pollution Control Board (CPCB) notified the ambient noise standards, in 1987 under section 20 of the Air (Prevention and Control of Pollution) Act, 1981. The noise standards specify 55 dB (A) and 45 dB (A) as limits for day and night time, respectively, for residential areas; 75 dB (A) and 70 dB (A) in the day and night

Table 2.2.6: Top Ten Locations with respect to NO_2 During 2007 in Residential Areas

	Residential Area		
Sl. No.	**Location**	**State**	**Annual Average conc. (µg/m^3)**
1	Town Hall, Delhi	Delhi	82*
2	Maulali, Kolkata	West Bengal	76*
3	Ghuseri Naskarpara, Howrah	West Bengal	68*
4	Gandhi Maidan, Patna	Bihar	67*
5	Salt Lake, Kolkata	West Bengal	66*
6	Sarojini Nagar, Delhi	Delhi	65*
7	Minto Park, Kolkata	West Bengal	65*
8	Bator, Howrah	West Bengal	57
9	Lal Bazaar, Kolkata	West Bengal	54
10	Regional Office, Dhanbad	Jharkhand	52
*- Locations where annual mean concentration of NO_2 exceeded the NAAQS of 60 µg/m^3 for Residential areas			

Source: Central Pollution Control Board, 2008

Table 2.2.7: Top Ten Locations with respect to NO_2 During 2007 in Industrial Areas

	Industrial Area		
Sl. No.	**Location**	**State**	**Annual Average conc. (µg/m^3)**
1	Bandhaghat, Howrah	West Bengal	91*
2	Behala Chowrasta, Kolkata	West Bengal	73
3	Howrah Municipal Corporation, Howrah	West Bengal	73
4	Mayapuri Industrial Area, Delhi	Delhi	70
5	Dew India Ltd, Durgapur	West Bengal	65
6	Dunlop Bridge, Kolkata	West Bengal	62
7	Cossipore, Kolkata	West Bengal	60
8	Kwality Hotel, Durgapur	West Bengal	59
9	Asansol Municipal Corporation, Asansol	West Bengal	57
10	Bistupur Vehicle Testing Center, Jamshedpur	Jharkhand	53
*- Locations where annual mean concentration of NO_2 exceeded the NAAQS of 80 µg/m^3 for Industrial areas			

Source: Central Pollution Control Board, 2008

time for industrial areas and 50 dB (A) and 40 dB (A) in the day and night time for silence zones.

For residential areas, average noise level exceeds the day as well as night time limit for major cities. The situation is worse in silence zone areas.

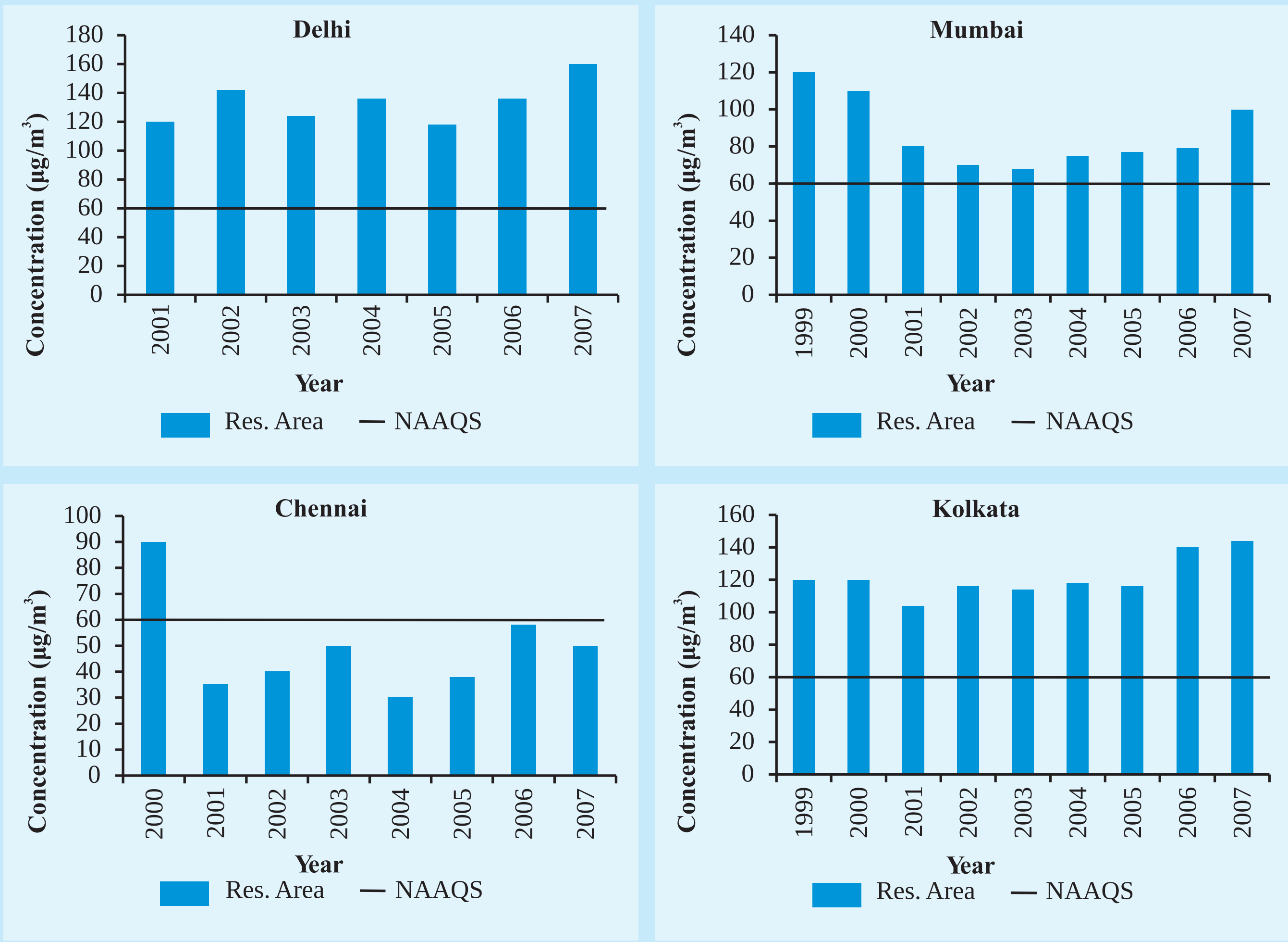
There are significant health impacts of noise pollution as depicted in table 2.2.13.

IMPACT

Health Problems

Air quality is deteriorating especially in metropolitan cities, mainly due to vehicular emissions. There is evidence that the health of over 900 million urban people around the world is deteriorating daily because of high levels of ambient air pollutants. The toxicology of air pollution is very complex as

Figure 2.2.7: Trends in Annual Average Concentration of RSPM in Residential Areas of Delhi, Mumbai, Chennai and Kolkata



Remark: Data for 2007 for Chennai, Kolkata and Mumbai is the average of data available as on date

Souce : Central Pollution Control Board, 2008

Table 2.2.8: Top Ten Locations with respect to RSPM During 2007 in Residential Areas

	Residential Area		
Sl. No.	**Location**	**State**	**Annual Average Conc. (µg/m³)**
1	M/s Modi Oil & General Mills, Gobindgarh	Punjab	252*
2	PPCB Office Building, Ludhiana	Punjab	231*
3	Ahirpara, Khurja	Uttar Pradesh	201*
4	Deputy Ka Padao, Kanpur	Uttar Pradesh	198*
5	Town Hall, Delhi	Delhi	198*
6	Kidwai Nagar, Kanpur	Uttar Pradesh	197*
7	A S School, Khanna	Punjab	196*
8	Aminabad, Lucknow	Uttar Pradesh	193*
9	Aliganj, Lucknow	Uttar Pradesh	190*
10	Sharda Nagar, Kanpur	Uttar Pradesh	185*
*- Locations where annual mean concentration of RSPM exceeded the NAAQS of 60µg/m³ for Residential areas			

Source: Central Pollution Control Board, 2008

Table 2.2.9 : Top Ten Locations with respect to RSPM During 2007 in Industrial Areas

	Industrial Area		
Sl. No.	**Location**	**State**	**Annual Average Conc.(µg/m³)**
1	Sub-divisional Office, Satna	Madhya Pradesh	288*
2	Rita Sewing Machine, Ludhiana	Punjab	261*
3	Sahibabad Industrial Area, Ghaziabad	Uttar Pradesh	250*
4	Mayapuri Industrial Area, Delhi	Delhi	233*
5	Markfed Vanaspati, Khanna	Punjab	233*
6	M/s Raj Steel Rolling Mills, Gobindgarh	Punjab	228*
7	Bulandshahar Road Industrial Area, Ghaziabad	Uttar Pradesh	210*
8	CGCRI, Khurja	Uttar Pradesh	209*
9	Center for Development of Glass Industry, Firozabad	Uttar Pradesh	205*
10	VKIA, Jaipur	Rajasthan	202*
*- Locations where annual mean concentration of RSPM exceeded the NAAQS of 120 µg/m³ for Industrial areas			

Source: Central Pollution Control Board, 2008

Table 2.2.10: Top Ten Locations with respect to SPM During 2007 in Residential Areas

	Residential Area		
Sl. No.	**Location**	**State**	**Annual Average Conc.(µg/m³)**
1	Town Hall, Delhi	Delhi	476*
2	Regional Office, Noida	Uttar Pradesh	447*
3	Kidwai Nagar, Kanpur	Uttar Pradesh	442*
4	Deputy Ka Padao, Kanpur	Uttar Pradesh	440*
5	Ahirpara, Khurja	Uttar Pradesh	432*
6	Shivpur/Sigra, Varanasi	Uttar Pradesh	422*
7	Sharda Nagar, Kanpur	Uttar Pradesh	421*
8	A-1 Platters, Amritsar	Punjab	411*
9	Aminabad, Lucknow	Uttar Pradesh	402*
10	Jail Chauraha, Jhansi	Uttar Pradesh	402*
*- Locations where annual mean concentration of SPM exceeded the NAAQS of 140 µg/m³ for Residential areas			

Source: Central Pollution Control Board, 2008

there are different types of pollutants affecting the individual differently.

The pollutants in air, namely - SO_2, NO_x and Suspended Particulate Matter (SPM) - damage the human respiratory and cardio-respiratory systems in various ways. The elderly, children, smokers and those with chronic respiratory diseases are the most vulnerable. It has been reported that high levels of pollution affect mental and emotional health too. Elevated levels of lead in children result in impaired neurological development, leading to lowered intelligence quotient, poor school performance and behavioural difficulties.

A study conducted by All India Institute of Medical Sciences and Central Pollution Control Board in Delhi showed that exposure to higher levels of particulate matter contributed to respiratory morbidity. It indicated that the most common symptoms relating to air pollution were irritation of eyes (44 per cent), cough (28.8

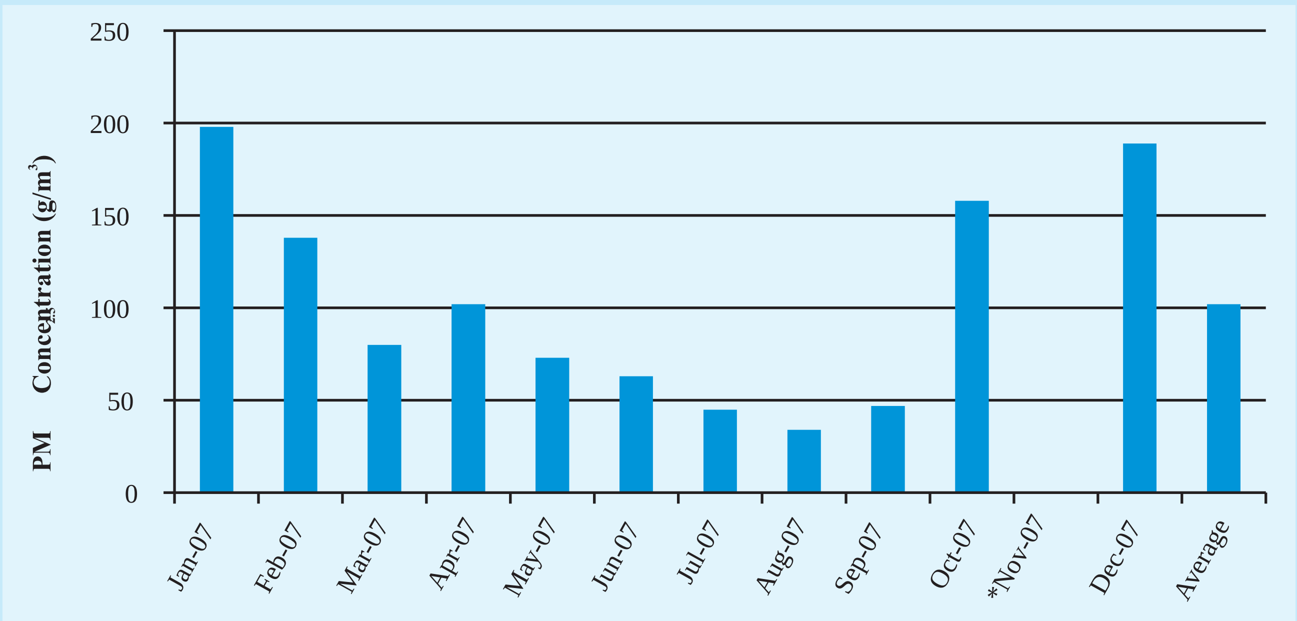
Table 2.2.11: Top Ten Locations with respect to SPM During 2007 in Industrial Areas

Sl. No.	Industrial Area: Location	State	Annual Average Conc. (µg/m³)
1	Regional Office, Udaipur	Rajasthan	250*
2	Center for Development of Glass Industry, Firozabad	Uttar Pradesh	486*
3	CGCRI, Khurja	Uttar Pradesh	485*
4	Fazalganj, Kanpur	Uttar Pradesh	484*
5	Sahibabad Industrial Area, Ghaziabad	Uttar Pradesh	475*
6	Mayapuri Industrial Area, Delhi	Delhi	461*
7	Jajmau, Kanpur	Uttar Pradesh	444*
8	Shahdara, Delhi	Delhi	440*
9	M/s GEE PEE Electroplating and Engineering Works, Noida	Uttar Pradesh	437*
10	Sub-divisional Office, Satna	Madhya Pradesh	433*

*- Locations where annual mean concentration of SPM exceeded the NAAQS of 360 µg/m³ for Industrial areas

Source: Central Pollution Control Board, 2008

Figure 2.2.8: Concentration of $PM_{2.5}$ (g/m³) at Bahadur Shah Zafar Marg (ITO), Delhi During 2007



* NA– Data not available/not adequate

Source: Central Pollution Control Board, 2008

per cent), pharyngitis (16.8 per cent), dyspnea (16 per cent) and nausea (10 per cent). In Mumbai, the prevalence of both symptoms and signs of such diseases is around 22.2 per cent.

Among the six major communicable diseases, maximum cases (2,58,07,722) were reported for Acute Respiratory Infection while maximum number of people (7,073) died due to Pulmonary Tuberculosis in India, during the year 2006 (Figure 2.2.9).

Climate Change

India is a fast growing economy and has many future developmental targets, several of which are directly or indirectly linked to energy and therefore increased green house gas emissions.

Though the contribution of India to the cumulative global CO_2 emissions is only 5 per cent but impacts could be severe at local level. India has nearly 700 million rural population directly

Table 2.2.12: Average Noise Levels (dB[A]) in Various Metropolitan Cities

SI. No.	Metropolitan Cities	Day/ Night	Industrial Area	Commercial Area	Residential Area	Silence Area
1	Kolkata	Day	78	82	79	79
		Night	67	75	65	65
2	Mumbai	Day	76	75	70	66
		Night	65	66	62	52
3	Chennai	Day	71	78	66	63
		Night	66	71	48	49
4	Bangalore	Day	78	76	67	67
		Night	53	57	50	--

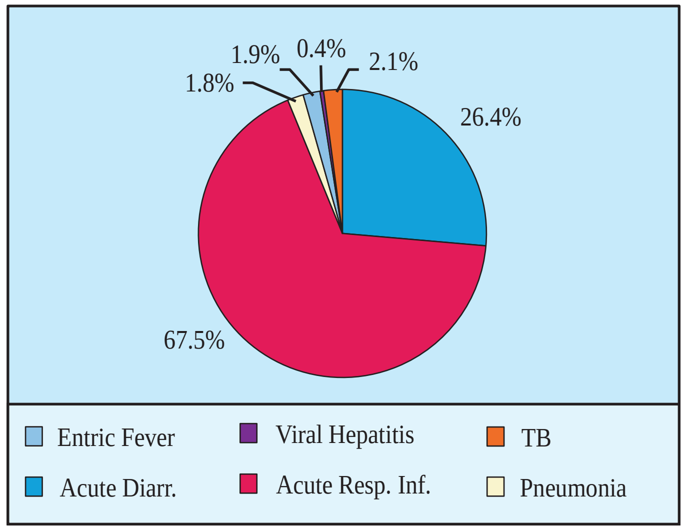
Source: Compendium of Environment Statistics India, 2007

Table 2.2.13: Effects of Noise Pollution on Human Health

A. Noise Hazards	
Stage: I Threat to Survival (a) Communication interference (b) Permanent hearing loss	**Stage: II** Causing injury (a) Neural-humoral stress response (b) Temporary hearing loss (c) Permanent hearing loss
B. Noise Nuisances	
Stage III Curbing Efficient Performance (a) Mental Stress (b) Task Interference (c) Sleep Interference	**Stage IV** Diluting Comfort and Enjoyment (a) Invasion of privacy (b) Disruption of Social Interaction (c) Hearing Loss

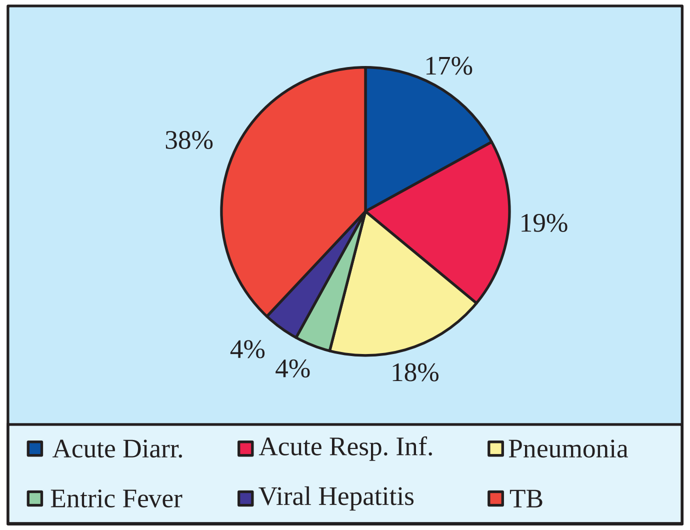
Source: West Bengal Pollution Control Board, 2008

Figure 2.2.9: Six Major Communicable Diseases (cases), 2006



Source: Monthly Health Condition from Directorate of Health Services of States/UTs

Figure 2.2.10: Six Major Communicable Diseases (deaths), 2006



Source: Monthly Health Condition from Directorate of Health Services of States/UTs

Table 2.2.14: Prevalence of Tuberculosis by Type of Housing and Fuels/Cooking Arrangements

		Number of persons per 100,000 suffering from		
Sl.No.	Cooking fuel	Tuberculosis[2]	Medically treated tuberculosis	Number of usual residents
1	Electricity or gas[1]	220	217	124,028
2	Kerosene	564	550	13,511
3	Coal/lignite/charcoal	472	436	12,001
4	Wood	463	430	257,123
5	Straw/shrubs/grass	1,012	924	28,038
6	Agriculture crop residues	703	703	20,872
7	Dung cakes	440	416	65,681
8	Other	755	755	640
	Total	445	418	522,027

Note: Total include usual residents with missing information on cooking fuel, place for cooking, and type of fire/stove among households using solid fuels who are not shown separately.

[1]Includes natural gas. and biogas.
[2]Includes coal, lignite, charcoal, wood, straw/shrubs/grass, agriculture crop waste and dung cakes.

Source: NFHS-3, 2005-2006

depending on climate sensitive sectors (agriculture, forests and fisheries) and natural resources for their subsistence and livelihoods. Further, the adaptive capacity of dry land farmers, forest dwellers, fisher folk and nomadic shepherds is very low.

Climate change is likely to impact all the natural ecosystems as well as socio-economic systems as shown by the National Communications Report of India to the UNFCCC.

Acid Rain

Acid rain is the direct consequence of air pollution caused by gaseous emissions (carbon monoxide, sulphur dioxide, nitrogen oxides) from industrial sources, burning of fuels (thermal plants, chimneys of brick-kilns or sugar mills.) and vehicular emissions. The most important effects of acid rain are damage to freshwater aquatic life, vegetation and damage to buildings and material.

In India, the main threat of an acid rain disaster springs from our heavy dependence on coal as a major energy source. Even though Indian coal is relatively low in sulphur content, what threatens to cause acid rain in India is the concentrated quantity of consumption, which is expected to reach very high levels in some parts of the country by 2020. As energy requirements in India are growing rapidly in tune with the growing economy, coal dependence in the country is expected to grow threefold over the current level of consumption, making the clouds of acid rain heavier over many highly sensitive areas in the country like the northeast region, parts of Bihar, Orissa, West Bengal and coastal areas in the south. Already, the soils of these areas have a low pH value, which acid rain will aggravate further making them infertile and unsuitable for agriculture.

The prospect of increasing consumption of coal in Asia makes the acid rain threat even more real than ever. Possible options for mitigation are: radical improvements in energy efficiency, a switchover to low sulphur fuels like natural gas, greater use of renewables, major cut-down and removal of sulphur from crude oil distillates like diesel, fuel oil, etc., and finally, the widespread use of state-of-the-art pollution control devices in all polluting sectors of the economy.

IMPACTS OF INDOOR AIR POLLUTION

Use of solid fuel (wood, animal dung, crop residue/grasses, coal, and charcoal) exposes people to high levels of toxic air pollutants, which result in serious health consequences. National Family Health Survey-3 (NFHS) found that 71 per cent of India's urban households and 91 per cent of rural households use solid fuels for cooking purposes.

There is a great deal of variation in the prevalence of TB according to the type of cooking fuel the household uses. It ranges from a low of 217 per 100,000 residents, (among households using electricity, liquid petroleum gas, natural gas, or biogas), to a high of 924 per 100,000 (among households using straw, shrubs, or grass for cooking). High TB prevalence is also seen amongst households using agricultural crop residue (703/100,000) or other fuels not specified in the table (755/100,000)(Table 2.2.14).

Studies have found that besides TB, acute respiratory infections, chronic obstructive pulmonary disease, asthma, lung cancer, ischaemic heart disease and blindness can also be attributed to indoor air pollution.

RESPONSE

1. Air (Prevention and Control of Pollution) Act, 1981

- Government of India enacted the Air (Prevention and Control of Pollution) Act, 1981 to arrest the deterioration in the air quality. The Act prescribes various functions for the Central Pollution Control Board (CPCB) at the apex level and State Pollution Control Boards at the state level. The main functions of the Central Pollution Control Board are as follows:
- To advise the Central Government on any matter concerning the improvement of the quality of the air and prevention, control and abatement of air pollution.
- To plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution.
- To provide technical assistance and guidance to the State Pollution Control Board.
- To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
- To collect, compile and publish technical and statistical data related to air pollution; and
- To lay down standards for the quality of air.

The main functions of the State Pollution Control Boards are as follows:

- To plan a comprehensive programme for prevention, control and abatement of air pollution and to secure the execution thereof.
- To advise the State Government on any matter concerning prevention, control and abatement of air pollution.
- To collect and disseminate information related to air pollution.
- To collaborate with the Central Pollution Control Board in programmes related to prevention, control and abatement of air pollution; and
- To inspect air pollution control areas, assess quality of air and to take steps for prevention, control and abatement of air pollution in such areas.

2. National Air Quality Monitoring Programme

- Central Pollution Control Board is executing a nation-wide National Air Quality Monitoring Programme (NAMP). The network consists of 342 operating stations covering 127 cities/towns in 26 States and 4 Union Territories of the country.
- The objectives of the NAMP are to determine the status and trends of ambient air quality; to ascertain whether the prescribed ambient air quality standards are violated; to assess health hazards and damage to materials; to continue the ongoing process of producing periodic evaluation of air pollution situation in urban and industrial areas of the country; to obtain the knowledge and understanding necessary for developing preventive and corrective measures and to understand the natural cleansing processes undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.
- Under the NAMP, four air-pollutants viz., SO_2, Oxides of Nitrogen as NO_2, SPM and RSPM (PM_{10}), have been identified for regular monitoring at all the locations.
- Keeping in view the monitored data available on air quality, the Hon'ble Supreme Court, in its various judgments, has

More vehicles means more air pollution

Table 2.2.15: Gasoline Lead Phase Out Programme

Phase	Date of Introduction	Lead Content	Areas Covered
Phase-I	June 1994	Low lead (0.15 g/l)	Delhi, Mumbai, Kolkata, Chennai
Phase-II	1.4.1995	Unleaded (0.013 g/l)+ low leaded	Delhi, Mumbai, Kolkata, Chennai
Phase-III	1.1.1997	Low leaded	Entire Country
Phase-IV	1.9.1998	Only unleaded	National Capital Territory (NCT)
Phase-V	31.12.1998	Unleaded+Low leaded	Capitals of States & UTs
Phase-VI	1.9.1998	Unleaded	National Capital Region (NCR)
Phase-VII	1.2.2000	Unleaded	Entire Country

Source: Central Pollution Control Board, 2008

Table 2.2.16: Diesel Sulphur Reduction Programme

Phase	Date of Introduction	Sulphur Content (%)	Areas Covered
Phase-I	April 1996	0.50	Four Metros & Taj
Phase-II	August 1997	0.25	Delhi & Taj
Phase-III	April 1998	0.25	Metro Cities
Phase-IV	January 2000	0.25	Entire Country
Phase-V	April 2000	0.05	NCR-private vehicles
	January 2000	0.05	Mumbai-all vehicles
	March 2001	0.05	NCT-all vehicles
	June 2001	0.05	NCT-all vehicles
	July 2001	0.05	Chennai & Kolkata
Phase-VI	October 2001	0.05	All retail outlets of four metros
Phase-VII	2003	0.05	Ahmedabad, Surat, Agra, Pune & Kanpur
Phase-VIII	2005	0.05	Entire Country
Phase-IX	2005	0.035	10 Metro Cities & Agra
Phase-X	2010	0.035	Entire Country
Phase-XI	2010	0.005	10 Metro Cities

Source: Central Pollution Control Board, 2008

Table 2.2.17: Gasoline Benzene Reduction Programme

Date of Introduction	Benzene Content	Areas Covered
Before 1996	No specification	Entire Country
April 1996	5% benzene	Entire Country
April 2000	3% benzene	Metro Cities
November 2000	1% benzene	NCT & Mumbai
2005	1% benzene	All Metro Cities

Source: Central Pollution Control Board, 2008

Table 2.2.18: Vehicular Pollution Control Measures & Impact on Air Quality in Delhi

	1994	1996	1998	2000	2001(Jan-June)
Emission Norms of Vehicles	• Relaxed norms	• Emission norms made stringent as compared to 1991	• Emission norms made for cat. convertor fitted vehicles made stringent • Hot-start replaced by cold-start tests which gives less emissions	• Euro-I equivalent norms for all types of vehicles, expert passenger vehicles which are Euro-II equivalent	• CNG/LPG Norms finalized
Fuel Quality Improvement	• Diesel sulphur 1% • Gasoline Lead 0.56 g/l • Benzene no limit	• Fuel quality specifications notified under EPA for the first time Pb (g/l)=0.15 Diesel S=0.5%	• Diesel sulphur reduced to 0.25% • Gasoline Benzene reduced to 3% Gasoline Lead phased	• Diesel sulphur to reduce 0.05% in selected outlets • Gasoline Benzene reduced to 1% • Gasoline sulphur with 0.05% max. sulphur in all outlets • Low smoke 2-T oil introduced	• Diesel with 0.05% sulphur throughout retail outlets in NCT
Other Measures	-	• Govt. vehicles to run on CNG/ Catalytic Converter	• 15 years old commercial vehicles banned • Pre-mix 2-T oil in retail outlets	• Buses more than 8 years old phased out • Replacement of Pre-1990 autos/ taxis with vehicles on clean fules • Conversion of Post-1990 autos to CNG initiated Fuel testing lab established	• All Auto/taxis and buses to run on CNG • At present 1600 buses, 11000 taxis and cars, 25000 autos on CNG
CO(μg/m^3)	3343	5587	5450	4686	3069
SO_2(μg/m^3)	42	35	25	18	16
NO_2(μg/m^3)	66	75	63	59	-
Pb(μg/m^3)	408	312	136	101	-
RSPM(μg/m^3)	-	-	200	191	163
Vehicle No. (Lakh)	23.72	27.96	31.67	34.0	-
% of Calm Wind	-	-	41.69	43.0	-

Source: Central Pollution Control Board, 2008

Table 2.2.19: Ambient Air Quality of Delhi - Comparison of Pre-CNG (2000) with 2008*

Parameter	Prescribed Annual Standard (Residential)	2000	2008*	Percentage Increase/ Decrease
No. of Vehicles (Approx. in Lakhs)		35	55	57
SO_2	60	18	5	(-72)
NO_2	60	36	48	33
SPM	140	405	413	2
RSPM	60	159	192	21
CO	2000	4686	2348	(-50)

All values are in µg/m^3

*Data of November and December is taken from the year 2007 for averaging the year 2008

Observations:

Increase in number of vehicles (57 per cent), NO_2 (33 per cent), SPM (2 per cent) & RSPM (21 per cent)

Decrease in SO_2 (72 per cent) & CO (50 per cent)

Source: Central Pollution Control Board, 2008

identified sixteen cities namely; Hyderabad, Patna, Ahmedabad, Faridabad, Jharia, Bangalore, Pune, Mumbai, Sholapur, Jodhpur, Chennai, Agra, Kanpur, Lucknow, Varanasi and Kolkata as equal to or more polluted than Delhi. Action plans for improvement of air quality in these cities have been drawn.

- The CPCB has evolved a format for preparation of action plans, which has been circulated to all State Pollution Control Boards/Committees. The action plans emphasize on identification of sources of air pollution, assessment of pollution load and adoption of abatement measures for identified sources. Setting up of an inter-departmental task force for implementation of city specific action plans has also been suggested.

3. Vehicular Pollution Control Measures

I. Vehicular Emission Norms

In order to control vehicular pollution, a road map has been adopted as per the schedule proposed in the Auto Fuel Policy (2002), which includes use of cleaner fuels, automobile technologies and enforcement measures for in-use vehicles through improved Pollution Under Control (PUC) certification system. As per the Policy, Bharat Stage-II norms for new vehicles have been introduced throughout the country from April 1, 2005. EURO-III equivalent emission norms for all new vehicles, except 2-3 wheelers, have been introduced in 11 major cities from April 1, 2005. To meet Bharat Stage-II, EURO-III and EURO-IV emission norms, matching quality of petrol and diesel is being made available.

The vehicle emission norms in India are detailed below.

a) During 1990-91, for the first time in India, notified mass emission norms for vehicles at the manufacturing stage as well as for in-use vehicles were implemented. These norms were notified under the EPA, the Motor Vehicle Rules and the Air Act.

b) The emission norms introduced in 1996 have been crucial in controlling vehicular pollution because of stringency in the norms along with specifications on fuel quality. For the first time, crankcase and evaporative emission norms were introduced.

c) From April 1995, in the four metros - Delhi, Mumbai, Kolkata and Chennai, passenger cars were allowed to register themselves only if they were fitted with a catalytic converter. Emission norms for such vehicles were stricter by 50 per cent compared to the1996 norms.

d) The testing method for passenger car norms was changed from hot start to cold start. This was a more stringent requirement compared to the earlier one.

e) Year 2000 experienced stricter norms which were already notified in 1997 under the Motor Vehicle Rules. Automobile manufacturers had to undergo major modifications to meet these standards.

f) As per the Hon'ble Supreme Court's directions, only private vehicles conforming to at least EURO-I norms are to be registered. Consequently, in Mumbai, EURO- II norms for private vehicles (4 wheelers) was made applicable from 2001. In Kolkata, India-2000 norms (EURO-I) were implemented from November 1999.

g) From October 1, 1999 emission norms for agricultural tractors were introduced throughout the country. Bharat Stage-II and Bharat Stage-III emission norms for tractors were scheduled to be implemented from 2003 and 2005 respectively.

h) The Bharat Stage-II norms for new 4-wheeler, private non-commercial vehicles were introduced in Mumbai from January 2001 and in Kolkata and Chennai from July 2001 to October 24, 2001.

i) Only those taxies were registered in Delhi, which conformed to Bharat Stage-II norms.

j) Bharat State-II norms for Diesel 4-wheeler transport vehicles were introduced in NCT from 24th October, 2001, and in Greater Mumbai, Kolkata and Chennai from October 31, 2001.

k) An expert committee on the Auto Oil Policy was constituted during September 2001. The interim report of the committee was submitted to the government on January 1, 2000, recommending Bharat Stage-III emission norms for all categories of 4-wheelers in seven mega cities from 2005 and for the rest of the country by 2010. The final report of the committee was submitted in September 2002 and includes the road map for control of vehicular pollution till 2010.

II. Fuel Quality Specifications

For the first time, diesel and gasoline fuel quality with respect to environment related parameters was notified under the EPA in April 1996.

All these measures were introduced in phases (Table 2.2.15, 2.2.16 and 2.2.17).

III. Traffic Management

a) Restrictions have been imposed on goods vehicles during day time from August 1999 in Delhi.

b) Left lane of the roads have been made exclusive for buses and other HMV (Heavy Motor Vehicles) in Delhi.

c) Time clocks have been installed at important traffic signals to enable the drivers to switch off their vehicles depending on the time left in the clocks.

d) More fly-overs and subways have been constructed and T-Junctions have been closed for better traffic flow.

IV. Public Transport Systems

a) Number of buses have been increased in major cities to encourage the use of public transportation and reduce private vehicle use.

b) Delhi and Kolkata have introduced the Metro Rail system. The Government of Maharashtra has also developed a master plan for the Mumbai Metro with implementation in three phases over nine corridors. Other states like Karnataka is in the initial phase of implementing Mass Rapid Transit System (MRTS).

c) To provide better public transport and to ease congestion, proposals for Bus Rapid Transit System (BRTS) have been approved for Ahmedabad, Bhopal, Indore, Jaipur, Pune, Rajkot, Vijayawada and Visakhapatnam under JNNURM, covering a total length of more than 310 kms.

V. Reduction of Emissions by Using Lubricants

a) Specifications of 2T oil for two stroke engine with respect to smoke emissions were notified under the EPA in September 1998, for implementation from April 1, 1999 throughout the country.

b) Pre-mix 2T oil dispenser has been installed at all petrol filling stations in Delhi so that excessive oil is not being used by the vehicle owners. Sale of loose 2T oil was banned from December 1998 in Delhi and Kolkata.

VI. Technology

a) Fitting catalytic converter for new petrol passenger cars was made compulsory from April 1, 1995 in four metros and 45 cities from September 1, 1998.

b) Two wheeler scooters with four stroke engine were introduced in the market from October 1998.

c) Registration of only rear engine auto rickshaws was allowed from May 1996 onwards.

VII. Alternate Fuels

a) CNG vehicles were introduced in Mumbai and Delhi. At present more than 80,000 CNG vehicles (19000 cars, 49810 autos, 4935 RTVs & 8874 buses) are plying in Delhi and about 23,000 in Mumbai. All city buses were converted to the CNG mode in Delhi.

b) There are more than 111 CNG filling stations installed in Delhi with an average consumption of 674 tonnes per day of CNG.

c) Emission norms for CNG & LPG driven vehicles have been notified.

d) Petrol vehicles are running on ethanol blended (5 per cent) petrol in states of Maharashtra, Andhra Pradesh, Goa, Gujarat, Haryana, Karnataka, Tamil Nadu, Uttar Pradesh, Daman & Diu and Union Territories of Dadar & Nagar Haveli, Chandigarh and Pondicherry.

e) Planning Commission, Government of India, has announced a National Mission on bio-diesel. Specifications for this have been drafted by the Bureau of Indian Standards (BIS).

VIII. Control of Pollution from In-use Vehicles

Idling emission norms have been notified for in-use vehicles. Pollution Under Control (PUC) certificates are issued for adherence to idling emission norms every 3-6 months. The number of computerized PUC centres in Delhi alone is around 353.

IX. Mass Awareness Programmes

a) Messages/articles related to vehicular emissions are disseminated through newsletters, pamphlets, newspapers, magazines, television, radio, internet, workshops and summer exhibitions.

b) Display of ambient air quality data through display systems in major cities through newspapers, daily news and internet.

c) NGOs working on vehicular pollution control are being encouraged for mass awareness campaigns.

Noise monitoring at Kota

4. Industrial Pollution Control

The measures taken for controlling air pollution from industries are as follows:

a) Emission standards have been notified under the Environment (Protection) Act, 1986 to check pollution.

b) Industries have been directed to install the necessary pollution control equipments in a time bound manner and legal action has been initiated against the defaulting units.

c) 24 critically polluted areas have been identified. In all, Action Plan has been formulated for restoration of environmental quality in these areas.

d) Environmental guidelines have evolved for siting of industries.

e) Environmental clearance is made compulsory for 29 categories of development projects involving public hearing/NGO participation as an important component of the EIA process.

f) Environmental audit in the form of environmental statement has been made mandatory for all polluting industries.

g) Preparation of Zoning Atlas for setting up industries based on environmental considerations, in various districts of the country, has been taken up.

h) Power plants (coal based) located beyond 1000 kms from the pit-head are required to use low ash content coal (not exceeding 34 per cent) with effect from June 1, 2002. Power plants located in the sensitive areas are also required to use low ash coal, irrespective of their distance from the pit-head.

POLICY SUGGESTIONS

a) Take an integrated approach towards energy conservation and adoption of renewal energy technologies, including hydropower, by appropriately linking efforts to improve conversion, transmission, distribution, and end-use efficiency, and R&D in dissemination of renewable energy technologies. Remove policies, legal, and regulatory barriers in setting up of decentralized generation and distribution systems for power and other secondary energy forms, based on local primary energy resources.

b) Accelerate the national programmes of dissemination of solar cookers and improved fuel wood stoves suited to local cooking practices and biomass resources.

c) Strengthen the monitoring and enforcement of emission standards and prepare and implement action plans for both point and non-point sources, relying on a judicious combination of flats and incentive based instruments.

d) Formulate a national strategy for urban transport to ensure adequate investment, public and private, in low pollution mass transport systems.

e) Promote reclamation of wastelands by energy plantations for rural energy, through multi-stakeholder partnership involving the land-owing agencies, local communities and investors.

f) Strengthen efforts for partial substitution of fossil fuels by bio-fuels, through promotion of bio-fuel plantation, promoting relevant research and development, and strengthening regulatory certification of the new technologies.

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Stone crushing unit needs dust control systems to minimize air pollution

WATER

From the East to the West and from the North to the South, water has defined life in the Indian subcontinent for thousands of years. On an average, the combination of rainfall, surface and groundwater resources have been sufficient for providing adequate water to the Indian population.

Rise in demand and development pressures are changing the scenario of water availability in India. Erosion in the watersheds due to rapid development and poor land management practices is increasing siltation and changing stream hydraulics. Groundwater reserves are becoming more and more depleted even as surface water sources become too polluted for human use. Biodiversity in the country's once extensive wetlands and coastal mangroves is fast declining. To add to this, current socio-economic activities and economic incentives are encouraging the unsustainable consumption of this resource.

The realization that India's water resources need to be more carefully managed, is leading to the adoption of sustainable water management practices. By managing its water more judiciously, India can avert the crisis that looms large over the future.

NATIONAL WATER RESOURCES AT A GLANCE

Surface Water

India is blessed with many rivers. Twelve major river systems drain the subcontinent along with a number of smaller rivers and streams and form a total catchment area of approximately 252.8 Mha. Of the major rivers, the Ganga-Brahmaputra-Meghna system is the biggest, with a combined catchment area of about 110 Mha. which is more than 43 per cent of the catchment area of all the major rivers in the country. Other major rivers with a catchment area of more than 10 Mha. are Indus (32.1 Mha.), Godavari (31.3 Mha.), Krishna, (25.9 Mha.) and Mahanadi (14.2 Mha.).

Over 70 per cent of India's rivers drain in the Bay of Bengal, mostly as a part of the Ganga-Brahmaputra system. The Arabian Sea, on the western side of the country, receives 20 per cent of the total drainage from the Indus system as well as from a number of smaller rivers down the western coast. The remaining ten per cent drain into the interior basins and few natural lakes scattered across the country.

Table 2.3.1: Water Availability in India

Sl. No.	Items		Quantity (Cubic Km)
1	Annual Precipitation (including snowfall)		4000
2	Average Annual Availability		1869
3	Per Capita Water Availability (2001) in cubic metres		1820
4	Estimated Utilizable Water Resources		1122
	(i) Surface Water Resources	690 Cu.Km.	
	(ii) Ground Water Resources	431 Cu. Km.	

Source: Ministry of Water Resources, 2006

Table 2.3.2: Water Availability- Basinwise

Sl. No.	Name of the River Basin	Average Annual Availability (cubic km/year)
1	Indus (up to Border)	73.31
2	a) Ganga	525.02
	b) Brahmaputra, Barak & Others	585.6
3	Godavari	110.54
4	Krishna	78.12
5	Cauvery	21.36
6	Pennar	6.32
7	East Flowing Rivers Between Mahanadi & Pennar	22.52
8	East Flowing Rivers Between Pennar and Kanyakumari	16.46
9	Mahanadi	66.88
10	Brahmani & Baitarni	28.48
11	Subernarekha	12.37
12	Sabarmati	3.81
13	Mahi	11.02
14	West Flowing Rivers of Kutch, Sabarmati including Luni	15.1
15	Narmada	45.64
16	Tapi	14.88
17	West Flowing Rivers from Tapi to Tadri	87.41
18	West Flowing Rivers from Tadri to Kanyakumari	113.53
19	Area of Inland drainage in Rajasthan desert	Negligible
20	Minor River Basins Draining into Bangladesh & Burma	31
	Total	1869.35

Source: Ministry of Water Resources, 2006

Groundwater

Groundwater represents one of the most important water sources in India. Total replenishable groundwater potential of the country has been estimated by the Ministry of Water Resources as 431 Km^3 per year (Table 2.3.1). Excluding the water reserved for drinking, industrial and other purposes (other than irrigation), which is about 16 per cent of the total potential, the potential available for irrigation is 360 Km^3 per year. The figure for net draft of groundwater considering the present utilization indicates that a substantial portion of the total potential (about 68 per cent) still remains untapped.

WATER DEMAND

Access to adequate water is one of the leading factors limiting development in India. Agricultural, industrial and domestic uses are competing more and more for a limited supply. The agricultural sector continues to dominate water use owing to its continued importance to the Indian economy, while industrial demands are increasing as the sector continues to grow. Domestic needs claim only a small portion of the annual water withdrawals as access to adequate water and sanitation supplies remains low throughout the country. Greater access and an improvement in the socio-economic situation is likely to result in a higher demand for water in the coming years, in rural India.

Agriculture Demand

Agriculture remains central to the Indian economy and therefore, receives the greatest share of the annual water allocation. According to the World Resources Institute (2000), 92 per cent of India's utilizable water is devoted to this sector, mostly in the form of irrigation.

The necessity of irrigation in agricultural production is greater due to the unpredictable nature of the monsoon. In regions completely dependent on rain-fed agriculture, a weak monsoon season can result in drought like conditions leading to reduced yields or even total crop failure. The normal monsoon too allows the farmers to produce only one crop a year with a low yield. Indeed, the productivity of irrigated agriculture per unit of land has been estimated as seven times more than that of the rain-fed agriculture (*World Bank, 1999*).

The growth in the irrigated area, along with improvements in the farming technologies and plant genetics, has been responsible for the incredible growth in crop production over this period. The increase in production also has contributed greatly to the national economy and to India's food security. However, irrigation expansion has also placed greater demands on surface and groundwater resources. Groundwater alone accounts for 39 per cent of the water used in agriculture and the surface water use often comes at the expense of other sectors such as the industrial and the domestic supply.

On the other end, flood conditions could prove to be equally devastating for the agricultural sector and require careful planning in terms of drainage and construction of flood control structures. Development projects such as dam and canal construction were devised to help mitigate the effect of monsoon on rivers and seasonal streams. For the most part, they have been successful in reducing the impact of flooding in some areas, their effectiveness being limited in exceptional rainfall situations.

Industrial Demand

In the past several decades, industrial production has increased in India owing to an increasingly open economy and greater emphasis on industrial development and international trade. Water consumption for this sector has consequently risen and will continue growing at a rate of 4.2 per cent per year (*World Bank, 1999*). According to the World Bank, demand of water for industrial, energy production and other uses will rise from 67 billion m^3 to 228 billion m^3 by 2025.

Hydroelectric generation already accounts for a large percentage of water demand. The potential in India has been estimated to be 84,000 MW, of which only 22,000 MW is currently being harnessed (*MOWR, 2001*). The large untapped potential, particularly in the northern regions of India, and the growing demands for electricity from a larger population and industrial sector, will ensure that the development of this activity continues in the coming years.

Domestic Demand

Demand from the domestic sector has remained low and accounts for only five per cent of the annual freshwater withdrawals in India (*World Resources Institute, 2000*). Domestic water use will increase as the population continues to grow and access to water is improved. Recent data from the World Bank indicates that the demand over the next twenty years will double from 25 billion m^3 to 52 billion m^3.

Only 85 per cent of the urban and 79 per cent of the rural population has access to safe drinking water and fewer still have access to adequate sanitation facilities (*World Resources Institute, 2000*) despite Central Government's commitment to provide the same in the National Water Policy (1987). Most urban areas are serviced by a municipal water distribution system. Usually, the municipal water supply originates from local reservoirs or canals, but in some cases water may be imported through inter-basin transfer. Although major cities in India enjoy access to central water supply systems, these schemes often do not adequately cover the entire urban population and are notoriously inefficient and unreliable. In rural areas, access to water is even more precarious. Over 80 per cent of the rural domestic water comes from groundwater sources since it is more reliable in terms of water quantity and quality. Still, in areas where water is scarce, rural women travel long distances to wells or streams to fetch water for their daily needs.

WATER POLLUTION

Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic,

A High Altitude Lake in Kanchanjunga National Park

organic and inorganic pollutants (*MOWR 2000*). In many cases, these sources have been rendered unsafe for human consumption as well as for other activities such as irrigation and industrial needs. This illustrates that degraded water quality can contribute to water scarcity as it limits its availability for both human use and the ecosystem.

In 1995, the Central Pollution Control Board identified severely polluted stretches on 18 major rivers in India (*World Bank 1999*). Not surprisingly, the majority of these stretches were found in and around large urban areas. The high incidence of severe contamination near urban areas indicates that the industrial and domestic sector's contribution to water pollution is much higher than their relative importance, implied in the Indian economy. Despite this, agricultural activities still dominate in terms of overall impact on water quality.

Besides rapidly depleting groundwater table, the country faces another major problem on the water front - groundwater contamination - a problem which has affected as many as 19 states, including Delhi. The geogenic contaminants, including salinity, iron, fluoride and arsenic have affected groundwater in over 200 districts spread across 19 states (Table 2.3.3 and Table 2.3.4). Studies have shown that long-term intake of fluoride can cause tooth decay and crippled bones. Arsenic can cause skin cancer and skin pigmentation.

Table 2.3.3: State-wise Details of Distribution of Flouride in Groundwater above Permissible Limit

Sl. No.	State	Fluoride	
		No. of districts affected	Districts (in parts)
1	Andhra Pradesh	19	Adilabad, Anantpur, Chitoor, Guntur, Hyderabad, Karimnagar, Khammam, Krishna, Kurnool, Mehaboobnagar, Medak, Nalgonda, Nellore, Prakasham, Rangareddy, Vishakhapatanam, Viziangaram, Warangal, West Godawari
2	Assam	4	Goalpara, Kamrup, Karbi, Anglong, Naugoan
3	Bihar	9	Aurangabad, Banka, Buxar, Jamui, Kaimur, Munger, Nawada, Rohtas, Supaul
4	Chhattisgarh	12	Bastar, Bilaspur, Dantewara, Janjgir-Champa, Jashpur, Kanker, Korba, Koriya, Mahasamund, Raipur, Rajnandgaon, Suguja
5	Delhi	6	East Delhi, New Delhi, Northwest Delhi, South Delhi, Southwest Delhi, West Delhi
6	Gujarat	18	Ahmedabad, Amreli, Anand, Banaskantha, Bharuch, Bhavnagar, Dahod, Junagarh, Kachchh, Mahesana, Narmada, Panchmahals, Patan, Rajkot, Sabarkantha, Surat, Surendranagar, Vadodara
7	Haryana	14	Bhiwani, Faridabad, Gurgaon, Hissar, Jhajjar, Jind, Kaithal, Kurkshetra, zMahendragarh, Panipat, Rewari, Rohtak, Sirsa, Sonepat
8	Jammu & Kashmir	2	Rajauri, Udhampur
9	Jharkhand	6	Bokaro, Giridih, Godda, Gumla, Palamau, Ranchi
10	Karnataka	20	Bagalkot, Bangalore, Bellary, Belgaum, Bidar, Bijapur, Chamarajnagar, Chikmagalur, Chitradurga, Devangere, Dharwar, Gadag, Gulbarga, Haveri, Kolar Koppala, Mandya, Mysore, Raichur, Tumkur
11	Kerala	1	Palakkad
12	Madhya Pradesh	19	Bhind, Chhatarpur, Chhindwara, Datia, Dewas, Dhar, Guna, Gwalior, Harda, Jabalpur, Jhabua, Khargone, Mandsaur, Rajgarh, Satna, Seoni, Shajapur, Sheopur, Sidhi
13	Maharashtra	8	Amrawati, Chandrapur, Dhule, Gadchiroli, Gondia, Jalna, Nagpur, Nanded
14	Orissa	11	Angul, Balasore, Bargarh, Bhadrak, Boudh, Cuttack, Deogarh, Dhenkanal, Jajpur, Keonjhar, Suvarnapur
15	Punjab	11	Amritsar, Bhatinda, Faridkot, Fatehgarh Saheb, Firozpur, Gurdaspur, Mansa, Moga, Muktsar, Patiala, Sangrur
16	Rajasthan	30	Ajmer, Alwar, Banswara, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chhittorgarh, Churu, Dausa, Dholpur, Dungarpur, Ganaganagar, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajasamand, SawaiModhopur, Sikar, Sirohi, Tonk, Udaipur
17	Tamil Nadu	16	Coimbatore, Dharmapuri, Dindigul, Erode, Karur, Krishnagiri, Namakkal, Perambalur, Puddukotai, Ramnathpuram, Salem, Shivaganga, Theni, Thiruvannamalai, Vellore, Virudunagar
18	Uttar Pradesh	10	Agra, Aligarh, Etah, Firozabad, Jaunpur, Kannauj, Mahamayanagar, Mainpuri, Mathura, Maunathbhanjan
19	West Bengal	8	Bankura, Bardhhman, Birbhum, Dakhin, Dinajpur, Malda, Nadia, Purulia, Uttar Dinajpur

Source: Ministry of Water Resources, 2008

Table 2.3.4: Occurrence of High Arsenic in Groundwater of some States of India

State	District	Blocks where high Arsenic is observed wells of CGWB
Assam	Dhemaji	Dhemaji, Bodordloni, Sisiborgaon
Bihar	Bhojpur	Barhara, Shahpur, Koilwar, Arrah, Bihiya, Udawant Nagar
	Bhagalpur	Jagdishpur, Sultanganj, Nathnagar
	Begusarai	Matihani, Begusarai, Barauni, Balia, Sabehpur Kamal, Bachwara
	Buxar	Brahmpur, Semary, Chakki, Buxar
	Darbhanga	Biraul
	Khagaria	Khagaria, Mansi, Godri, Parbatta
	Kishangarh	Kishanganj, Bahadurganj
	Katihar	Manasahi, Kursela, Sameli, Barari, Manihari, Amdabad
	Lakhiserai	Piparia, Lakhiserai
	Munger	Jamalpur, Dharhara, Bariarpur, Munger
	Patna	Maner, Danapur, Bakhtiarpur, Barh
	Purnea	Purnea East, Kasba
	Saran	Dighwara, Chapra, Revelganj, Sonpur
	Samastipur	Mohinuddin Nagar, Mohanpur, Patori, Vidhyapati Nagar
	Vaishali	Raghopur, Hajipur, Bidupur, Desri, Sahdei Bujurg
Chhattisgarh	Rajnandgaon	Chouki
West Bengal	Bardhman	Purbasthali I & II, Katwa I & II, and Kala II
	Haora	Uluberia II and Shampur II
	Hugli	Balagarh
	Malda	English Bazar, Manikchak, Kaliachak I, II & III, Ratua I and II
	Murshidabad	Raninagar I & II, Domkal, Nowda, Jalangi, Hariharpara, Suti I & II, Bhagwangola I & II, Beldanga I & II, Berhampur, Raghunathganj I & II, Farakka, Lalgola, Murjigang, Samsherganj
	Nadia	Karimpur I & II, Tehatta I & II, Kaliganj, Nawadwip, Haringhata, Chakda, Santipur, Naksipara, Hanskhali, Krishnagarh, Chapra,Ranaghat I & II, Krishnanagar I & II.
	North 24 Parganas	Habra I & II, Barasat I & II, Rajarhat, Deganga, Beduria, Gaighata, Amdanga, Bagda Boangoan, Haroa, Hasnabad, Basirhat I & II, Swarupnagar, Barackpur I & II Sandeshkhali II
	South 24 Parganas	Baruipur, Sonarpur, Bhangar I & II, Joynagar I, Bishnupur I & II, Mograhat II, Budge Budge II
Uttar Pradesh	Agra	Agra, Etmadpur, Fatehabad, Khairagarh
	Aligarh	Jawan Sikandarpur
	Ballia	Belhari, Baria, Muralichapra, Reoati, Siar
	Balrampur	Gaindas Bujurg, Gainsari, Harraiyyabazar, Pachparwa, Sridatganj, Tulsipur
	Gonda	Bhelsar, Colonelganj, Haldarmau, Katrabazar, Nawabganj, Pandari, Kripal, Tarabgani, Wazirganj
	Gorakhpur	Gorakhpur
	Lakhimpur Kheri	Daurahra, Ishanagar, Nighasan, Pallia, Ramia Vihar
	Mathura	Mathura
	Moradabad	Moradabad

Source: Ministry of Water Resources, 2008

PRESSURES

Agriculture

The rapid increase in agro-chemical use in the past five decades, has contributed significantly to the pollution of both surface and groundwater resources. Pesticide consumption rose from less than one million tonne (technical grade) in 1948 to a maximum of 75 million tonnes in 1990 (CSE 1999). Per hectare consumption of fertilizers has increased from 69.8 kg in 1991-92 to 113.3 kg in 2006-07 at an average rate of 3.3 per cent.

Fertilizers and pesticides enter the water supply through run-offs and leaching into the groundwater table and pose a hazard to human, animal and plant population. Some of these chemicals include several substances considered extremely hazardous by WHO and are banned or under strict control in developed countries. Studies on the Ganga River indicate the presence of chemicals such as HCH, DDT, endosulfan, methyl malathion, malathion, dimethoate, and ethion in levels greater than those recommended by the international standards (*World Bank 1999*). Some of these substances have been known to bio-accumulate in certain organisms, leading to an increased risk of contamination when used for human consumption and a persistence of the chemicals in the environment over long periods of time.

Groundwater overdraft is a serious concern

Water enriched with nutrients leads to eutrophication. Decaying organic matter releases odourous gases and partially decomposed matter accumulates on the river or lakebed, thereby limiting water's suitability for human consumption and other uses. High levels of fertilizer use has been associated with increased incidence of eutrophication in rivers and lakes in several of India's most important water bodies, such as the Hussein Sagar in Hyderabad and Nainital in Uttar Pradesh (*MOWR 2000*)

Industries

Although the industrial sector only accounts for three per cent of the annual water withdrawals in India, its contribution to water pollution, particularly in urban areas, is considerable. Wastewater generation from this sector has been estimated to be 55,000 million m^3 per day, of which 68.5 million m^3 are dumped directly into local rivers and streams without prior treatment (*MOWR 2000*). The government has called for the establishment of Common Effluent Treatment Plants (CETP) in industrial areas but their implementation has been slow, and most industries either are not connected to CETPs or only partially treat their wastewater before disposal. The Central and State Pollution Control Boards have identified 1,532 'grossly polluting' industries in India, although almost non of the industries comply with the emission standards (*World Bank 1999*).

Wastewater from industrial activities is often contaminated with highly toxic organic and inorganic substances, some of which are persistent pollutants and remain in the environment for many years. For instance, over 50 per cent of the urban organic load in some cities originates from industrial effluents. Further, heavy metal contamination from thermal power, tannery and mining activities has occurred in several locations (*World Bank 1999*). Water contamination from industrial areas is compounded usually due to the high concentration of industries over a small area. Increasing industrial development, coupled with inadequate zoning and emissions regulations, will only aggravate the problem in the coming years.

Domestic Usage

All of India's fourteen major river systems are heavily polluted, mostly from the 50 million cubic meters of untreated sewage discharged into them each year (*APCSS 1999*). The domestic sector is responsible for the majority of wastewater generation in India. Combined, the 22 largest cities in the country produce over 7,267 million litres of domestic wastewater per day, of which slightly over 80 per cent is collected for treatment (*CSE 1999*).

Inadequate treatment of human and animal wastes also contributes to high incidence of water-related diseases in the country. Till date, only 19.2 per cent of the rural and 70 per cent of the urban inhabitants have access to adequate sanitation facilities (*WRI 2000*). Therefore, water contaminated by human waste is often discharged directly into watercourses or seeps into the groundwater table from faulty septic tanks or pit latrines. The level of faecal coliform bacteria in most rivers often exceeds WHO standards and is responsible for causing a number of gastro-intestinal ailments among the population.

Improper disposal of solid waste also leads to surface and groundwater pollution. Runoff from garbage dumps and city streets carries litter, deposed particulate matter and chemicals to nearby streams and canals. Leaching from landfills and garbage pits transports toxic substances and heavy metals to the water table. Annual production of solid waste in India has been estimated to be 2,000 million tonnes (*MOWR 2000*). This figure will undoubtedly continue to increase with the growing population and the higher consumption of disposable goods resulting from improvement in the socio-economic conditions of the rural and urban residents.

STATE & TRENDS

The water quality data on rivers, lakes, ponds, tanks and groundwater locations being monitored under the network, is evaluated against the water quality criteria, and the monitoring locations, on exceeding one or more parameters are identified as polluted, and require action for restoration of water quality. The locations on rivers, lakes, ponds, tanks and groundwater which have not met the criteria are summarized below.

- High Biochemical Oxygen Demand (BOD), one of the most important indicators of pollution, was observed in Amlakhadi at Ankleshwar (714 mg/l) followed by Ghaggar at Moonak, Punjab (626 mg/l); Khari at Lali village, Ahmedabad (320 mg/l); Musi at Hyderabad (225 mg/l); Sabarmati at Ahmedabad (207 mg/l); Kalinadi at Kannuaj, Uttar Pradesh (136 mg/l); Khan at Kabitkhedi, Indore, Madhya Pradesh (120 mg/l); Damanganga D/s Daman at Kachigaon (112 mg/l); Kalinadi at D/s of Muzzafarnagar, Uttar Pradesh (110 mg/l); Saroonagar, Ranga Reddy Dist. Andhra Pradesh (71 mg/l); Gandigudem at Medak Dist. (60 mg/l); Hindon at Saharanpur (60 mg/l); Yamuna at Sonepat (59 mg/l); Krishna D/s of Islampur (40mg/l); Satluj D/s Hussainwala Firozpur, Punjab (40 mg/l); Bhima at Pune (36 mg/l); Elangabeel System point, Assam (64 mg/l); Bharalu at Guwahati, Assam (43 mg/l); Sukhna at Parwanoo Dist., Solan (36 mg/l); Chandola Lake at Ahemdabad (36 mg/l); Hussain Sagar Lake, Budamaru, Andhra Pradesh (33 mg/l); Dhadar at Kothada (32 mg/l); Bhaleshwar Khadi at N.H. No. 8 (27 mg/l); Gomti at Sitapur (25 mg/l); Chambal at Dholpur (25 mg/l); Yamuna between Delhi and Etawah (10-59 mg/l) and Tapi at Uphad, Maharashtra (25 mg/l). Due to a high BOD, dissolved oxygen in these stretches was observed to be either nil or very low most of the time.
- Total number of observations having BOD less than 3 mg/l; 3 to 6 mg/l and above 6 mg/l was 64 per cent, 18 per cent and 18 per cent, respectively. The total number of observations having total Coliform number less than 500 MPN/100 ml was 45 per cent; between 500-5000 MPN/100 ml was 31 per cent and exceeding 5000 MPN/100 ml was 24 per cent MPN/100 ml. Similarly, the number of observations having Faecal Coliform bacterial count less than 500 MPN/100 ml was 53 per cent; between 500-5000 MPN/100 ml was 26 per cent and 21 per cent observations were exceeding 5000 MPN/100 ml.
- Faecal Coliform, another important indicator of pollution in India was found the highest in the Yamuna river in Agra, Nizamuddin, Mazawali and Okhla (MPN $5.2x10^6$ to $3.7x10^6$) followed by Hindon after confluence with Krishna ($1.1x10^6$ to $4.6x10^5$); Ganga at Dakshineshwar and Uluberia ($1.1x10^6$ to $2.8x10^5$); Damodar at Haldia ($1.4x10^6$); Khari at Lali Village, Ahmedabad ($7.5x10^5$); Sabarmati at Ahmedabad ($1.1x10^6$ to $4.6x10^5$); Bharalu at Guwahati, Assam ($2.4x10^5$); Ganga at Varanasi ($1.1 x 10^5$); Satluj at Ludhiana ($1.1x10^5$); Tapi at Ukai ($1.5x10^5$); Kalinadi at Muzaffarnagar ($3.1x10^5$); Damanganga at Silvasa ($1.2x10^6$); and Brahmaputra at Dhenukapahar and Pandu ($2.4x10^5$).

IMPACT

Due to various factors, available water is deteriorating in quality. Tests indicate that the biological contamination of surface water sources, much of it due to untreated or partially treated sewage, exceeds permissible limits at many locations. Similarly, overexploitation of groundwater, besides other human activities has led to contamination of groundwater in many parts of the country. While salinity (dissolved salts in water) and iron make the taste of water and vegetables cooked in it unappealing, long-term usage of water with fluoride and arsenic can lead to several health hazards.

Around 85 per cent of the rural population of the country uses groundwater for drinking and domestic purposes. High concentrations of fluoride and arsenic in groundwater beyond the permissible limits of 1.5 mg/l and 0.05 mg/l, respectively poses health hazard. In all, 19 states in India have been identified as 'endemic' areas for fluorosis, with an estimated 44 million people impacted, and another 66 million at risk. The scenario is the worst in the hard rock terrain viz., granites.

Arsenic is a known carcinogen and is highly toxic. It is perhaps the only human carcinogen for which there is adequate evidence of carcinogenic risk by both inhalation and ingestion (Centeno et al. 2002; Chen & Ahsan 2004).The occurrence of Arsenic in groundwater was first reported in 1980 in West Bengal in India. Apart from West Bengal, arsenic contamination in groundwater has been found in the states of Bihar, Chhattisgarh, Uttar Pradesh and Assam. Arsenic in groundwater has been reported in 15 districts in Bihar, 9 districts in Uttar Pradesh, 8 districts in West Bengal and one district each in Chhattisgarh and Assam.

RESPONSE

The management of India's water resources falls under the jurisdiction of a number of government agencies, although the primary responsibility for the development of water resources belong to the individual states. The Central Government oversees the implementation of national policy on resource development and exploitation, as well as manages inter-state and international rivers and river valleys. It also provides technical advice to individual states on development, flood control, coastal erosion, dam safety, navigation and hydropower when required.

National Water Quality Monitoring Programme (NWMP)

CPCB in collaboration with State pollution control boards established a nationwide network for water quality monitoring comprising 1,019 stations in 27 States and 6 Union Territories. The monitoring is undertaken on a monthly or quarterly basis for surface water and on a half yearly basis for groundwater. The monitoring network covers 200 Rivers, 60 Lakes, 5 Tanks, 3 Ponds, 3 Creeks, 13 Canals, 17 Drains and 321 Wells.

The water quality monitoring results obtained between 1995 to 2006 indicate that organic and bacterial contamination continue to be critical in water bodies. This is mainly due to discharge of domestic wastewater mostly in untreated form from the urban centres of the country. The municipal corporations at large are not able to treat the wastewater, increasing municipal sewage load flowing into water bodies without treatment. Secondly, the receiving water bodies also do not have adequate water for dilution, because of which the oxygen demand and bacterial pollution is depicting an increasing trend and leading to water borne diseases. The water quality monitoring results were analyzed with respect to the indicator of organic matter (Bio-chemical oxygen demand) and indicator of pathogenic bacteria (total coliform and faecal coliform).

The result of such analysis shows that there is gradual degradation in water quality.

National Water Policy

A comprehensive policy on water is necessary on the face of a growing number of social, economic and environmental issues surrounding water resources in India. In 1987, the National Water Resources Council adopted the National Water Policy (NWP) and submitted the document to Parliament for implementation. The NWP is the primary document stating the position of the Government of India (GOI) on water resource issues, ranging from drought and flood management to drinking water provisions.

In essence, the policy serves as a guideline to help planners and managers develop the country's water resources to its maximum potential. But the adoption of the policy is also a step-forward for the government in terms of promoting the sustainable management of the country's water resources.

The policy addresses many issues regarding planning, development and allocation of water, including groundwater and surface water sources. Among the points addressed in the policy are:

- Development of standardized national information system containing data on water availability and use is essential for appropriate planning;
- Resource planning should be conducted using a catchment or a watershed as the basic unit;
- Water development projects should be multi-purpose and should address various priorities such as drinking water provision and flood-mitigation;
- Environmental impact of new projects should be assessed and minimized wherever possible;

A view of Dal Lake in Kashmir

- Socially disadvantaged groups such as Scheduled Castes and Tribes and other minority groups are to be included in the planning process as much as possible, and farmers must become increasingly involved in the irrigation management policies;
- Groundwater development should be based on the basis of the potential and recharge capabilities of the aquifer;
- Water allocation should be based on the following priorities: drinking water, irrigation, hydro-power, navigation, industrial and other uses;
- Irrigation planning should attempt to maximize benefits to farmers and integrate soil and water conservation practices;
- Water rates should reflect the true cost of water use and encourage economic use of the resource;
- Promotion of conservation through education, regulation and incentives be encouraged;
- Development of a master plan for flood control and management should be undertaken and include soil conservation, forestry management, zoning and forecasting considerations;
- Drought-prone areas should be given priority in water development projects and programmes such as soil moisture conservation and water harvesting practices should be encouraged;
- Additional research in a number of areas such as hydro-meteorology, groundwater hydrology and recharge, water harvesting, crops and cropping systems, sedimentation and reservoirs, river morphology and hydraulics, recycling and re-use, and sea water resources should be pursued.

The National Water Resources Council is the body responsible for reviewing the progress made by the government in implementing the policy. The Council is composed of Secretaries from various Ministries associated with water resources and the Chief Secretaries of States/Union Territories. Through the National Water Board, the Council is able to make recommendations regarding the financing and development of new projects and provide suggestions on further action to be taken.

Acts And Regulations

Water in India is governed under three different Acts: the Environmental Protection Act (1986), the River Boards Act (1956) and the Inter-State Water Disputes Act (1956). Other Acts and Regulations affect water resources in different ways by addressing its importance for agriculture, biodiversity and conservation and drinking water. These three Acts, however, have the broadest scope in terms of how they affect all aspects of water management.

A common effluent treatment plant at Chennai

River Boards Act

The regulation and development of inter-state rivers and river valleys was to be entrusted to various River Boards when this Act was adopted in 1956. The River Boards were designed to advise the central government on development opportunities, co-ordinate activities and resolve disputes. Under their mandate, the Boards were required to provide advice to the government on the following topics:

- Conservation with a view to control and optimise use of water resources;
- Promotion and operation of schemes related to irrigation, water supply and drainage;
- Promotion and operation of schemes related to hydro-power and flood control;
- Promotion and control of navigation;
- Promotion of aforestation and control of soil erosion;
- Prevention of pollution; and
- Other duties as deemed necessary.

The Indian government has been unable to constitute a River Board since the Act was enacted, almost fifty years ago. However, there is a realisation of the fact that the Act should be revised and amendments are currently under way to strengthen its powers.

Inter-State Water Disputes (ISWD) Act, 1956

Since the majority of the rivers in India are shared between neighbouring States, the ISWD Act was enacted in 1956 to adjudicate any dispute regarding the distribution or control of rivers or river valleys. The Act gives the Government the power to constitute Tribunals to serve as intermediaries in the disputes. Till date, five Inter-State Water Tribunals have been established:

- Godavari Water Disputes Tribunal (April 1969)
- Krishna Water Disputes Tribunal (April 1969)
- Narmada Water Disputes Tribunal (October 1969)
- Ravi and Beas Water Disputes Tribunal (April 1986)
- Cauvery Water Disputes Tribunal (June 1990)

The first three Tribunals have been concluded, but a final decision is still pending on the last two matters.

International Treaties

A number of international disputes regarding the allocation and management of water of several large transboundary rivers have arisen between India and its neighbours. Fortunately, these differences have been settled through diplomatic channels with the signing of treaties and agreements. The three principal treaties are:

- The Indus Water Treaty - India and Pakistan (1960)
- The Indo Nepal Treaty on the Integrated Development of Mahakali River (1996)
- The Ganga Water Sharing Treaty with Bangladesh: Sharing of Lean Season Flow of Ganga at Farakka Barrage in India (1996)

All three disputes arose from disagreements on the allocation of water resources between India and the other countries. In case of both Indus and Mahakali Rivers, the equitable distribution of irrigation water was under contention. The Farakka Barrage dispute originated when the water level entering Bangladesh from India was reduced to almost nothing during the lean season (January to May) due to the construction of the Farakka Barrage on the Indian side of the border. In 1996, an agreement was reached between the governments of India and Bangladesh to share the flow during the lean season in the ratio of 60 per cent (Bangladesh) and 40 per cent (India).

Although the treaties have been signed, there are still a number of issues which remain unresolved. However, in general, the treaties have generated a sense of goodwill between India and its neighbours, which bodes well for future collaborations.

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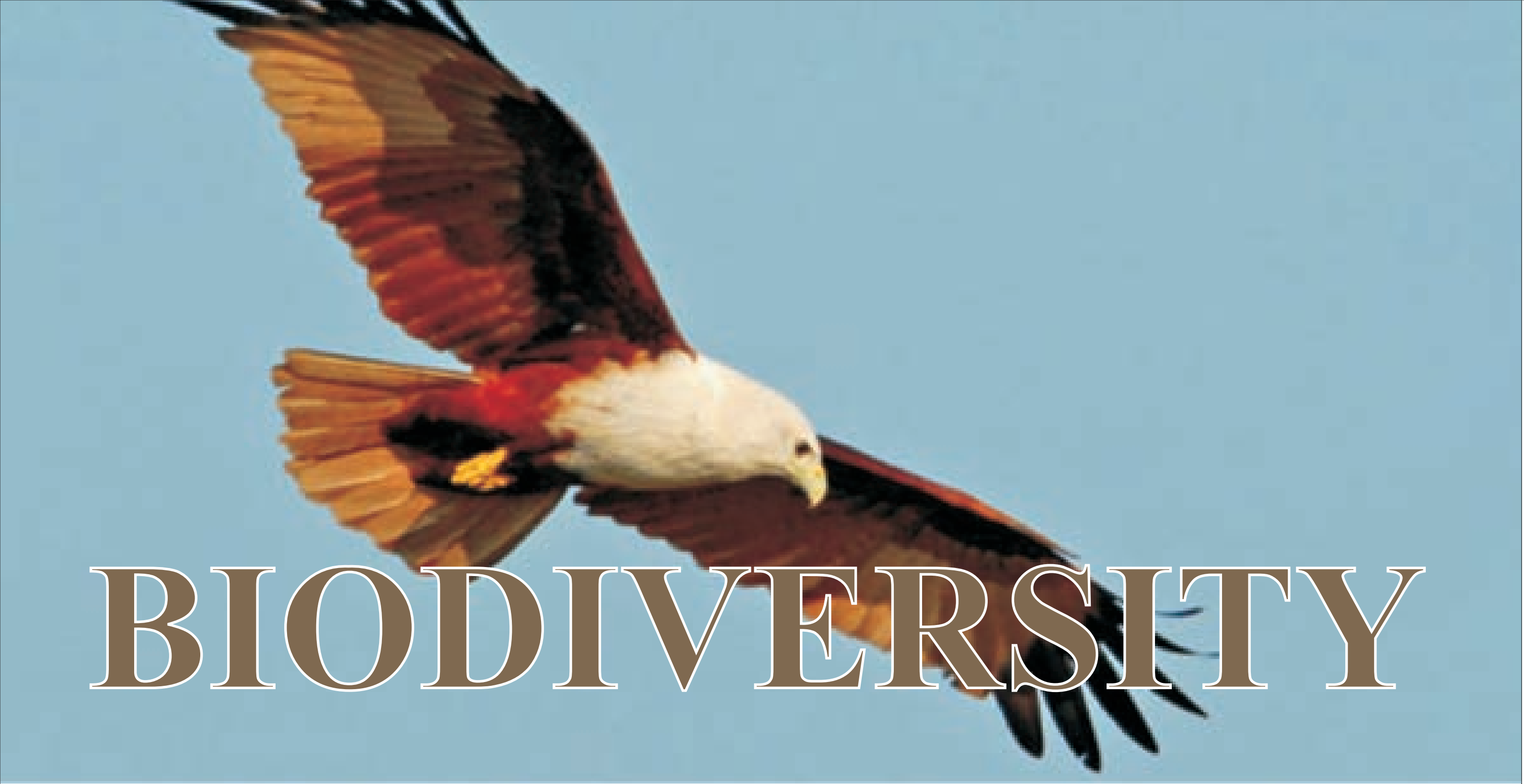


BIODIVERSITY

India is one of the 17 identified mega diverse countries of the world. From about 70 per cent of the total geographical area surveyed so far, 45,500 plant species (including fungi and lower plants) and 91,000 animal species, representing about seven per-cent of the world's flora and 6.5 per cent of the world's fauna, respectively, have been described. Nearly 6,500 native plants are still used prominently in the indigenous healthcare systems.

From the biodiversity standpoint, India has some 59,353 insect species, 2,546 fish species, 240 amphibian species, 460 reptile species, 1,232 bird species and 397 mammal species, of which 18.4 per cent are endemic and 10.8 per cent are threatened. The country is home to at least 18,664 species of vascular plants, of which 26.8 per cent are endemic. With only 2.4 per cent of the total land area of the world, the known biological diversity of India contributes 8 per cent to the known global biological diversity. It has been estimated that at least 10 per cent of the country's recorded wild flora, and possibly the same percentage of its wild fauna, are on the threatened list, many of them on the verge of extinction.

India has two biodiversity hot spots, namely:

1. The Eastern Himalayas
2. The Western Ghats

And, it is composed of diverse ecological habitats:

1. Forests
2. Grasslands
3. Wetlands
4. Coastal and Marine ecosystems
5. Desert ecosystems

BIODIVERSITY PROFILE OF INDIA

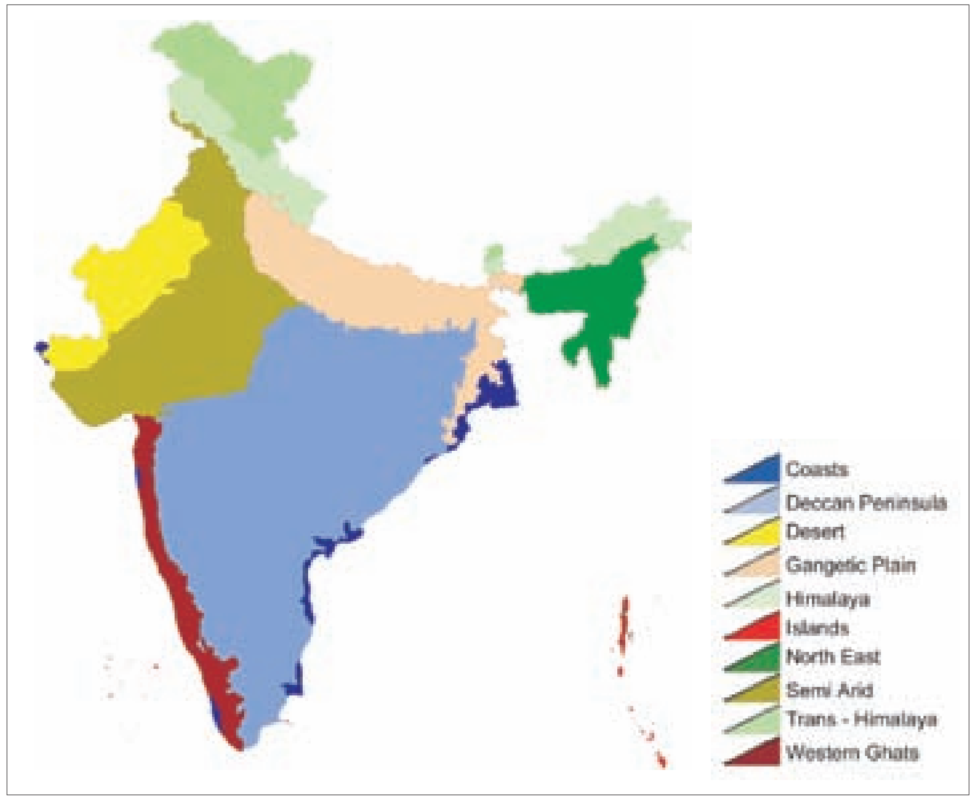
India, with varied terrain, topography, land use, geographic and climatic factors, can be divided into ten recognizable bio-geographic zones (*Rodgers et al., 2000*). These zones encompass a variety of ecosystems - mountains, plateaus, rivers, forests, deserts, wetlands, lakes, mangroves, coral reefs, coasts and islands.

Trans-Himalayan Region, constituting 5.6 per cent of the total geographical area, includes the high altitude, cold and arid mountain areas of Ladakh, Jammu & Kashmir, North Sikkim, Lahaul and Spiti areas of Himachal Pradesh. This zone has sparse alpine steppe vegetation that harbours several endemic species and is a favourable habitat for the biggest populations of wild sheep and goat in the world and other rare fauna that includes Snow Leopard (*Uncia uncia*) and the migratory Black-necked Crane (*Grus nigricollis*). The cold dry desert of this zone represents an extremely fragile ecosystem.

Himalayan Zone, in the far North, constituting 6.4 per cent of the total geographical area includes some of the highest peaks in the world and makes India one of the richest areas in terms of habitats and species. The steep slopes, unconsolidated soils and intense rainfall render the zone extremely fragile. The alpine and sub-alpine forests, grassy meadows and moist mixed deciduous forests provide diverse habitat for endangered species of bovids such as Bharal (*Pseudois nayaur*), Ibex (*Capra ibex*), Markhor (*Capra falconeri*), Tahr (*Hemitragus jemlabicus*), and Takin (*Budoreas taxicolor*). Other rare and endangered species restricted to this zone include Hangul (*Cervus eldi eldi*) and Musk Deer (*Moschus moschiferus*) .

Indian Desert Zone, constituting 6.6 per cent of the total

Figure 2.4.1: Biogeographic Classification of India



Source : State of Environment Atlas of India 2007, MoEF

geographical area, includes the Thar and the Kutch deserts and has large expanses of grassland that supports several endangered species of mammals such as Wolf *(Canis lupus)*, Caracal *(Felis caracal)*, Desert Cat *(Felis libyca)* and birds of conservation interest viz., Houbara Bustard *(Chamydotis undulate)* and the Great Indian Bustard *(Ardeotis nigriceps)*.

Semi-arid Region, constituting 16.6 per cent of the total geographical area, is a transition zone between the desert and the dense forests of Western Ghats. Peninsular India has two large regions, which are climatically semi-arid. This semi-arid region also has several artificial and natural lakes and marshy lands. The dominant grass and palatable shrub layer in this zone supports the highest wildlife biomass. The cervid species of Sambar *(Cervus unicolor)* and Chital *(Axis axis)* are restricted to the better wooded hills and moister valley areas respectively. The Lion *(Leo persica)*, an endangered carnivore species (restricted to a small area in Gujarat), Caracal *(Felis caracal)*, Jackal *(Canis aureus)* and Wolf *(Canis lupus)* are some of the endangered species that are characteristic of this region.

Western Ghats, constituting 4.0 per cent of the total geographical area, is one of the major tropical evergreen forest regions in India. The zone stretches from the hills to the South of the Tapti River in the North to Kanyakumari in the South and in the West, this zone is bound by the coast. This zone represents one of the biodiversity 'hot spots' with some 15,000 species of higher plants, of which 4,000 (27 per cent) are endemic to the region.

The Western Ghats harbour viable populations of most of the vertebrate species found in peninsular India, besides an endemic faunal element of its own. Significant species endemic to this region include Nilgiri Langur (*Presbytis jobni*), Lion Tailed Macaque (*Macaca silenus*), Grizzled Giant Squirrel (*Ratufa macroura*), Malabar Civet (*Viverricula megaspila*), Nilgiri Tahr (*Hemitragus bylocrius*) and Malabar Grey Hornbill (*Ocycerous griseus*). The Travancore Tortoise (*Indotestudo forstem*) and Cane turtle (*Heosemys silvatica*) are two endangered *taxa* restricted to a small area in central Western Ghats.

Deccan Plateau, constituting 42 per cent of the total geographical area, is a semi-arid region that falls in the rain shadow area of the Western Ghats. This bio-geographic zone of peninsular India is by far the most extensive zone, covering India's finest forests, particularly in the States of Madhya Pradesh, Maharashtra and Orissa. Majority of the forests are deciduous in nature but there are regions of greater biological diversity in the hill ranges. The zone comprising of deciduous forests, thorn forests and degraded scrubland support diverse wildlife species. Species such as Chital (*Axis axis*), Sambar (*Cervus unicolor*), Nilgai (*Boselapbus tragocamelus*) and Chousingha (*Tetracerus quadricornis*) are abundant in this zone. Some other species like Barking deer (*Muntiacus muntjak*) and Gaur (*Antilope cervicapra*) are more frequent in, or are restricted to moister areas, but are still found in fairly large numbers. Species with small populations include the Elephant (*Elephas maximus*) in Bihar-Orissa and Karnataka-Tamil Nadu belts, Wild

Buffalo (*Bubalus bubalis*) in a small area at the junction of Orissa, Madhya Pradesh and Maharashtra and the hard ground Swamp Deer (*Cervus duvauceli*), now restricted to a single locality in Madhya Pradesh.

Gangetic Plain, constituting 10.8 per cent of the total geographical area, is a flat alluvial region lying to the North and South of the Ganga River and its major tributaries and in the foothills of the Himalayas. The Gangetic plain is topographically homogenous for hundreds of kilometers. The characterstic fauna of this region include Rhino (*Rhinoceros unicornis*), Elephant (*Elephas maximus*), Buffalo (*Bubalus bubalis*), Swamp Deer (*Cervus duvauceli*), Hog-Deer (*Axis porcinus*) and Hispid Hare (*Carprolagus bispidus*). This zone gains considerable ecological significance in the context of increasing industrialization and pollution and the consequent environmental degradation and deforestation.

North-East Region, constituting 5.2 per cent of the total geographical area, represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese bio-geographical regions as well as being a meeting point of the Himalayan mountains and peninsular India. The North-East is thus the bio-geographical 'gateway' for much of India's fauna and flora and also a biodiversity hotspot. A diverse set of habitats coupled with long term geological stability has allowed the development of significant levels of endemism in all animal and plant groups. Many of the species contributing to this biological diversity are either restricted to the region itself, or to the smaller localized areas of the Khasi Hills.

The country's extensive ***Coasts***, constituting 2.5 per cent of the total geographical area with sandy beaches, mangroves, mud flats, coral reefs and marine angiosperm pastures make them the wealth and health zones of India. The coastline from Gujarat to Sunderbans is estimated to be 5,423 km long. A total of 25 islets constitute the Lakshadweep, which are of coral origin, and have a typical reef lagoon system, rich in biodiversity. However, the densely populated Lakshadweep islands virtually have no natural vegetation.

Nepenthes Khasiana - commonly known as Pitcher Plant

Andaman and Nicobar Islands, constituting 0.3 per cent of the total geographical area are one of the three tropical moist evergreen forests zones in India. The islands house an array of flora and fauna not found elsewhere. The elongated North-South oriented groups of 348 Andaman Islands have a bio-geographical affinity with Myanmar. The Nicobar Islands, lying only 90 kms away from Sumatra have much stronger Indonesian and South-East Asian elements. These islands are centres of high endemism and contain some of India's finest evergreen forests and support a wide diversity of corals. However, endemic island biodiversity is found only in the Andaman and Nicobar Islands.

Wetlands occur in various geographical regions such as the cold arid zones of Ladakh, warm arid zones of Rajasthan, tropical monsoonic Central India, North Eastern region, South peninsular region and the coastal wetlands.

HOT SPOTS IN INDIA

India has two identified biodiversity hot spots. These are the Eastern Himalayas and the Western Ghats.

Eastern Himalaya

Phyto-geographically, the Eastern Himalaya forms a distinct floral region and comprises of Nepal, Bhutan, states of East and North-East India, and a contiguous sector of Yunnan province in South-Western China. In the whole of Eastern Himalaya, there are an estimated 9,000 plant species, out of which 3,500 (i.e. 39 per cent) are endemic. In the Indian portion, there occurs some 5,800 plant species, roughly 2,000 (i.e. 36 per cent) of which are endemic. At least 55 flowering plants endemic to this area are recognised as rare, for example, the Pitcher Plant (*Nepenthes khasiana*).

The area has long been recognised as a rich centre of primitive flowering plants and is popularly known as the 'Çradle of Speciation'. Species of several families of monocotyledons, Orchidaceae, Zingiberaceae and Arecaceae are found in the area. Gymnorperms and Pteridophytes (ferns) are also well represented here.

The area is also rich in wild relatives of plants of economic significance e.g. rice, banana, citrus, ginger, chilli, jute and sugarcane. It is also 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*) has been cultivated in this region for the last 4,000 years. Many wild and allied species of tea, the leaves of which are used as a substitute for tea, are found in the North East, in their natural habitats.

The Taxol plant (*Taxus wallichiana*) is sparsely distributed in the region and is listed under the red data category due to its over-exploitation for extraction of a drug effectively used against cancer.

As regards faunal diversity, 63 per cent of the genera of land mammals in India are found in this region. 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 region is also a rich centre of avian diversity - more than 60 per cent of the bird species found in India have been recorded in the North East. The region also hosts two endemic genera of lizards, and 35 endemic reptilian species, including two turtles. Of the 240 Indian amphibian species, at least 68 species are known to occur in the North East, 20 of which are endemic.

From Namdapha National Park itself, a new genus of mammal, a new subspecies of a bird, six new amphibians species, four new species of fish, at least 15 new species of beetles and six new species of flies have been discovered.

Western Ghats

The Western Ghats region is considered to be one of the most important bio-geographic 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 endemic.

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 ten genera are endemic to the region.

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

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

Many of the endemic and other species are listed as threatened. Nearly 235 species of endemic flowering plants are considered endangered. Rare fauna of the region include - Lion Tailed Macaque, Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill.

BIOMES

Wetlands

Wetlands in India are distributed in different geographical regions, ranging from the Himalaya to the Deccan plateau. The

Bengal Tiger

Table 2.4.1: State-wise List of Wetlands of International Importance in India under Ramsar Convention

Sl. No.	State/UT	Name of Ramsar Site	Area (ha.)	Date of Declaration
1	Andhra Pradesh	Kolleru Lake	90100	19/08/02
2	Assam	Deepor Beel	4000	19/08/02
3	Himachal Pradesh	Pong Dam Lake Renuka Wetland Chandertal Wetland	15662 20 49	19/08/02 08/11/05 08/11/05
4	Jammu & Kashmir	Wular Lake Tsomoriri Hokera Wetland Surinsar-Mansar Lakes	18900 12000 1375 350	23/03/90 19/08/02 08/11/05 08/11/05
5	Kerala	Ashtamudi Wetland Sasthamkotta Lake Vembanad-Kol Wetland	61400 373 151250	19/08/02 19/08/02 19/08/02
6	Madhya Pradesh	Bhoj Wetland	3201	19/08/02
7	Manipur	Loktak Lake	26600	23/03/90
8	Orissa	Chilika Lake Bhitarkanika Mangroves	116500 65000	01/10/81 19/08/02
9	Punjab	Harike Lake Kanjili Ropar	4100 183 1365	23/03/90 22/01/02 22/01/02
10	Rajasthan	Sambhar Lake Keoladeo National Park	24000 2873	23/03/90 01/10/83
11	Tamil Nadu	Point Calimere Wildlife and Bird Sanctuary	38500	19/08/02
12	Tripura	Rudrasagar Lake	240	08/11/05
13	Uttar Pradesh	Upper Ganga River (Brijghat to Narora Stretch)	26590	08/11/05
14	West Bengal	East Kolkata Wetlands	12500	19/08/02
		Total sites 25	**677131**	

Source: National Biodiversity Action Plan, 2008, MoEF

variability in climatic conditions and topography is responsible for significant diversity. Based on their origin, vegetation, nutrient status and thermal characteristics, they are classified into following different types:

- **Glaciatic Wetlands** (e.g., Tsomoriri in Jammu and Kashmir, Chandertal in Himachal Pradesh)
- **Tectonic Wetlands** (e.g., Nilnag in Jammu and Kashmir, Khajjiar in Himachal Pradesh, and Nainital and Bhimtal in Uttaranchal)
- **Oxbow Wetlands** (e.g., Dal Lake, Wular Lake in Jammu and Kashmir and Loktak Lake in Manipur and some of the wetlands in the river plains of Brahmaputra and Indo-Gangetic region. Deepor Beel in Assam, Kabar in Bihar, Surahtal in Uttar Pradesh)
- **Lagoons** (e.g., Chilika in Orissa)
- **Crater Wetlands** (Lonar lake in Maharashtra)
- **Salt Water Wetlands** (e.g., Pangong Tso in Jammu and Kashmir and Sambhar in Rajasthan)
- **Urban Wetlands** (e.g., Dal Lake in Jammu and Kashmir, Nainital in Uttaranchal and Bhoj in Madhya Pradesh)
- **Ponds/Tanks, Man-made Wetlands** (e.g., Harike in Punjab and Pong Dam in Himachal Pradesh)
- **Reservoirs** (e.g., Idukki, Hirakud dam, Bhakra-Nangal dam)
- **Mangroves** (e.g., Bhitarkanika in Orissa)
- **Coral reefs** (e.g., Lakshadweep)
- **Others -** Creeks (Thane Creek in Maharashtra), seagrasses, estuaries, thermal springs are some other types of wetlands in the country.

There are in all 104 identified wetlands under the National Wetland Conservation & Management Programme (NWCMP).

Ramsar Convention

India is a signatory to the Ramsar Convention and plays an important role in conservation and wise use of wetlands. On the basis of the country's initiatives in the field of wetland conservation, India was nominated as a member of the Standing Committee from 1993-1996 and from 1999-2002. So far, 25 sites from India have been identified as Ramsar sites of international importance and six new sites are under process of designation (Table 2.4.1).

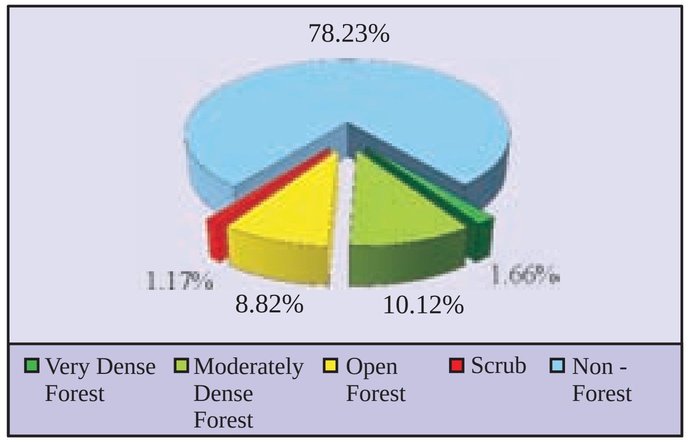
Forests

As per the latest report of the Forest Survey of India (2005), forests cover 23.6 per cent of India's total geographic area, which includes 3.04 per cent of the tree cover. Area under grasslands is about 3.9 per cent and deserts cover about 2 per cent. It is estimated that India has about 4.1 million hectares of wetlands (excluding paddy fields and mangroves).

Between 1990 and 2000, India gained an average of 3,61,500 hectares of forest per year. This amounts to an average annual reforestation rate of 0.57 per cent. Between 2000 and 2005, this rate of decreased by 92.3 per cent to 0.04 per cent per annum. In total, between 1990 and 2005, India gained 5.9 per cent in forest cover, or around 3.762 Mha. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, India gained one per cent in forest and woodland habitat.

India possesses a distinct identity, not only because of its geography, history and culture but also because of the great diversity of its natural ecosystems. The panorama of Indian forests ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands, the Western Ghats, and the North-Eastern States, to dry alpine scrub high in the Himalayas to the north. Between the two extremes, the country has semi-evergreen rain forests, deciduous monsoon forests, thorn forests, subtropical pine forests in the lower mountain zone and temperate mountain forests (*Lal, 1989*).

Figure 2.4.2: Forest Cover in India



Source: State of Forest Report 2005, Forest Survey of India

The main areas of tropical forest are found in the Andaman and Nicobar Islands, the Western Ghats which fringe the Arabian Sea coastline of peninsular India and the greater Assam region in the North-East. Small remnants of rain forest are found in Orissa state. Semi-evergreen rain forest is more extensive than the evergreen formation, partly because evergreen forests tend to degrade to semi-evergreen with human interference.

The tropical vegetation of North-East India (which includes the states of Assam, Nagaland, Manipur, Mizoram, Tripura and

Sesamum orientale

Meghalaya as well as the plain regions of Arunachal Pradesh) typically occurs at elevations up to 900 m. It embraces evergreen and semi-evergreen rain forests, moist deciduous monsoon forests, riparian forests, swamps and grasslands. Evergreen rain forests are found in the Assam Valley, the foothills of the eastern Himalaya and the lower parts of the Naga Hills, Meghalaya, Mizoram and Manipur where the annual rainfall exceeds 2,300 mm. In the Assam Valley, the giant *Dipterocarpus macrocarpus* and *Shorea assamica* occur singly, occasionally attaining a girth of up to 7 m and a height of up to 50 m. The monsoon forests are mainly moist Sal (*Shorea robusta*) forests, which occur widely in this region . The Andaman and Nicobar islands have tropical evergreen rain forests and tropical semi-evergreen rainforests as well as tropical monsoon forests. The tropical evergreen rain forests are only slightly less grand in stature and rich in species than on the mainland. The dominant species is *Dipterocarpus grandiflorus* in hilly areas, while *Dipterocarpus kerrii* is dominant on some islands in the southern parts of the archipelago. The monsoon forests of the Andamans are dominated by *Pterocarpus dalbergioides* and *Terminalia* spp.

Egretta Gularis - a Western reef egret

Marine Environment

The near shore coastal waters of India are extremely rich fishing areas. The total commercial marine catch for India has stabilized over the last ten years at between 1.4 and 1.6 million tonnes, with fishes from the clupeoid group, e.g. Sardines (*Sardinella* sp.), Indian Shad (*Hilsa* sp.) and Whitebait (*Stolephorus* sp.) accounting for approximately 30 per cent of all landings.

The Indian reef area is estimated to be 2,375 km^2. Coral reefs occur along only a few sections of the mainland, principally the Gulf of Kutch, off the southern mainland coast, and around a number of islands opposite Sri Lanka. This general absence is largely due to the presence of major river systems and the sedimentary regime on the continental shelf. Elsewhere, corals are also found in Andaman & Nicobar and Lakshadweep island groups, although their diversity is reported to be lower than in South-East India.

Indian coral reefs have a wide range of resources which are of commercial value. Exploitation of corals, coral debris and coral sands is widespread in the Gulf of Mannar and Gulf of Kutch reefs, while ornamental shells, chanks and pearl oysters are the basis of an important reef industry in the south of India. Sea fans and seaweeds are exported for decorative purposes, and there is a spiny lobster fishing industry along the South-East coast, notably at Tuticorin, Madras and Mandapam. Commercial exploitation of aquarium fishes from Indian coral reefs has gained importance only recently and as yet no organized effort has been made to exploit these resources. Reef fisheries are generally at the subsistence level and yields are not recorded.

Other notable marine area includes seagrass beds which, although not directly exploited, are valuable as habitats for commercially harvested species, particularly prawns, and mangrove stands. In the Gulf of Mannar, the green tiger prawn *Penaeus semisulcatus* is extensively harvested for the export market. Seagrass beds are also important feeding areas for the Dugong (*Dugong dugon*) and several species of marine turtle.

Five species of marine turtle occur in Indian waters - Green turtle (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea)*, Hawksbill (*Eretmochelys imbricata*) and Leatherback (*Dermochelys coriacea*). Most of the marine turtle populations found in the Indian region are in decline. The principal reason for the decrease in numbers is deliberate human predation. Turtles are netted and speared along the entire Indian coast. In South-East India, the annual catch is estimated at 4,000-5,000 animals, with *C. mydas* accounting for about 70 per cent of the harvest. *C. caretta* and *L. olivacea* are the most widely consumed species (Salm, 1981). *E. imbricata* is occasionally eaten but it has caused deaths and so is usually caught for its shell alone. *D. coriacea* is boiled for its oil, which is used for caulking boats and as a protection from marine borers. Incidental netting is widespread.

A Mangrove Corridor in Andaman & Nicobar Islands

Mangroves

Mangroves are salt-tolerant forest ecosystems found mainly in tropical and sub-tropical inter-tidal regions of the world. They comprise of trees or shrubs that have the common trait of growing in shallow and muddy salt water or brackish waters, especially along quiet shorelines and in estuaries. They exhibit a remarkable capacity for saltwater tolerance. Mangrove forests are one of the most productive and biodiverse wetlands on earth. Yet, these unique coastal tropical forests are among the most threatened habitats in the world.

Status of Mangroves in India

Mangroves in India account for about five per cent of the world's mangrove vegetation and are spread over an area of about 4,500 km^2 along the coastal States/UTs of the country. Sunderbans in West Bengal accounts for a little less than half of the total area under mangroves in India. The Forest Survey of India has been assessing the vegetation cover of the country, including mangroves using remote sensing since 1983. It published its first assessment of mangroves of India in 1987 and estimated it to be 4,046 km². Thereafter, mangroves have been assessed regularly on a two-year cycle. West Bengal has the maximum mangrove cover in the country, followed by Gujarat and Andaman & Nicobar Islands.

Mangroves mapping was done in 2005, utilizing their unique reflectance characteristics. In the assessment, mangrove cover has also been categorized into very dense mangrove (canopy density of more than 70 per cent), moderately dense mangrove (canopy density between 40-70 per cent) and open mangrove (canopy density between 10-40 per cent). The current assessment shows that the mangrove cover in the country is 4,445 km^2, which is 0.14 per cent of the country's total geographic area. The very dense mangrove comprises 1,147 km^2 (25.8 per cent of mangrove cover), moderately dense mangrove is 1,629 km^2 (36.6 per cent)

Small Green Bee-eater Merops orientalis while open mangrove covers an area of l, 669 km^2 (37.6 per cent) (Figures 2.4.3 & 2.4.4).

Compared with 2003 assessment, there has been a marginal decrease in the mangrove cover of the country mainly because of the Tsunami that hit Andaman & Nicobar Islands on 26 December, 2004. Gujarat has shown an increase in mangrove cover mainly owing to plantations and adoption of protection measures.

Medicinal and Aromatic Plants

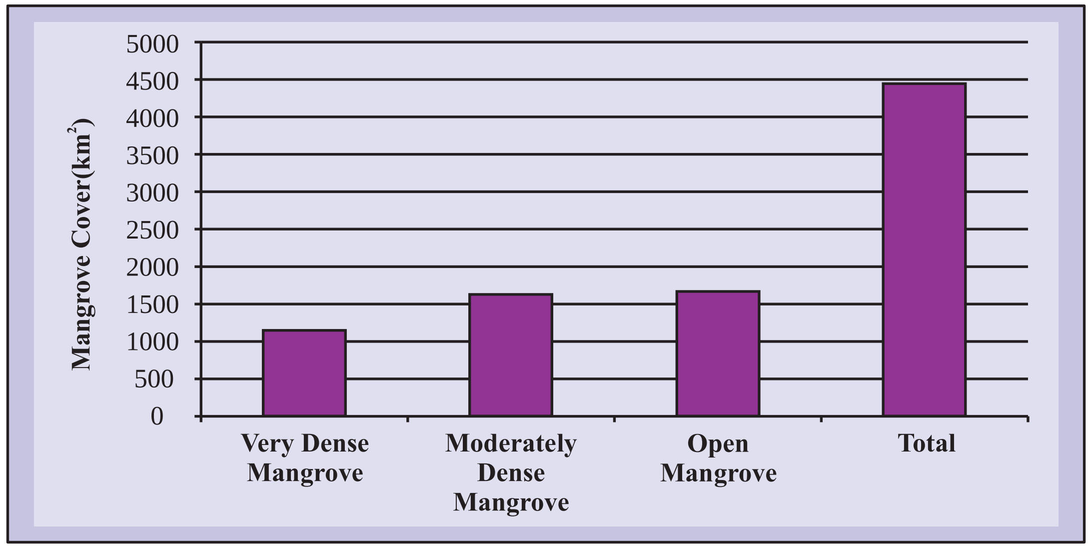
Medicinal and aromatic plants have been used in the country for a long time for their medicinal properties. About 2,000 native plant species have curative properties and 1,300 species are known for their aroma and flavour. For the Indian systems of medicine, popularly known as Ayurveda, Unani and Siddha, herbal drugs are in great demand in the country. There is already a spurt in demand for plant-based drugs and lately, many such species of medicinal values are being brought under systematic cultivation. India has been considered a treasure house of valuable medicinal and aromatic plant species.

The Ministry of Environment and Forests, Government of India has identified and documented over 9,500 plant species considering their importance in the pharmaceutical industry. Out of these, about 65 species have large and consistent demand in world trade. India, however, produces only limited quantities of these. In terms of market share in production value, India holds only the sixth place with a mere 7 per cent share. On the contrary, we still import about ten types of essential oils to the tune of 8,000 tonnes per annum. Indian exports are thus guided by what may be termed as a trader's vision rather than by a knowledge-products vision.

Sacred groves

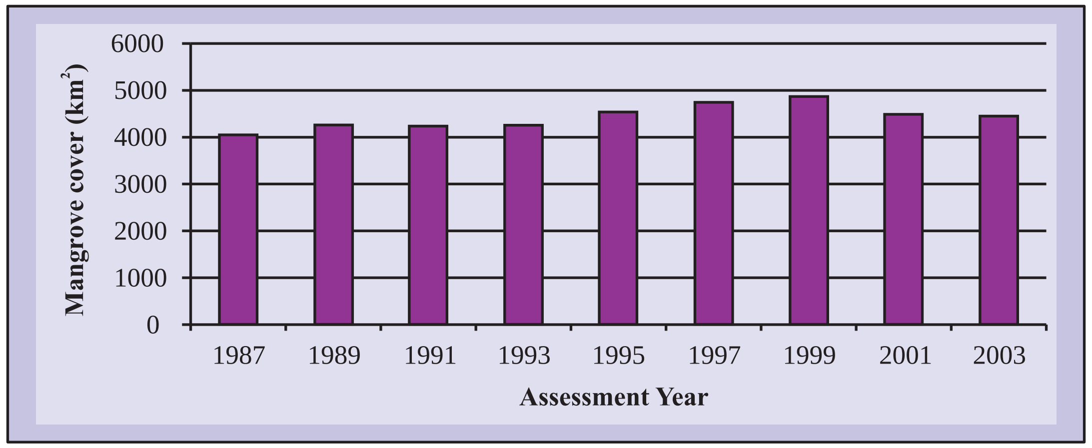
India has over 19,000 sacred groves. Sacred groves are initiatives of communities for conserving biodiversity based on their religious beliefs but of late, these are being degraded or converted to plantations. Since there are several medicinal plants and wild relatives of crop plants occurring naturally in these areas, the sacred groves need to be conserved. Traditional norms and practices for conservation of neighbourhood forests and common land are also diminishing, although certain rural and tribal communities continue to safeguard their biological resource base even at the cost of their livelihood and sustenance.

Figure 2.4.3: Type of Mangrove Cover in India



Source: State of Forest Report, 2005, Forest Survey of India

Figure 2.4.4: Total Mangrove Cover in India



Source: State of Forest Report, 2005, Forest Survey of India

Heracleum wallichii-Alpine Medicinal Plant

PRESSURES

Threats to Biodiversity

Traditional and substantial dependence on biodiversity resources for fodder, fuel wood, timber and minor forest produce has been an accepted way of life for the rural population that accounts for nearly 74 per cent of India's population. With radical demographic changes, the land to man ratio and forest to man ratio has rapidly declined. The lifestyles and the biomass resource needs having remained unchanged, the remnant forests have come under relentless pressure of encroachment for cultivation, and unsustainable resource extraction rendering the very resource base unproductive and depleted of its biodiversity. Coupled with these incongruities and aberrations in land use, the unsound development strategies have led to increasing threats to biodiversity resources by way of illegal encroachment of 0.07 Mha. of forest, cultivation of 4.37 Mha. and diversion of forest for river valley projects (0.52 Mha.), industries and townships (0.14 Mha.), transmission lines and roads (0.06 Mha.) and an additional 1.5 Mha. for miscellaneous purposes (*TERI, 1999*). The unabated pace of development of infrastructure to harness hydropower, driven by necessity to meet the growing requirements of water for inputs to irrigation, domestic use and industrial purposes, has led to the construction of over 4,000 dams across India. The creation of valley bottom reservoirs in wilderness areas has brought on the destruction of some of the finest forests and biodiversity-rich unique ecosystems. Deforestation due to hydropower and mining projects are perhaps the greatest threats to biodiversity in India.

Human activities are directly and indirectly responsible for current high rates of biodiversity loss. Some of the major issues are:

- Habitat loss, fragmentation and degradation result due to agricultural activities, extraction (including mining, fishing, logging and harvesting) and development (human settlements, industry and associated infrastructure). Habitat loss and fragmentation leads to the formation of isolated, small, scattered populations. These small populations are increasingly vulnerable to inbreeding depression, high

Box 2.4.1 : Bishnois – Committed to Conservation

The Bishnoi tribe of Western Rajasthan has, over the centuries, protected the trees and wild animals in and around their villages. Bishnois do not cut trees for fuel and timber; they remove only the dead trunks and twigs. Spotted deer, black buck and blue bulls can be seen foraging fearlessly in their fields. Even if the crop is consumed by herds of deer, the Bishnois do not chase away the animals.

In 1730 A.D., Maharaja Abhaya Singh of Jodhpur ordered cutting of trees in large numbers to provide timber for building a fortress. He sent soldiers to Bishnoi villages to cut down Khejari trees growing in the area. When soldiers applied the axe, the Bishnoi villagers pleaded to spare the trees. When the soldiers did not relent, they hugged the trees and as many as 363 of them laid down their lives to save the trees. The Bishnois worship nature in all its manifestations, conserve trees and medicinal plants, provide food and water to animals, and are vegetarians in their diet.

Table 2.4.2: Threatened Species

Mammals	Birds	Reptiles	Amphibians	Fishes	Molluscs	Other Inverts	Plants	Total
96	76	25	65	40	2	109	246	659

INDIA	EX	EW	Subtotal	CR	EN	VU	Subtotal	LR/cd	NT	DD	LC	Total
Animals	1	0	1	51	105	257	413	2	252	231	1631	2,530
Plants	7	2	9	45	112	89	246	1	22	18	70	366

IUCN Red List Categories: EX - Extinct, EW - Extinct in the Wild, CR - Critically Endangered, EN - Endangered, VU - Vulnerable, LR/cd - Lower Risk/conservation dependent, NT - Near Threatened (includes LR/nt - Lower Risk/near threatened), DD - Data Deficient, LC - Least Concern(includes LR/lc - Lower Risk, least concern).

Source: IUCN Red List, 2008

infant mortality and are susceptible to stochastic environmental events, and consequently, possible extinction. Changes in forest composition and quality, and the resultant habitat type lead to decline in primary food species for wildlife.

- Poaching and hunting
- Invasive species
- Over-exploitation of wild bio resources
- Pollution of atmosphere, water and soil
- Global climate change

RESPONSE

1) Wild Life (Protection) Act, 1972

In respect of Wildlife Conservation, the following actions will be pursued:

a) Expand the Protected Area (PA) network of the country, including Conservation and Community Reserves, to give fair representation to all bio-geographic zones of the country. In doing so, develop norms for delineation of PAs in terms of the Objectives and Principles of the National Environment Policy, in particular, participation of local communities, concerned public agencies, and other stakeholders, who have a direct and tangible stake in protection and conservation of wildlife, to harmonize ecological and physical features with needs of socio-economic development.

b) Revisit the norms, criteria and needs of data for placing particular species in different schedules of the Wildlife Protection Act.

c) Formulate and implement programmes for conservation of endangered species outside protected areas, while reducing the scope for man-animal conflict.

d) Empower, build capacities, and facilitate access to finance and technology for local people, in particular tribals, who are relocated from PAs, or live in the fringe areas, for provision of eco-tourism services in the PAs.

e) Paralleling multi-stakeholder partnerships for afforestation, formulate and implement similar partnerships for enhancement of wildlife habitat in Conservation Reserves and Community Reserves, to derive both environmental and eco-tourism benefits.

f) Promote site-specific eco-development programmes in fringe areas of PAs, to restore livelihoods and access to forest produce by local communities, owing to access restrictions in PAs.

g) Strengthen capacities and implement measures for captive breeding and release into the wild, identified endangered species.

h) Review and tighten the provisions of relevant legislation to enhance their deterrence. Further, strengthen institutional measures and capacities of enforcement authorities, with respect to intelligence collection, investigation, and prosecution, to deal with wildlife crime.

i) Ensure that human activities on the fringe areas of PAs do not degrade the habitat or otherwise significantly disturb wildlife.

2) The National Forest Policy, 1988

The National Forest Policy, 1988, and the Indian Forest Act, as well as the regulations under it, provide a comprehensive basis for forest conservation. The National Forest Commission, set up in 2003, is reviewing the policy, legislative and institutional basis of forest management. Nevertheless, it is necessary, considering some of the underlying causes of forest loss, to take some further steps. These include the following :

a) Legal recognition of the traditional entitlements of forest-dependant communities, taking into consideration the provisions of the Panchayat (Extension to the Scheduled Areas) Act, 1996 (PESA). This would remedy a serious historical injustice, secure their livelihoods, reduce possibilities of conflict with the Forest Departments, and provide long-term incentives to these communities to conserve the forests.

b) Formulate innovative strategy to increase forest and tree cover from 23.69 per cent in 2003 to 33 per cent of the country's land area by 2012, through afforestation of degraded forest land, wastelands, and tree cover on private or revenue lands.

c) Formulate appropriate methodology for reckoning and restoring the environmental values of forests, which are unavoidably diverted to other uses.

d) Formulate and implement a 'Code of Best Management Practices' for dense natural forests, to realize the objectives and principles of National Environment Policy. Forests of high indigenous genetic diversity should be treated as entities with incomparable value.

e) Denotify Bamboo and similar other species as 'Forest Species' under the Forest Conservation Act, to facilitate their cultivation outside notified forests, and encourage their productive utilization in economic activities.

f) Promote plantation of only such species as are conducive to the conservation and sustainability of given ecosystems.

g) It is essential that women play a greater role in the management of natural resources. While they have to bear the burden of natural resource degradation, they have little control over the management of these resources. Relevant provisions of the National Policy for the Empowerment of Women provide a framework for incorporating elements of proposed actions.

3) Biological Diversity Act, 2002

To regulate access to genetic resources and associated sharing arrangements, apart from developing policies and programmes on long term conservation and protection of biological resources and associated knowledge, the Biological Diversity Act, 2002 was promulgated. The National Biodiversity Authority (NBA) set up at Chennai on 1st October 2003 as per the provisions of the Biological Diversity Act, 2002 is mandated to facilitate implementation of the Act.

4) National Biodiversity Action Plan (NBAP)

The Union Ministry of Environment and Forests (MoEF), the nodal agency for implementing the provisions of Convention on Biological Diversity (CBD) in India, developed a strategy for biodiversity conservation at macro-level in 1999 and enacted the Biological Diversity Act in 2002, followed by the Rules thereunder in 2004. There is a need now to develop and implement a suitable national action plan for promoting biodiversity conservation, sustainable use of its components and equitable sharing of benefits arising from such use. The National Environment Policy, 2006, seeks to achieve balance and harmony between conservation of natural resources and development processes and also forms the basic framework for the National Biodiversity Action Plan.

The objectives of the NBAP are founded in the backdrop of the cardinal principles already set out in the NEP 2006. The most important of these principles is that human beings are at the centre of sustainable development concerns. The other relevant principles on which the objectives are premised include the right to development, precautionary approach, economic efficiency, entities with 'incomparable value', equity, public trust doctrine, decentralization, integration, preventive actions, and environmental offsetting.

The objectives are broad-based and relate to current perceptions of key threats and constraints to biodiversity conservation and are as follows.

i. Strengthening and integration of in situ, on-farm and ex situ conservation

ii. Augmentation of natural resource base and its sustainable utilization; Ensuring inter and intra-generational equity

Our National Bird Peacock

iii. Regulation of introduction of invasive alien species and their management
iv. Assessment of vulnerability, and adaptation to climate change and desertification
v. Integration of biodiversity concerns in economic and social development
vi. To prevent, minimize and abate impacts of pollution
vii. Development and integration of biodiversity databases
viii. Strengthening implementation of policy, legislative and administrative measures for biodiversity conservation and management
ix. Building of national capacities for biodiversity conservation and appropriate use of new technologies
x. Valuation of goods and services provided by biodiversity and use of economic instruments in the decision-making processes
xi. International cooperation to consolidate and strengthen bilateral, regional and multilateral cooperation on issues related to biodiversity.

5) Forest Certification

Forest certification has emerged as one of the market mechanisms to address environmental concerns of the green consumers on one hand and help promote sustainable forest management on the other. Forest certification also contributes to the promotion of economically viable, environmentally appropriate and socially beneficial management of forests as defined by the Helsinki criteria. Forest certification was launched over a decade ago to help protect forests from destructive logging practices. Like the 'organically grown' label on produce, forest certification was intended as a seal of approval, a means of notifying consumers that a wood or paper product comes from forests managed in accordance with strict environmental and social standards.

At present, most of the certified forests are in the developed countries. Globally, as of July 2005, the total area of certified forests was estimated at about 245 Mha.

The process of certification in tropical timber producing countries like India has been slow on account of several reasons including inflexibility of international certification standards like FSC (Forest Stewardship Council) and PEFC (Pan European Forest Certification Council), lack of recognition of broader local land-use issues, wide-range of NTFPs (Non-Timber Forest Products) conflicts, incompatibility between legal settings and certification standards and high costs of certification. There are only two FSC certificates existing in India as on date.

It is also important to note that there seems to be no domestic market for forest certified products in the country till now. However, there could be potential export markets for certain products based on forest resources as raw material, for example, wood/natural fibre based handicraft products.

As a first step in the direction for initiating forest certification processes in the country, a National Working Group has been set up involving officials of the MoEF and SFDs (State Forest Departments), industry representatives and environment based NGOs, institutional experts and independent experts having international expertise in forest certification.

Rhino in Kaziranga National Park

6) Coastal Management Zone Draft Notification, 2008

Ministry of Environment and Forests issued the Coastal Regulation Zone Notification in 1991, under which coastal stretches were declared Coastal Regulation Zones (CRZ) and restrictions were imposed on the setting up and expansion of industries, operations and processes in the said Zones for its protection. The Government had constituted an Expert Committee under the Chairmanship of Prof. M.S. Swaminathan to review the various issue pertaining to implementation of the Coastal Regulation Zone Notification, 2004. The Committee submitted its report along with its recommendations to the Ministry in April, 2005. Based on these recommendations, the Ministry has formulated a draft CMZ Notification. This draft has been discussed with various stakeholders and based on the suggestions received, the draft notification is under finalization.

7) *Ex-situ* Conservation

Attention has been paid to *ex-situ* conservation measures also as they complement *in-situ* conservation measures and are even otherwise important. There are about 70 botanical gardens, including 33 University botanical gardens. Also, there are 275 centres of *ex-situ* wildlife preservation in the form of zoos, deer parks, safari parks, aquaria etc. A Central Zoo Authority supports, oversees, monitors and coordinates the development and management of zoos in the country. A scheme entitled Assistance to Botanical Gardens provides one-time assistance to botanical gardens to institute and strengthen measures for *ex-situ* conservation of cultivated plants and domesticated animals. While zoological parks have been looked upon essentially as centres of education and recreation, they have played an important role in the conservation of species such as Manipur Thamin Deer and the White-Winged Wood Duck.

The Indian National Gene Bank established by the ICAR as a part of the National Bureau of Plant Genetic Resources, has conserved more than 1,50,000 accessions and samples. The capacity of this gene bank has been increased to about one million, making it the largest gene bank of the world. It has more than 7,100 accessions of underutilized crops.

8) *In-situ* conservation

Approximately, 4.83 per cent of the total geographical area of the country has been earmarked for extensive *in-situ* conservation of habitats and ecosystems through a protected area network of 99 National Parks and 523 Wildlife Sanctuaries. The results of this network have been significant in restoring viable populations of large mammals such as tigers, lions, rhinoceros, crocodiles and elephants. To conserve the representative ecosystems, the Biosphere Reserve Programme is being implemented. In all, 15 biodiversity rich areas of the country have been designated as Biosphere Reserves. Programmes have also been launched for scientific management and wise use of fragile ecosystems. Specific programmes for management and conservation of wetlands, mangroves and coral reefs systems are being implemented. National and sub-national level committees oversee and guide these programmes to ensure strong policy and strategic support.

Number and Extent of Protected Areas

The network of protected areas presently covers 4.83 per cent of the country's total land area and includes 99 national parks and 523 wildlife sanctuaries. Of these, 100 cover both terrestrial and freshwater ecosystems and 31 are marine protected areas. There are also 15 Biosphere Reserves and several Reserved Forests, which are part of the most strictly protected forests outside the protected areas.

Biodiversity and Protected Areas

India has some 2,356 known species of amphibians, birds, mammals and reptiles according to figures from the World Conservation Monitoring Center. Of these, 18.4 per cent are endemic, meaning they exist in no other country, and 10.8 per cent are threatened. India is home to at least 18,664 species of vascular plants, of which 26.8 per cent are endemic. About 4.9 per cent of the country's area is protected under IUCN categories I-V.

1. Nature Reserves, Wilderness Areas, and National Parks (categories I and II)
2. Areas Managed for Sustainable Use and Unclassified Areas (category VI and 'other')
3. Natural Monuments, Species Management Areas, and Protected Landscapes and Seascapes (categories III, IV, and V)

Biosphere Reserves

The programme of Biosphere Reserve was initiated under the 'Man & Biosphere' (MAB) programme of UNESCO in 1971. The purpose of the formation of the biosphere reserve is to conserve in-situ all forms of life, along with its support systems, in their totality, so that it could serve as a referral system for monitoring and evaluating changes in natural ecosystems. The first biosphere reserve of the world was established in 1979. Since then the network of biosphere reserves has increased to 531 in 105 countries across the world (MAB, 2008). Presently, there are 15 existing biosphere reserves in India (Table 2.4.3).

Project Tiger

As per the recommendations of a special task-force of the Indian Board of Wildlife, Project Tiger was launched in 1973 with the following objectives:

- To ensure maintenance of the 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.

Starting with nine reserves in 1973-74, the number has grown to 29 in 2006 (Table 2.4.4). A total area of 38,620 km^2 corresponding to 1.17 per cent of the total geographical area of the country is covered by Project Tiger.

Table 2.4.3: Number of Biosphere Reserves set up in India

Sl. No.	Name	Date of Estbl.	Area (in km^2)	Location
1	Achanakamar - Amarkantak	2005	**3835.51** (Core 551.55 & Buffer 3283.86)	Covers parts of Anupur and Dindori districts of Madhya Pradesh and parts of Bilaspur Districts of Chhattisgarh State
2	Agasthyamalai	12.11.2001	**1828**	Neyyar, Peppara and Shendurney Wildlife Sanctuaries and their adjoining areas in Kerala
3	Dehang-Dibang	02.09.98	**5111.5** (Core 4094.80 & Buffer 1016.70)	Part of Siang and Dibang Valley in Arunachal Pradesh
4	Dibru-Saikhowa	28.07.97	**765** (Core 340 & Buffer 425)	Part of Dibrugarh and Tinsukia Districts (Assam)
5	Great Nicobar	06.01.89	**885** (Core 705 & Buffer 180)	Southern most islands of Andaman and Nicobar (Andaman and Nicobar Islands)
6	Gulf of Mannar	18.02.89	**10,500** Total Gulf Area (Area of Island 5.55 km^2)	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
7	Khangchendzonga	07.02.2000	**2619.92** (Core 1819.34 & Buffer 835.92)	Parts of Khangchendzonga Hills and Sikkim
8	Manas	14.03.89	**2837** (Core 391 & Buffer 2446)	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang Districts (Assam)
9	Nanda Devi	18.01.88	**5860.69** (Core 712.12, Buffer 5,148.570 & Transition 546.34)	Part of Chamoli, Pithoragarh, and Bageshwar Districts (Uttarakhand)
10	Nilgiri	01.09.86	**5520** (Core 1240 & Buffer 4280)	Part of Wayanad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani Hills (Tamil Nadu, Kerala and Karnataka)
11	Nokrek	01.09.88	**820** (Core 47.8 & Buffer 227.92 Transition Zone 544.60)	Part of Garo Hills (Meghalaya)
12	Pachmarhi	03.03.99	**4926**	Parts of Betul, Hoshangabad and Chindwara Districts of Madhya Pradesh
13	Simlipal	21.06.94	**4374** (Core 845, Buffer 2129 & Transition 1400)	Part of Mayurbhanj District (Orissa)
14	Sunderbans	29.03.89	**9630** (Core 1700 & Buffer 7900)	Part of delta of Ganga and Brahamaputra river system (West Bengal)
15	Kachch	29.01.08	**12454**	Parts of Kachch, Rajkot, Surendranagar and Patan district of Gujarat

Source: National Biodiversity Action Plan, 2008, MoEF

Table 2.4.4: List of Tiger Reserves in India

State	Tiger Reserve	Year of Establishment	Total Area (km^2)
Assam	1. Kaziranga	2006	859
	2. Manas	1973-74	2840
	3. Nameri	1999-2000	344
Arunachal Pradesh	4. Namdapha	1982-83	1985
	5. Pakhui	1999-2000	862
Andhra Pradesh	6. Nagarjunsagar- Srisailam	1982-83	3568
Bihar	7. Valmiki	1989-90	840
Chhattisgarh	8. Indravati	1982-83	2799
Jharkhand	9. Palamau	1973-74	1026
Karnataka	10. Bandipur Nagarhole (extension)	1973-74 1999-2000	866 643
	11. Bhadra	1998-99	492
Kerala	12. Periyar	1978-79	777
Madhya Pradesh	13. Bandhavgarh	1993-94	1162
	14. Bori-Satpura	1999-2000	1486
	15. Kanha	1973-74	1945
	16. Panna	1994-95	542
	17. Pench	1992-93	758
Maharashtra	18. Melghat	1973-74	1677
	19. Pench	1992-93	257
	20. Tadoba-Andheri	1993-94	620
Mizoram	21. Dampa	1994-95	500
Orissa	22. Simlipal	1973-74	2750
Rajasthan	23. Ranthambhore	1973-74	1334
	24. Sariska	1978-79	866
Tamil Nadu	25. Kalakad-Mundathurai	1988-89	800
Uttar Pradesh	26. Dudhwa Katernighat (Extension)	1987-88 1999-2000	811 551
Uttaranchal	27. Corbett	1973-74	1316
West Bengal	28. Buxa	1982-83	759
	29. Sunderbans	1973-74	2585
Total Area			**38,620**

Source: Wildlife Institute of India, 2007

Box 2.4.2: Forest Cover Change in Tiger Reserves

Forest Survey of India analyzed the forest cover of all the 28 Tiger Reserves (TRs) and in their outer surroundings (10 km strip), using remote sensing and GIS. Forest cover estimates based on satellite data of IRS-IC/ID (LISS III) of the years 1997, 2000 and 2002 has been used in the study. The change in the forest cover was analyzed for the period 1997-2002.

It was found that between 1997 and 2002, five TRs have shown an increase in forest cover, 11 TRs have shown decrease, and 12 TRs have shown no change. Major losses in forest cover have occurred in Nameri, Buxa, Manas, Indravati and Dampa TRs mainly due to socio-economic reasons and natural disasters.

Forest cover in the outer surroundings has increased in two TRs, decreased in 21 TRs and has not changed in five TRs. The total forest cover inside the TRs and their outer surroundings has increased by 94 km^2 and 124 km^2 respectively. The detailed report of the study may be obtained from FSI or from the National Tiger Conservation Authority.

Project Elephant

It was launched in 1991-92 to assist the States having free ranging populations of wild elephants to ensure the long term survival of identified viable populations of elephants in their natural habitats . The project is being implemented in the states of Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Orissa, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal.

Major activities of Project Elephant include:

- Ecological restoration of existing natural habitats and migratory routes of elephants
- Development of scientific and planned management for conservation of elephant 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 causes of death
- Research on Project Elephant management related issues
- Public education and awareness programmes
- Eco-development
- Veterinary care

National Parks and Wildlife Sanctuaries

The Wildlife Act provided for setting up National Parks and Sanctuaries for wildlife conservation. The Government of India has pledged all efforts to conserve the natural heritage of the country and seeks not only to protect and preserve what remains of wild fauna and flora, but also to augment this priceless national asset.

a. Multi-pronged pressures on forests are exerted by increasing human population, cattle grazing, fuel and fodder collection, industry and forest fires, etc. The remaining good forest cover is, therefore, estimated to be just 11 per cent against the desirable 33 per cent of the total land area as per the National Forest Policy. Up to the late Seventies, forest land was a prime target for diversion for resettlement, agriculture and industrialization, and this trend was contained only by the Forest (Conservation) Act, 1980.

b. A two-pronged strategy to increase forest cover essentially comprises of:

- Improving canopy cover in the forest land.
- Undertaking afforestation in non-forest and degraded lands, preferably contiguous to forest blocks.

c. Realizing the role of forests in controlling soil erosion, moderation of floods, recharging of ground aquifers, as habitat for wildlife, conservation of biodiversity and gene pool, etc., programmes were launched as early as the Second Five Year Plan for extensive Watershed Management, followed later by establishment of a Protected Areas Network, under the Wildlife (Protection) Act, 1972, comprising Biosphere Reserves, National Parks and Sanctuaries - both terrestrial and aquatic. This Network now comprises of 15 Biosphere Reserves, 99 National Parks and 523 Wildlife Sanctuaries (Table 2.4.5). Another 217 sanctuaries, covering an area of 16,669.44 km^2, are proposed in the Protected Area Network Report, along with dedicated conservation programmes such as Project Tiger, Crocodile Rehabilitation and Project Elephant. The Central Zoo Authority caters to the ex-situ conservation of wildlife through 275 zoos, deer parks, safari parks and aquaria, etc. India is also a signatory to several International Conventions like the Convention on International Trade in Endangered Species, International Whaling Convention (IWC), Convention on Migratory Species (CMS), World Heritage Convention (WHC), etc. India has recently taken the lead in formation of the Global Tiger Forum.

National Lake Conservation Plan

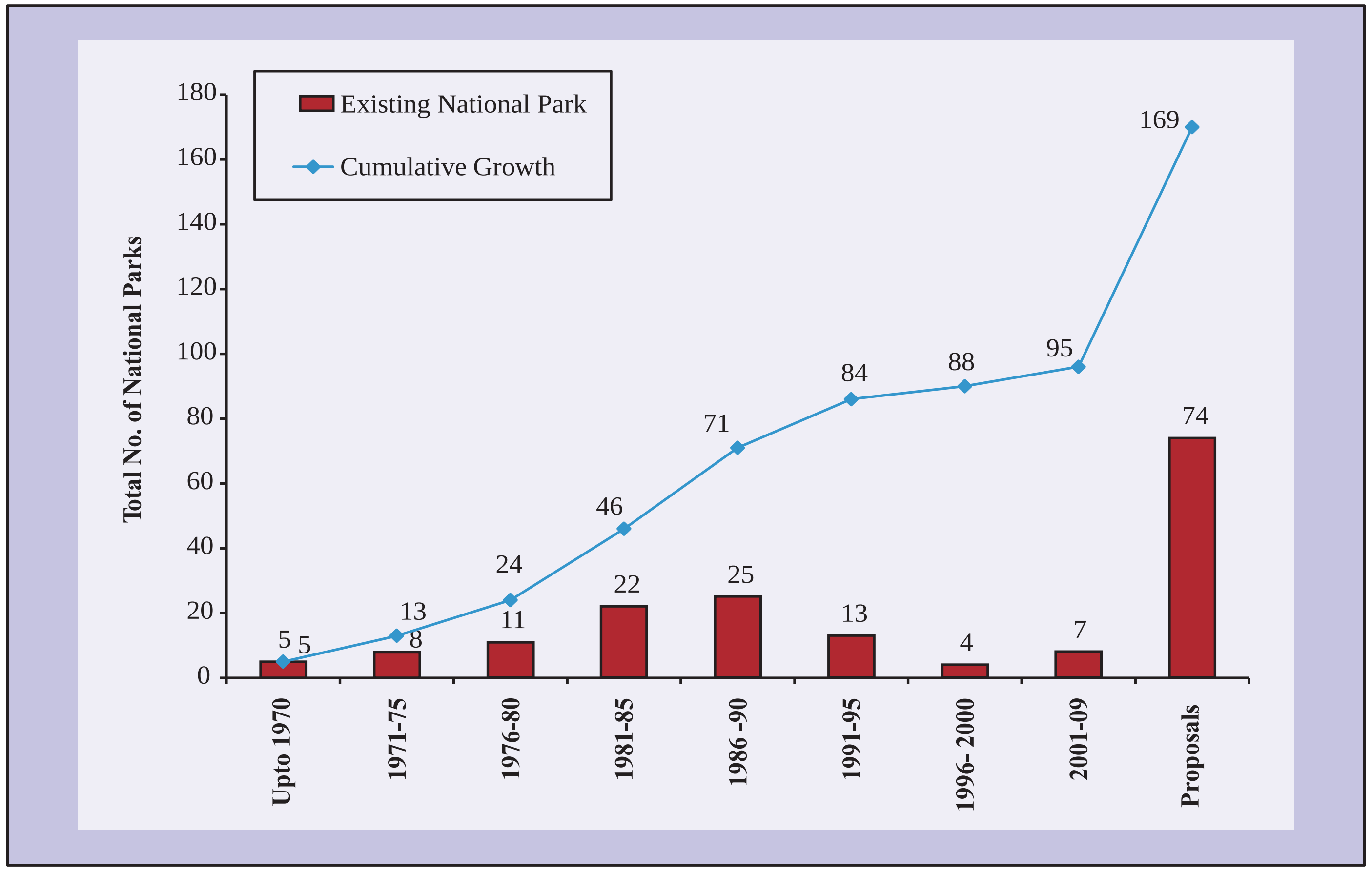
Recognizing the importance of lakes, the Ministry of Environment & Forests, Government of India, launched the National Lake Conservation Plan (NLCP), a centrally sponsored scheme exclusively aimed at restoring the water quality and ecology of the lakes in different parts of the country. The scheme was approved by the Government of India in the IX[th] Five Year Plan (Feb 2002) as 100 per cent central funding to 70:30 costs-sharing between the Centre and the concerned State Government. The objective of the scheme is to restore and conserve the urban and semi-urban lakes of the country, degraded due to wastewater discharge into the lakes and other unique freshwater ecosystems, through an integrated ecosystem approach.

Table 2.4.5: Current Protected Areas Statistics of India (as on March 2009)

Geographical Area (G.A.) of India			32,87,263 km^2
Forest Area of India (FSI, 2005)			667,088 km^2
Percentage Forest Area of Geographical Area of India			20.29 %
Current Protected Area Status			
National Parks	99	Area Covered	39,155 km^2
Wildlife Sanctuaries	523	Area Covered	1,18,417 km^2
Conservation Reserves	43	Area Covered	1,155.06 km^2
Community Reserves	3	Area Covered	17.76 km^2
Protected Areas	668	Area Covered	1,58,745 km^2
National Parks % of G.A.	1.19%		
Wildlife Sanctuaries % of G.A.	3.60%		
Conservation Reserves % of G.A.	0.04%		
Protected Areas % of G.A.	4.83%		

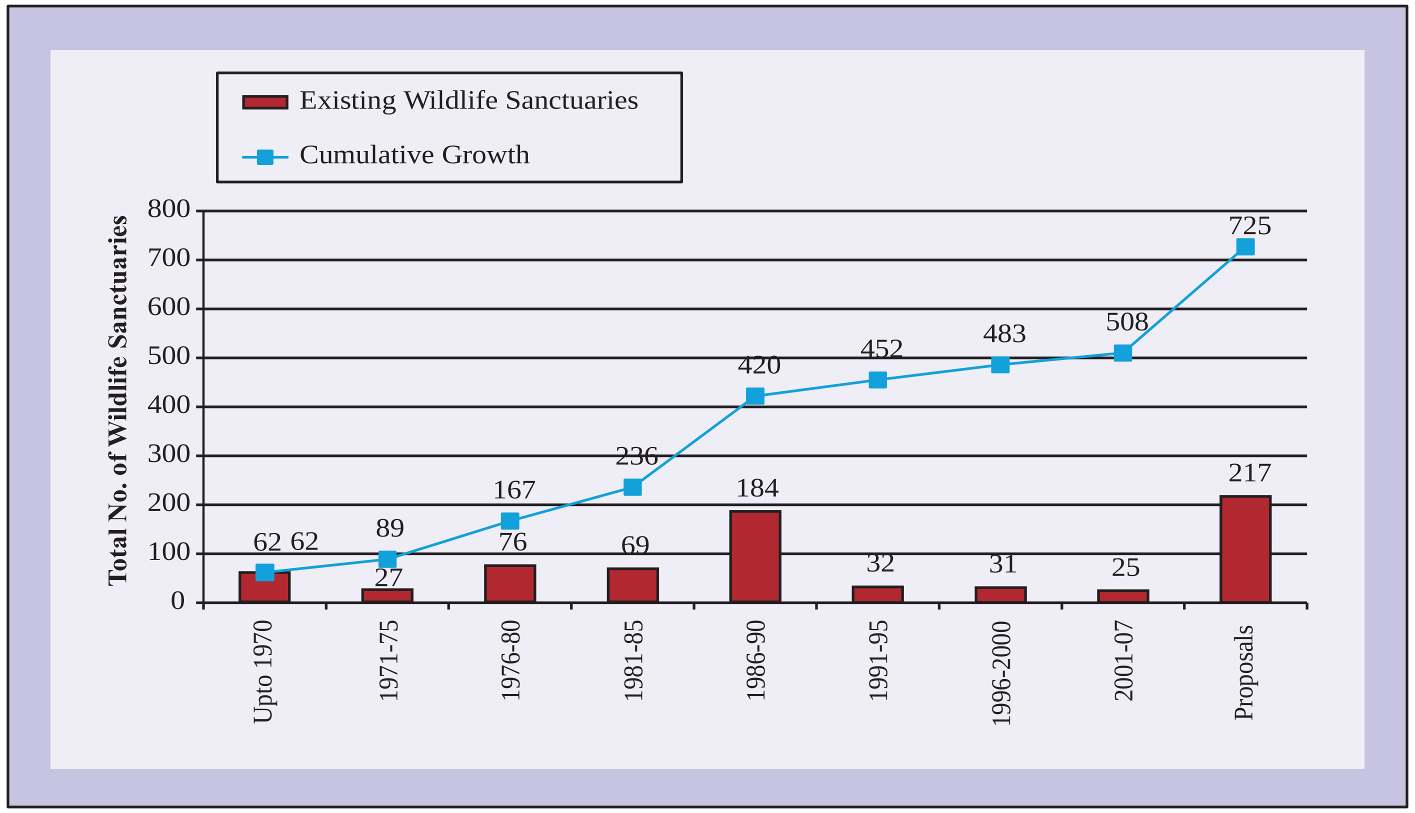
Source: Wildlife Institute of India, 2009

Figure 2.4.5 : Growth of National Parks in India



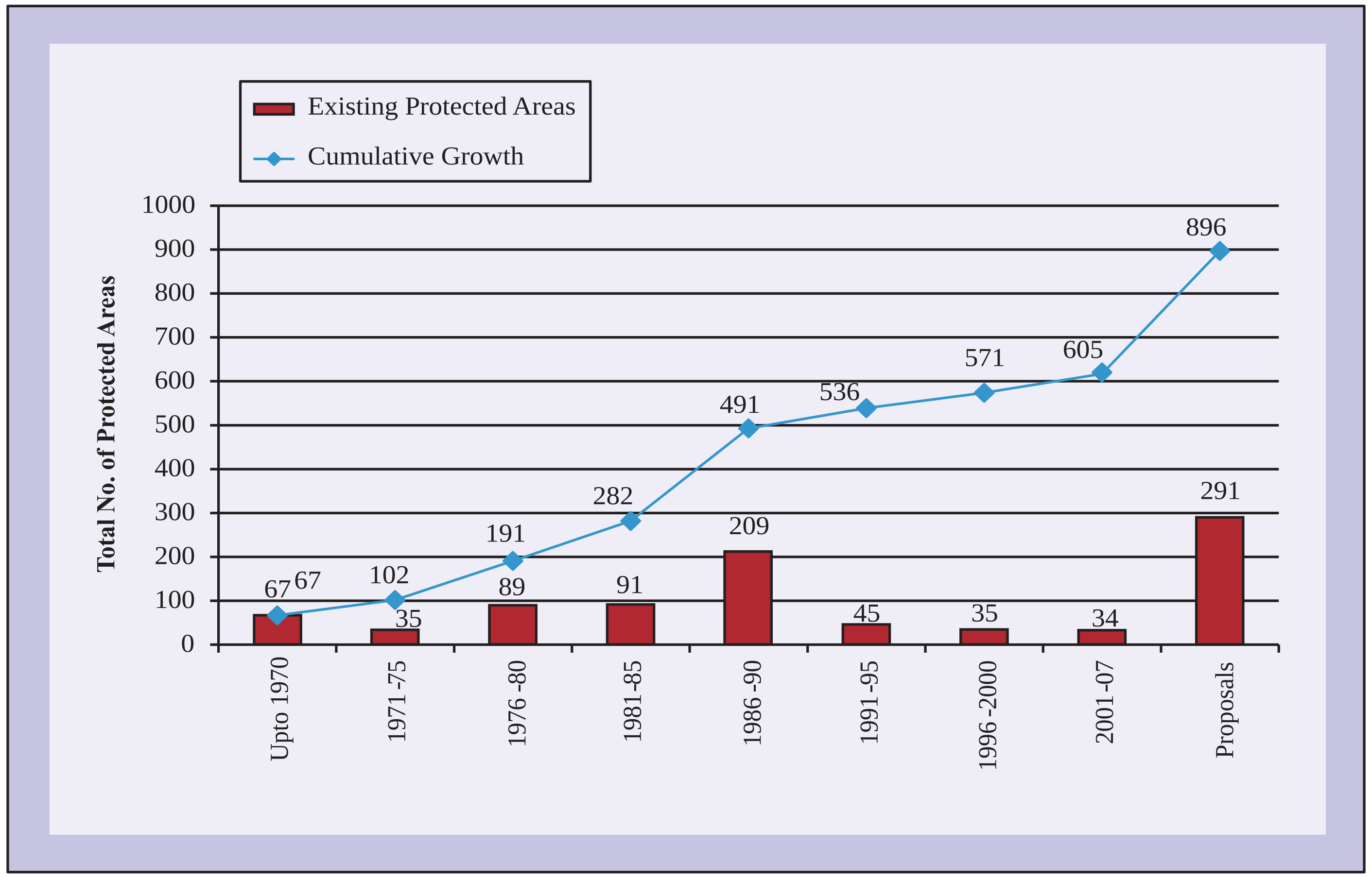
Source: Wildlife Institute of India,2009

Figure 2.4.6 : Growth of Wildlife Sanctuaries in India



Source: Wildlife Institute of India,2009

Figure 2.4.7: Growth of Protected Areas in India



Source: Wildlife Institute of India,2009

Malayan Giant Squirrel

National Wetland Conservation and Management Programme (NWCMP)

Recognizing the importance of protecting wetlands, the Government of India operationalized a wetland conservation programme in 1985-86 in close collaboration with the concerned State Governments. Several steps were taken to arrest further degradation and shrinkages of water bodies due to encroachments, siltation, weed infestation, catchment erosion, surface runoff carrying pesticides and fertilizers from agriculture fields, and discharge of domestic sewage and effluents, which resulted in deterioration of water quality, prolific weed growth, decline in biodiversity and other associated problems.

There are a total of 104 identified wetlands under the National Wetland Conservation & Management Programme (NWCMP). These wetlands are eligible for financial assistance on a 100 per cent grant basis from the concerned State Governments for undertaking activities like survey and demarcation, weed control, catchment area treatment, de-siltation, conservation of biodiversity, pollution abatement, livelihood support, creation of minor infrastructure, educational awareness, capacity building of various stakeholders and community development. So far, 24 states have been covered.

POLICY SUGGESTIONS

Wetland Conservation

For wetland conservation, a holistic view is necessary, which looks at each identified wetland in terms of its causal linkages with other natural entities, human needs, and its own attributes.

The following actions could be considered:

a) Set up a legally enforceable regulatory mechanism for identified valuable wetlands, to prevent their degradation and enhance their conservation. Develop a national inventory of such wetlands.

b) Formulate conservation and prudent use strategies for each significant catalogued wetland, with participation from local communities, and other relevant stakeholders.

c) Formulate and implement eco-tourism strategies for identified wetlands through multi-stakeholder partnerships involving public agencies, local communities, and investors.

d) Take explicit account of impact on wetlands of significant development projects during the environmental appraisal of such projects; in particular, the reduction in the economic value of wetland environmental services should be explicitly factored into the cost-benefit analyses.

e) Consider unique wetlands as entities with 'incomparable values', in developing strategies for their protection.

f) Integrate wetland conservation, including conservation of village ponds and tanks, into sectoral development plans for poverty alleviation and livelihood improvement, and link efforts for conservation and sustainable use of wetlands with the ongoing rural infrastructure development and employment generation programmes. Promote traditional techniques and practices for conserving village ponds.

ECO -TECHNOLOGY SOLUTIONS

Technological processes often lead to higher withdrawals and consumption of natural resources and higher addition of pollutants than what ecological limits permit. These contribute to underdevelopment through destruction of ecosystems.

The need for eco-technological solutions has been felt for sometime and a few sporadic and scattered innovations and efforts are being made silently in the areas of agriculture, mining and fishing for mitigating the adverse impacts. The successful adoption of alternative eco-technologies depend upon their integration into the existing livelihood systems. Stakeholders are both the experimenters and potential beneficiaries of alternative systems. Much of the biological diversity is in the custody of farmers who follow age-old farming and land-use practices and thereby are excellent conservators of biodiversity. However, due to the increasing demand for food, fodder and other natural resources there is a need to develop eco-technologies as they are the blend of traditional knowledge and modern technology.

The Patents Act, 1970 addresses several aspects of the issue of disclosure. The Act mandatorily requires disclosure of source and geographical origin of biological material used in an invention while applying for patents. Failure to disclose or wrongful disclosure are considered as grounds for opposition to the grant of patent and the patent may be revoked. The Act also requires the applicant to furnish a declaration with regard to having obtained the necessary permission of the competent authority to use the biological material from India. There is a need to harmonize these provisions with the Biodiversity Conservation Act, in particular to enable local communities, holding the traditional knowledge for use of such biological material, to benefit from providing access to such knowledge.

There is a need to formulate an appropriate system for Prior Informed Consent and Fair and Equitable Benefit sharing in respect of biological material and traditional knowledge to enable both the country and the local communities to derive economic benefits by providing access. These issues are complex and therefore, modalities for their implementation need to be carefully worked out. Finally, efforts should be made to attain greater congruence between these issues and trade related aspects of Intellectual Property Rights.

Box 2.4.3: New Technology for Mining

The process of open-cast mining scars the landscape, disrupts ecosystems and destroys microbial communities. Over the long term, open-cast mining reduces forest productivity, damages aquatic and atmospheric ecosystems and sometimes leads to substantial alterations in microclimates. Such changes, in turn, have adverse economic and social impacts on nearby communities whose residents majorly depend on the region's natural resources for their livelihoods.

The National Environmental Engineering Research Institute (NEERI) has developed a sustainable eco-friendly technology that reclaims and rejuvenates the 'soil spoils' left behind by open-cast mining. The strategy, which experts have labeled as the Integrated Biotechnological Approach (IBA), involves the use of diverse organic materials (for example, such industrial wastes as press-mud, a by-product of sugar mills, and treated sludge, a by-product of paper mills) to build soil productivity. These organic materials, which nourish the depleted soil, are supplemented by the planting of saplings that contain specialized cultures of endomycorrhizal fungi and such nitrogen-fixing bacteria such as Rhizobium and Azotobacter. IBA has increased the survival rate of plant species found on land that is scarred by open-cast mining to more than 80 per cent. At the same time, it has boosted the species growth rate by a factor of five. Barren, eroded slopes have been transformed into lush-green tree-lined landscapes. Equally importantly, the areas' biodiversity is slowly being regenerated. In fact, IBA forests ultimately produce commodities of high value, including timber, fruit and gum. In addition to these long-term environmental benefits, over the short term, the strategy generates jobs and income.

Box 2.4.4: Traditional Ethos

In spite of modernization, traditional ecological ethos continue to survive in many local communities in India. Investigations into the traditional resource use norms and associated cultural institutions prevailing in rural Bengal society (*Deb and Malhotra, 2001*) demonstrate that a large number of elements of local biodiversity, regardless of their use value, are protected by the local cultural practices. Some of these may not have known the conservation effect, yet may symbolically reflect a collective appreciation of the intrinsic or existence value of life forms, and respect for nature. Traditional conservation ethics are still capable of protecting much of the country's decimating biodiversity, as long as the local communities have a stake in the management of natural resources.

One example from North East India is particularly notable (*Tiwari et al. 1998*). The tribal communities of Meghalaya - Khasis, Garos, and Jaintias - have a tradition of environmental conservation based on various religious beliefs. As elsewhere in India, particular patches of forests are designated as sacred groves under customary law and are protected from any product extraction by the community. Such forests are very rich in biological diversity and harbour many endangered plant species, including rare herbs and medicinal plants.

Traditional water-harvesting structures too are also a habitat for a variety of species. Even if the pond size is small, as is the case with about 60 per cent of the 1.5 million total tanks in India (*Pandey, 2001*), it may still be a useful habitat for many species in rural ecosystems. Indeed, the island biogeography theory – valid in numerous cases - suggesting that larger areas support more species did not stand in the case of the 80 ponds studied in Switzerland (*Oertli et al., 2002*).

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Gujarat Wetland

CHAPTER - 3

KEY ENVIRONMENTAL ISSUES

CLIMATE CHANGE

Ever since the industrial revolution began about 150 years ago, human activities have added significant quantities of GHGs to the atmosphere. An increase in the levels of GHGs could lead to greater warming which, in turn, could have major impact on the world's climate, leading to accelerated climate change.

Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased from 280 ppm to 379 ppm, 715 ppb to 1774 ppb and 270 ppb to 319 ppb respectively, between pre-industrial period and 2005 (*IPCC,2007*).

Eleven of the last twelve years rank among the 12 warmest years in the instrumental record of global surface temperatures since 1850. The updated 100-year linear for 1906-2005 is 0.74^{0}C. Globally, average sea level rose at an average rate of 1.8 mm per year over 1961 to 2003. The rate was higher over 1993 to 2003, about 3.1 mm per year (*IPCC, 2007*). The projected sea level rise by the end of this century is likely to be 0.18 to 0.59 metres.

In its 2007 Report, the Intergovernmental Panel on Climate Change (IPCC) predicts global temperatures will rise by 2-4.5^{0}C by the end of this century and for the next two decades a warming of about 0.2^{0}C per decade is projected. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1^{0}C per decade would be expected.

This unprecedented increase is expected to have severe impact on global hydrological systems, ecosystems, sea level, crop production and related processes. The impact would be particularly severe in the tropical areas, which mainly consist of developing countries, including India.

CLIMATE CHANGE SCENARIO IN INDIA

India is a large developing country with nearly 700 million rural population directly depended on climate sensitive sectors (agriculture, forests and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Further, the adaptive capacity of dry land farmers, forest dwellers, fisher folk and nomadic shepherds is very low. Climate change is likely to impact all the natural ecosystems as well as socio-economic systems as per the National Communications Report of India to the UNFCCC.

The Intergovernmental Panel on Climate Change, in its 2007 report, predicts that global temperatures will rise by 2-4.5^0 C by the end of this century, with a 2.7-4.3^{0}C increase over India by the 2080s. The panel also predicted an increase in rainfall over the Indian sub-continent by 6-8 per cent and that the sea level would rise by 88 centimetres by 2100.

The latest high resolution climate change scenarios and projections for India, based on Regional Climate Modelling (RCM) system, known as PRECIS developed by Hadley Center and applied for India using IPCC scenarios A2 and B2 depicts the following:

- An annual mean surface temperature rise by the end of this century, ranging from 3°C to 5°C (under A2 scenario) and 2.5°C to 4°C (under B2 scenario), with the warming more pronounced in the northern parts of India.
- A 20 per cent rise in all India summer monsoon rainfall and a further rise in rainfall is projected over all states except Punjab, Rajasthan and Tamil Nadu, which show a slight decrease.
- Extreme rise in maximum and minimum temperatures is also expected and similarly extreme precipitation is also projected, particularly over the West Coast of India and West Central India.

Box 3.1.1: IPCC Special Report on Emission Scenarios (SRES)

A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil-intensive (A1FI), non-fossil energy sources (A1T) or a balance across all sources (A1B) (where 'balanced' is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and the per capita economic growth and technological change are more fragmented and slower than other storylines.

B1. The B1 storyline and scenario family describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

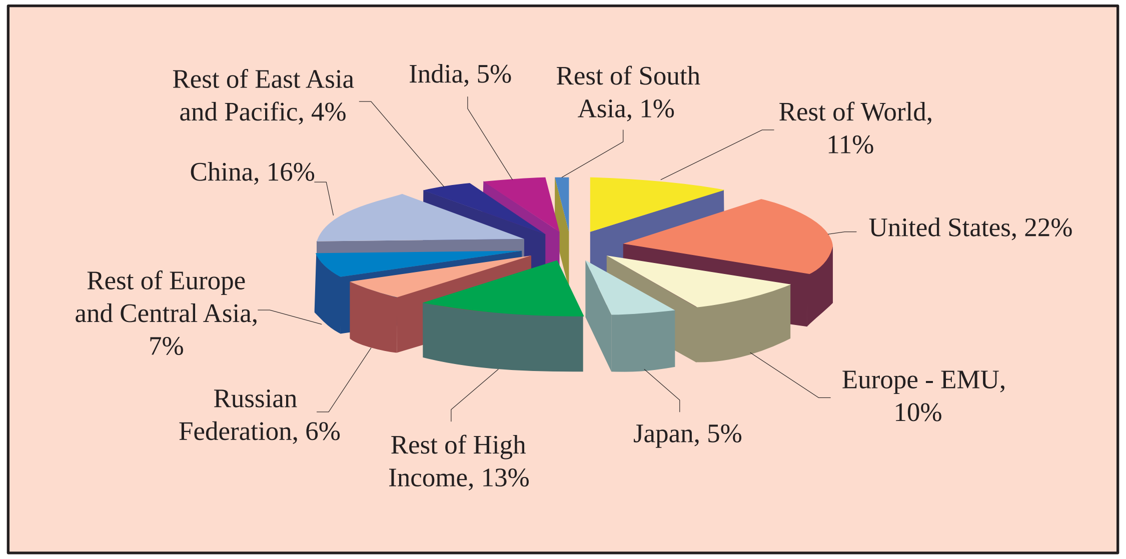
B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological changes than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

Source: Intergovernmental Panel on Climate Change, 2007

India's Contribution to global GHG Emissions

In recent years, development planning in India has increasingly incorporated measurable goals for enhancement of human wellbeing, beyond mere expansion of production of goods and services and the consequent growth of per capita income. India has many future developmental targets, several of which are directly or indirectly linked to energy consumption and therefore to GHG emissions.

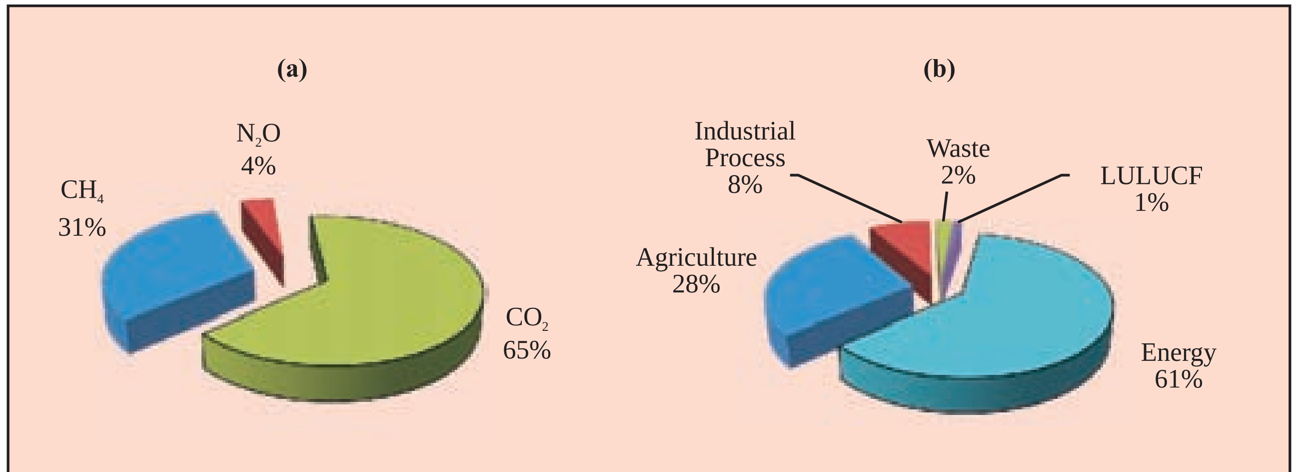
Figure 3.1.1: India's Share in Global CO_2 Emissions



Source: World Development Indicators, 2007

The contribution of India to the cumulative global CO_2 emissions is only 5 per cent (Figure 3.1.1). Thus historically, and at present, India's share in the carbon stock in the atmosphere is relatively very small in terms of per capita emissions. India's per capita carbon emissions average one-twentieth of those of the US and one-tenth of most countries in Western Europe and Japan. Sectoral distribution shows that the highest CO_2 equivalent emission contribution is from the energy sector (61 per cent) (Figure 3.1.2).

Figure 3.1.2 : Distribution of GHG Emissions from India



(a) Gas by Gas Emission Distribution (b) Sectoral Distribution of CO_2 Equivalent Emissions

Source: India's Initial National Communication to UNFCCC, 2004

STATE-WISE IMPACTS OF CLIMATE CHANGE

Climate changes characterized as global warming are leading to large-scale irreversible effects at continental and global scales. The likelihood, magnitude, and timing is observed to be increasing and accelerating. Many projected consequences of global warming once thought controversial, are now being observed.

The IPCC reports that the effects of global warming will be mixed across regions. For smaller values of warming (1 to 3°C), changes are expected to produce net benefits in some regions and for some activities, and net costs for others. Greater warming may produce net costs in all regions. Developing countries are vulnerable to reduced economic growth as a result of global warming.

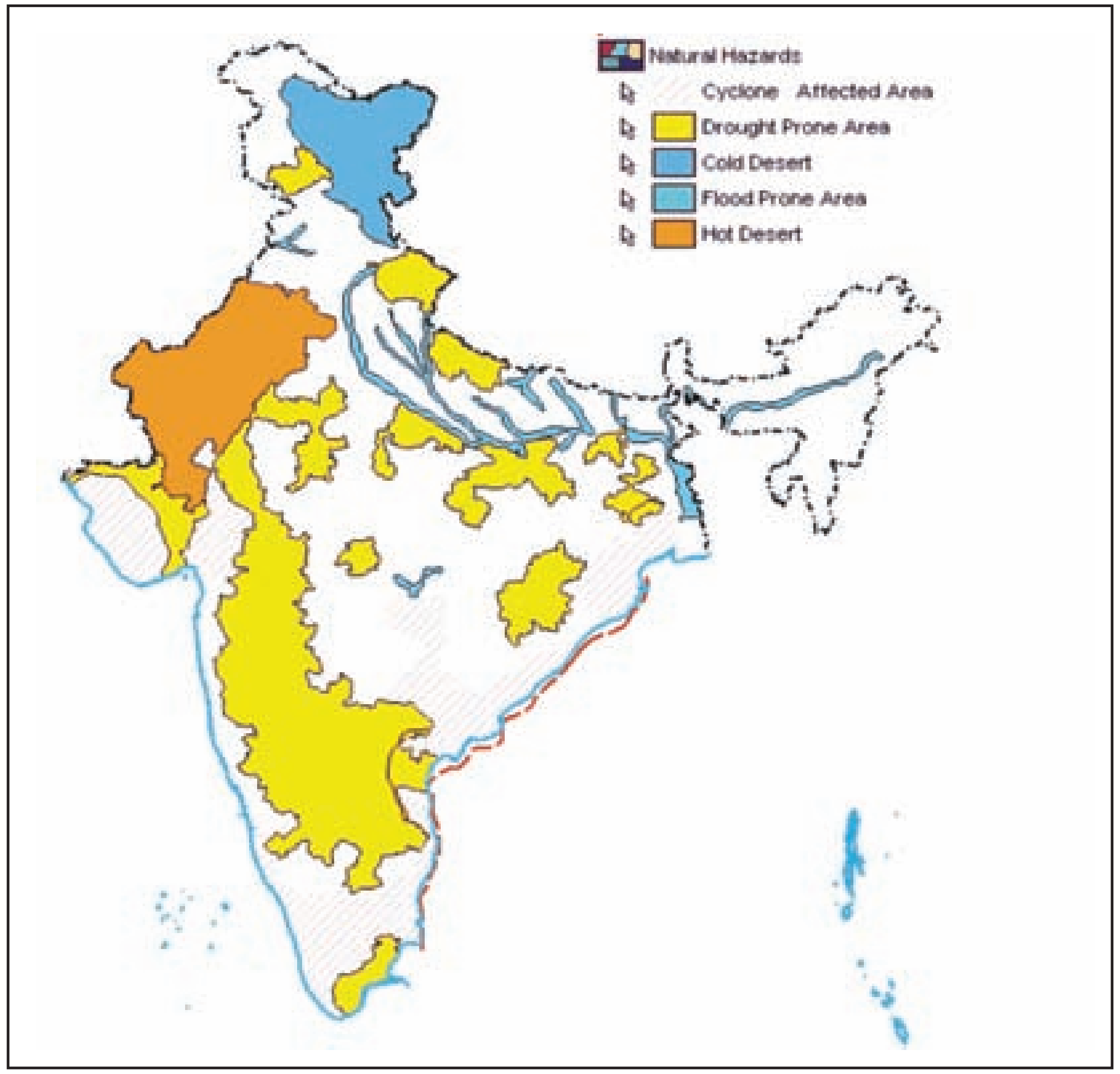
PHYSICAL IMPACT

Most of the consequences of global warming would result from physical changes like sea level rise, higher local temperatures, and changes in rainfall patterns, but synergistic effects such as the release of methane hydrates or clathrates and forests and species die-off may cause many unforeseen impacts such as a decrease in the levels of oxygen in the Earth's atmosphere. Most scientists believe that the warming of the climate will lead to more extreme weather patterns such as:

- **Heat Spells:** Extreme temperatures and heat spells have already become common over Northern India, often causing human fatalities. In 1998 alone, 650 deaths occurred in Orissa due to heat waves.
- **Storms/Cyclones**: India's 7,517 km coastline will be particularly hard-hit by storm surges and sea-level rise displacing millions, flooding low-lying areas, and damaging economic assets and infrastructure. The super-cyclone of 1999 wreaked havoc in Orissa, knocking decades off its development and claiming more than 30,000 human lives (Figure 3.1.3).

Loss of littoral rain forest in Great Nicobar Biosphere Reserve after Tsunami

Figure 3.1.3: Natural Hazards Affected Areas of India



Source: State of Environment Atlas of India, 2007, MoEF

Box 3.1.2: Cyclonic Events

The Spatial Pattern of Cyclone Incidences and the Facts (data from 1877 to 1990)

- 1,474 cyclones originated in the Bay of Bengal and the Arabian Sea during this period.
- 964 cyclones crossed the Indian coastline.
- Three districts of West Bengal (174 events).
- Seven districts of Orissa (422 events).
- Nine districts of Andhra Pradesh (203 events).
- 15 districts of Tamil Nadu (100 events)

The Temporal Pattern of Cyclone Incidences

- Depressions have a distinct peak in the month of August.
- Storms have two distinct peaks in June and October.
- Seven storms have distinct peaks in May and November
- The total number of tropical cyclones seasonally follow the path of the depression.

Average Based on Facts:

- 8.45 cyclones cross the Indian coastline per year.
- 5.15 depressions cross the Indian coastline on an average per year.
- 1.93 storms occur on an average per year.
- 1.35 severe storms occur on an average per year.

Source: India's Initial National Communication to UNFCCC, 2004

- **Rainfall:** Climate change has had an effect on the monsoons too. India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity. Subtle changes have already been noted in the monsoon rain patterns by scientists at IIT, Delhi. They also warn that by the 2050s, India will experience a decline in its summer rainfall, which accounts for almost 70 per cent of the total annual rainfall and is crucial to agriculture.

- **Melting of glaciers causing sea level rise & flooding:** According to International Centre for Integrated Mountain Development (ICIMOD), Himalayan glaciers could disappear within 50 years because of climate change, with far-reaching implications for more than a billion people in India. The Earth's temperature has increased by an average of 0.74^0C over the past 100 years. It is believed that global warming has pushed up the temperature of the Himalayas by up to 0.6^0C in the past 30 years.

Ice melt's share in sea level rise is increasing, and will accelerate if the larger ice sheets crumble. As mountain glaciers shrink, large regions that rely on glacial runoff for water supply could experience severe shortages. In northern India, a region already facing severe water scarcity, an estimated 500 million people depend on the tributaries of the glacier-fed Indus and Ganga rivers for irrigation and drinking water. But, as the Himalayas melt, these rivers are expected to initially swell and then fall to dangerously low levels, particularly in summers. (In 1999, the Indus reached record high levels because of glacial melt.) Some of the glaciers in the Himalayas are receding at an average rate of 10 to 15 metres per year. As glaciers melt, many glaciers form lakes at their end which are held together only by frozen mud dams. The dams can break and cause flash floods of water, rocks and gravel, destroying villages and fields downstream imitating the phenomenon termed as Glacial Lake Outburst Flood (GLOF).

As glaciers retreat, water flows are expected to be affected during the dry season, leading to freshwater scarcity in the summer months when melt waters contribute up to 75 per cent of the river water. The region's agriculture and power generation are partially dependent on this water supply. In the Ganga, one of the two biggest rivers in India, the loss of glacier melt water is expected to impact downstream water flows, causing water stress for several million people and also affect the irrigated land in the Ganga basin.

In Indian Himalaya Region (IHR), Gangotri glacier, the largest ice mass in the Ganga basin, is receding and shrinking at an unsustainable rate. The Gangotri glacier system has a number of glacial lakes. These lakes are formed by displacement of transverse and longitudinal crevasses, rapid melting of glacial ice and high precipitation and seismicity. G.B. Pant Institute of Himalayan Environment and Development (GBPIHED) has been carrying out research on glacial hydrology and glacio-fluvial aspect of the glacier since 1999. The study found that in the ablation period, the rising limb of hydrographs exhibited an abrupt increase to peak flow, arresting the GLOF dealings in the glacier. On 6th June 2000, large amount of sediment was transported from the glacier due to heavy rains and deposited as a huge bulk of debris in the valley near Bhujbas (four kilometres downstream of the glacier snout). This debris deposit blocked the Bhagirathi river to form a short-lived extensive lake. Bursting of this lake caused flash floods in the entire area sweeping a temple located on the riverbank and damaging the buildings at Bhujbas, including a pre-fabricated hut and base camp located there. The water level of the river was elevated by about 3m. Similar devastating events were observed at Gangotri town (located 18 km downstream of the snout of Gangotri glacier) where minor damages occurred to the Gangotri temple and three lodges. The bursting of such lakes could also spell disaster for the people living downstream.

SOCIO - ECONOMIC IMPACT

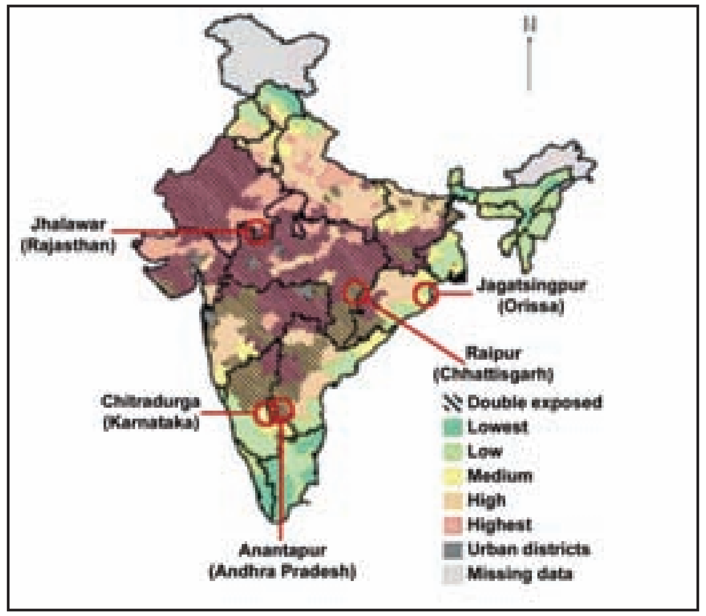
Agriculture

Food grain production in India has increased from 50 million tonnes in 1951 to 212 million tonnes in 2002, while mean cereal productivity has increased from 500 kg/hectare to almost 1,800 kg/hectare. Despite the progress, food production in India is still considerably dependent on the rainfall quantity and its distribution, which is highly variable, both spatially and temporally. In the past fifty years, there have been around 15 major droughts, due to which the productivity of rain-fed crops in drought years was adversely affected. Limited options of alternative livelihoods and widespread poverty continue to threaten livelihood security of millions of small and marginal farmers in the rain-fed agriculture region. Food security of India may be at risk in the future due to the threat of climate change leading to an increase in the frequency and intensity of droughts and floods, thereby affecting production of small and marginal farms. Simulations using dynamic crop models, having the flexibility to independently assess the impacts of temperature rise and CO_2 increase on crop production, indicate a decrease in yield of crops as temperature increases in different parts of India. These reductions were, however, generally offset by the increase in CO_2. The magnitude of this response varied with the crop, region, and the nature of climate change (*pessimistic* or *optimistic*, where *pessimistic* scenario refers to high increase in temperature and low increase in CO_2, while *optimistic* scenario refers to a large increase in CO_2 and a low rise in temperature). Irrigated rice yields may have a small gain, irrespective of the scenario throughout India. Wheat yields in central India are likely to suffer a drop in the crop yield upto two per cent in a pessimistic scenario, but there is also a possibility that yields may increase by six per cent if the global change is optimistic. Sorghum, being a C4 plant, does not show any significant response to increase in CO_2 and hence these scenarios are unlikely to affect its yield. However, if the temperature increases are higher, western India may show some negative impact on productivity due to reduced crop durations (Figure 3.1.4).

Forests

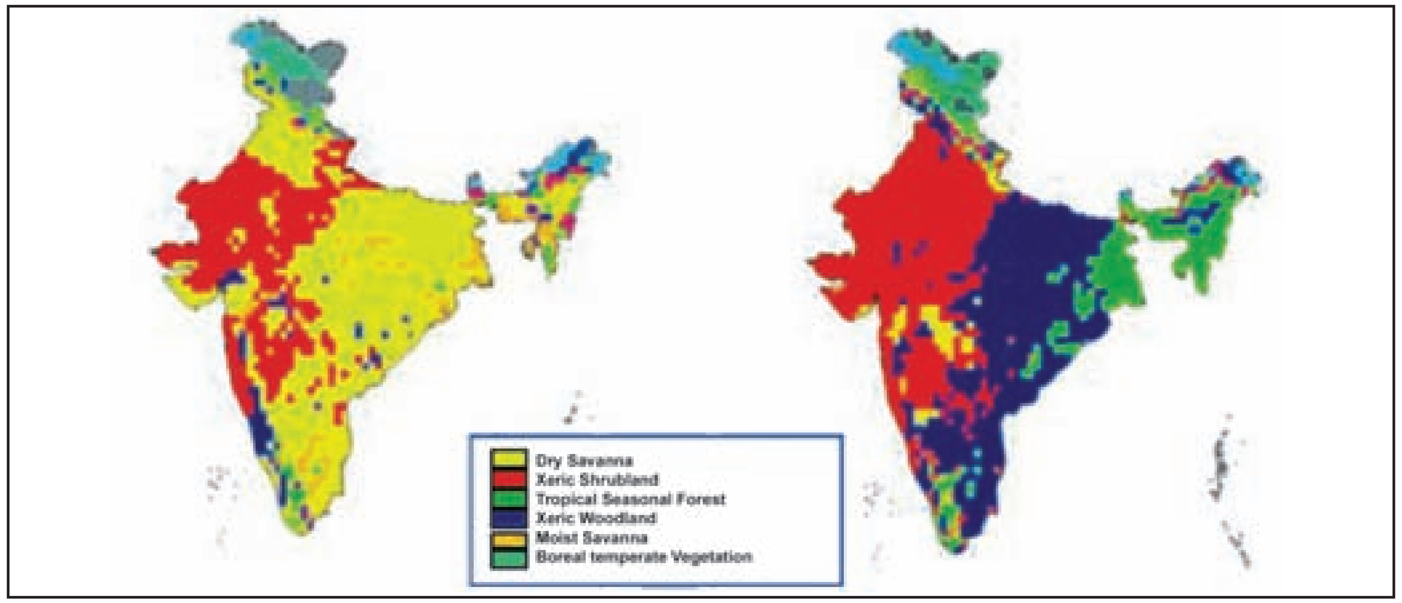
Preliminary assessments, using BIOME-3 vegetation response model, based on regional climate model projections (HadRM2) for India, show shifts in forest boundary, changes in species-assemblage or forest types, changes in net primary productivity, possible forest die-back in the transient phase, and potential loss or change in biodiversity (Figure 3.1.5). Enhanced levels of CO_2 are projected to result in an increase in the net primary productivity (NPP) of forest ecosystems over more than 75 per cent of the forest area. Even in a relatively short span of about 50 years, most of the forest biomes in India seem to be highly vulnerable to the projected change in climate. About 70 per cent of the vegetation in India is likely to find itself less than optimally adapted to its existing location, making it more vulnerable to the adverse climatic conditions as well as to the increased biotic stresses. Biodiversity is also likely to be adversely impacted. These impacts on forests will have adverse socio-economic implications for forest dependent communities and the national economy. The impacts of climate change on forest ecosystems are likely to be long-term and irreversible. Thus, there is a need for developing and implementing adaptation strategies to minimize the possible adverse impacts. Further, there is a need to study and identify the forest policies, programmes and silvicultural practices that contribute to the vulnerability of forest ecosystems to climate change.

Figure 3.1.4 : Vulnerability of Indian Agriculture to Climate Change and Globalization



Source: The Energy and Resources Institute, 2003-04

Figure 3.1.5 : Vegetation Map for the Year 2050 (Right) under GHG Run of Hard RM2 Considering all Grids of Indian and Potential Vegetation (including grids without forests) The Control Run (without GHG increase) is shown on the left

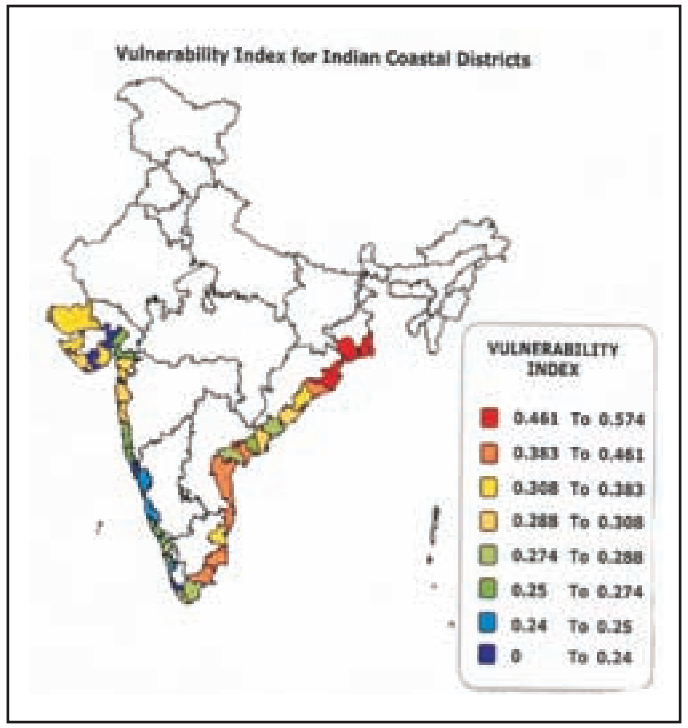


Source: India's Initial National Communication to UNFCCC, 2004

Desertification

Globally, about 1,900 Mha. of land is affected by land degradation. Climate change, leading to warming and water stress could further exacerbate land degradation, leading to desertification. It is important to note that the climate sensitive sectors (forests, agriculture, coastal zones) and the natural resources (groundwater, soil, biodiversity, etc.) are already under major stress due to socio-economic pressures. Climate change is likely to exacerbate the degradation of resources and socio-economic pressures. Thus India, with a large population dependent on climate sensitive sectors and low adaptive capacity will have to develop and implement adaptation strategies.

Figure 3.1.6 : Coastal Districts Vulnerable to Climate Change



Source: India's Initial National Communication to UNFCCC, 2004

Coastal Regions

Future climate change in the coastal zones is likely to be manifested through worsening of some of the existing coastal zone problems. Some of the main climate related concerns in the context of Indian coastal zones are erosion, flooding, submergence and deterioration of coastal ecosystems such as mangroves and salinization. In many cases, these problems are either caused by, or exacerbated by, sea level rise and tropical cyclones. The key climate related risks in the coastal zone include tropical cyclones, sea level rise and changes in temperature and precipitation. A rise in the sea level is likely to have significant implications on the coastal population and agricultural performance of India. A one metre rise in sea level is projected to displace approximately 7.1 million people in India and about 5,764 sq. km. of land area will be lost, along with 4,200 km of roads. The diverse impacts, expected as a result of sea level rise, include land loss and population displacement, increased flooding of low lying coastal areas and loss of yield and employment resulting from inundation and salinization. Damage to coastal infrastructure, aquaculture and coastal tourism, due to the erosion of sandy beaches, is also likely. The extent of vulnerability, however, depends not just on the physical exposure to sea level rise and the population affected, but also on the extent of economic activity of the areas and capacity to cope with impacts (Figure 3.1.6).

Global warming will lead to rise in sea level

Water Resources

Water resources will come under increasing pressure in the Indian subcontinent due to the changing climate. Presently, more than 45 per cent of the average annual rainfall, including snowfall in the country, is wasted as natural run-off to the sea. Rainwater harvesting schemes are now being implemented in the country to minimize this run-off loss based on present rainfall scenarios over the country, to increase groundwater levels. However, for the success of these schemes it is necessary that we focus on how climate change will affect the intensity, spatial and temporal variability of the rainfall, evaporation rates and temperature in different agro-climatic regions and river basins of India.

Climate projections developed for India for the 2050s, indicate an increase in the average temperature by 2-4°C during that period, an overall decrease in the number of rainy days by more than 15 days in western and central India and an increase by 5-10 days near the foothills of Himalaya and in North-East India. The projections also indicate an overall increase in the rainy day intensity by 1-4 mm/day except for small areas in northwest India where the rainfall intensities may decrease by 1 mm/day.

As many as 99 districts, spread over 14 states, were identified by the Central Water Commission (CWC) as drought prone in the country. Most of the drought prone areas so identified are concentrated in the states of Rajasthan, Karnataka, Andhra Pradesh, Maharashtra and Gujarat. Human factors that influence drought include incurred demand of water through population growth and agricultural practices, modification of land use that directly influences storage conditions and hydrological response of catchments and their vulnerability to drought. As pressures on water resources grow, so does the vulnerability to meteorological/hydrological/agricultural drought.

Table 3.1.1 : Comparison of Change in Water Balance Components as a Percentage of Rainfall

Basins	Scenario	Rainfall (mm)	Run-off (mm)	As a proportion of Rainfall (%)	Actual ET (mm)	As a proportion of Rainfall (%)
Cauvery	Control	1309.0	661.2	50.5	601.6	46.0
	GHG	1344.0	650.4	48.4	646.8	48.1
Brahmani	Control	1384.8	711.5	51.4	628.8	45.4
	GHG	1633.7	886.1	54.2	698.8	42.8
Godavari	Control	1292.8	622.8	48.2	624.1	48.3
	GHG	1368.6	691.5	50.5	628.3	45.9
Krishna	Control	1013.0	393.6	38.9	585.0	57.7
	GHG	954.4	346.9	36.4	575.6	60.3
Luni	Control	317.3	15.5	4.9	316.5	99.7
	GHG	195.3	6.6	3.4	207.3	106.1
Mahanadi	Control	1269.5	612.3	48.2	613.5	48.3
	GHG	1505.3	784.0	52.1	674.1	44.8
Mahi	Control	655.1	133.9	20.4	501.0	76.5
	GHG	539.3	100.0	18.5	422.7	78.4
Narmada	Control	973.5	353.4	36.3	586.8	60.3
	GHG	949.8	359.4	37.8	556.6	58.6
Pennar	Control	723.2	148.6	20.6	556.7	77.0
	GHG	676.2	110.2	16.3	551.7	81.6
Tapi	Control	928.6	311.2	33.5	587.9	63.3
	GHG	884.2	324.9	36.7	529.3	59.9
Ganga	Control	1126.9	495.4	44.0	535.0	47.5
	GHG	1249.6	554.6	44.4	587.2	47.0
Sabarmati	Control	499.4	57.0	11.4	433.1	86.7
	GHG	303.0	16.6	5.5	286.0	94.4

Source: India's Initial National Communication to UNFCCC, 2004

From the above table, one can observe that the impacts are different in different catchments (Table 3.1.1). The increase in rainfall due to climate change does not result in an increase in the surface run-off as may be generally predicted. For example, in the case of the Cauvery river basin, an increase of 2.7 per cent has been projected in the rainfall, but the run-off is projected to reduce by about 2 per cent and the evapo-transpiration to increase by about 2 per cent. This may be either due to increase in temperature and/or change in rainfall distribution in time. Similarly, a reduction in the rainfall in the Narmada is likely to result in an increase in the run-off and a reduction in the evapo-transpiration that is again contrary to the usual myth. This increase in run-off may be due to intense rainfall as a consequence of climate change. It is important to note that these inferences have become possible since a daily computational time step has been used in the distributed hydrological modeling framework. This realistically simulates the complex spatial and temporal variability inherent in the natural systems. It may be observed that even though an increase in precipitation is projected for the Mahanadi, Brahmani, Ganga, Godavari, and Cauvery basins for the Climate Change Scenario, the corresponding total run-off for all these basins has not necessarily increased. For example, the Cauvery and Ganga show a decrease in the total run-off. This may be due to an increase in evapo-transpiration on account of increased temperatures or variation in the distribution of rainfall. In the remaining basins, a decrease in precipitation is projected. The resultant total run-off for the majority of the cases, except for the

Narmada and Tapi, is projected to decline. As expected, the magnitude of such variations is not uniform, since they are governed by many factors such as land use, soil characteristics and the status of soil moisture. The Sabarmati and Luni basins are likely to experience a decrease in precipitation and a consequent decrease in the total run-off to the tune of two-thirds of the prevailing run-off. This may lead to severe drought conditions under a future Climate Change Scenario. The vulnerability of water resources has been assessed with respect to droughts and floods. Rainfall, run-off and actual evapo-transpiration have been selected from the available model outputs, since they mainly govern these two extreme impacts due to climate change.

Changing Ecosystem

Eco-systems will be particularly vulnerable to climate change, with a study estimating that between 15 and 40 per cent of species will face extinction, with 2^{o}C of warming. The impact of climate change would be particularly adverse on the forests, wetlands and coastal regions.

The precipitation decline and droughts in most delta regions of India have resulted in the drying up of wetlands and severe degradation of ecosystems. In some regions, the remaining natural flood plains are disappearing at an accelerating rate, primarily as a result of changes in land use and hydrological cycle, particularly changes in stream-flows due to climatic and human related factors.

According to IPCC, the most threatened flood plains will be those in South Asia. Evidence of the impacts of climate-related factors on mangroves remains limited to the severe destruction of mangroves due to reduction of freshwater flows and salt water intrusion in the Indus delta and Bangladesh (IUCN, 2003). In addition, around 30 per cent of Asia's coral reefs are likely to be lost in the next 30 years due to multiple stresses and climate change.

The higher impact will be on the Savannah biomes, Teak and Sal forests of Central and East India and the temperate biomes of the Himalayas. Moist and dry Savannahs are likely to be replaced by tropical dry forests and seasonal forests. By 2050, significant impact will be witnessed. The impact will be lower on the evergreen rain forests of the Western Ghats and the North-East. Composition of species and their dominance could also be altered, and large-scale forest depletion and loss of biodiversity are likely to mark the beginning of the bleak scenario.

Biodiversity

The impact of global warming on biodiversity has emerged as an active area in contemporary conservation biology research and it is extremely important for a country like India, where community dependence on forests is very high and climate change can have much worse impacts than expected or predicted on biodiversity of forest ecosystems (*Ravindranath et al., 2006*). In the Indian scenario, the two important measures of climate change which have direct and significant impact on the biodiversity are the variation in precipitation and temperature (*Sukumar, 2000*). The increase in precipitation can change the nature of the forest in terms of the floral species dominance, canopy cover, forest dynamics etc. It can rebuild the connections between fragmented ecosystems, support forest areas to encroach in to grasslands, alter tree species dominance and thereby change the forest class. Vice-versa, reduction in precipitation can support a shift towards deciduous category of forests, expansion of grass lands, lead to forest fragmentation and raise frequency of forest fires. All these can cause significant changes in faunal species distribution, demography and composition.

- There is a threat to species in the three distinct ecological zones that make up the **Sundarbans** - the largest contiguous mangrove area in the world. If the saline water front moves further inland, many species could be threatened. These changes could result in economic impacts. Direct employment supported by the Sundarbans is estimated to be in the range of 500,000-600,000 people for at least half of the year, and a large number of these people, who are directly employed in the industries that use raw materials from the Sundarbans (e.g. fishing, wood-cutting, collection of thatching materials, honey, beeswax, and shells) may lose their sources of income. Sea level rise also may threaten a wide range of mammals, birds, amphibians, reptiles and crustaceans.
- The predicted increase in precipitation in the forest areas in the Indian subcontinent is higher than that of the non-forest area (*Ravindranath et al., 2006*). Climate models predict 2-3.5^{0}C increase in temperature and 250-500 mm increase in precipitation in the North Eastern region (*Ravindranath et al., 2006; IPCC technical paper V*). Increase in rainfall may not have a significant impact on the forest areas of North East which are already experiencing high rainfall but any change in temperature regime may cause severe impact and significant changes (*Ravindranath and Sukumar, 1996*).

Human Health

Climate signals observed over India in the last 100 years show an increasing trend in surface temperature by 0.3°C, a change in the spatial pattern of rainfall and occurrence of more intense and frequent extreme temperature, rainfall and cyclone events. As a result, there is growing concern about the changing pattern over the years of some of the diseases that are directly influenced by the variable climate. Changes in the climate may affect vector-borne diseases in several ways, namely, their survival and reproduction rates, the intensity and temporal pattern of vector activity and the rates of development, survival and reproduction of pathogens within vectors.

Applying the same criteria as under the climate change conditions in the 2050s, it is projected that Malaria is likely to persist in Orissa, West Bengal and Southern parts of Assam, bordering North of West Bengal. However, it may shift from the central Indian region to the South Western coastal states of Maharashtra, Karnataka and Kerala. Also the Northern states,

Development of Pre-fab modular housing system using bamboo based composites

including Himachal Pradesh, may become Malaria prone in the future climate change regime. The duration of the transmission window is likely to widen in Northern and Western states and shorten in the Southern states.

RESPONSE / MEASURES

India has undertaken numerous response measures that are contributing to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC). India's development plans balance economic development and environmental concerns. The planning process is guided by the principles of sustainable development. Reforms in the energy and power sector have accelerated economic growth and enhanced the efficiency of energy use. These have been complemented by notable initiatives taken by the private sector.

In the last few years, several measures relating to environmental issues have been introduced. They have targeted a significant increase in the capacity of renewable energy installations, improving the air quality in major cities (the world's largest fleet of vehicles fuelled by compressed natural gas has been introduced in New Delhi) and enhancing afforestation. Other similar measures have been implemented by committing additional resources and realigning new investments, thus steering economic development onto a climate-friendly path.

SECTORAL INITIATIVES

1) Coal

Coal is, and will remain, the mainstay of commercial energy production in India in the near future. To ensure more efficient use of coal, the following measures have been taken:

- Rationalization of coal use
- Participation of private sector encouraged
- Reforms in pricing
- Technology upgradation involving coal-washing, improvements in combustion technology and the recovery of coal-bed methane

2) Oil

To promote fuel efficiency and conservation, the following measures have been undertaken:

- Reduction of gas-flaring
- Installation of waste heat recovery systems
- Energy audits
- Equipment upgradation
- Substitution of diesel with natural gas
- Establishment of PCRA (Petroleum Conservation Research Association) to increase awareness and develop fuel-efficient equipment.

3) Gas

This source of energy is the preferred substitute for coal and oil.

- In the residential sector, gas has replaced coal and kerosene
- CNG is being introduced as an alternative to petrol and diesel in the transport sector
- Major investments have been made in developing infrastructure for long distance and local distribution
- Import options are under consideration
- The share of gas in the power sector has increased from 2 to 8 per cent

4) Renewable Energy

India has an active programme to promote the use of renewable energy. Some salient features of the current renewables situation are given source-wise.

a) Hydropower

The government's policy objective is to exploit the huge potential in India's North-East. At present, about 25 per cent of the total installed capacity is accounted for by hydro. The total installed capacity of small hydropower projects is 1,423 MW.

b) Solar Energy

- Photovoltaic (PV) systems based on solar energy have been put to a variety of uses in rural electrification, railway signaling, microwave repeaters, power to border outposts and TV transmission and reception.
- Grid-connected PV power plants with an aggregate capacity of 1900 KWp (Kilowattpeak) have been set up for demand-side management or tail-end voltage support.
- A 140 MW Integrated Solar Combined Cycle (ISCC) plant is being set up, based on solar thermal technology and liquified natural gas.
- Solar lanterns, home and street-lighting systems, stand-alone power plants, and pumping systems are being promoted. So far, 9,20,000 SPV systems, with an aggregate capacity of 82 MWp (Megawattpeak), have been installed in the country.

c) Wind Energy

India is among the five leading nations in wind power generation

- The installed capacity is 1,507 MW, and generators of capacity 250-600 KW are manufactured here.
- Around 95 per cent of installed wind power capacity is in the private sector. State-of-the-art wind power systems are also being manufactured in the country. In fact, wind turbine equipment is also being exported to other developing and developed countries.

d) Biogas

- Biomass power generation plants of a total capacity of about 358 MW have been installed and gasification systems of a total capacity of 42.8 MW have been set up for decentralized energy application.
- In rural areas, over 3.2 million biogas plants and 33 million improved stoves have been installed.

e) Others

Projects with an aggregate capacity of about 15 MW have been completed using energy recovered from urban, municipal and industrial waste.

5) Energy Efficiency and Conservation

India is alive to the importance of improving the efficiency of energy usage and conservation measures. A Bureau of Energy Efficiency (BEE) has been set up to put into operation, conservation measures such as energy standards, labelling of equipment/appliances, building energy codes, and energy audits.

6) Transport

A major initiative has been the upgradation of vehicular emission norms. A norm called the 'Bharat 2000', similar to Euro-I norms was implemented throughout the country on 1 April, 2000 for all categories of vehicles manufactured in India.

Emission standards (Bharat Stage II) for motor cars and passenger vehicles came into force in the National Capital Region (NCR) on 1st April, 2000 and has been extended to Mumbai, Chennai and Kolkata. Apart from reducing pollution locally, these norms result in increased energy efficiency and therefore, reduced GHG emissions.

- Awareness and training programmes have been undertaken to educate drivers.
- The commercial manufacture of battery operated vehicles has begun in India. This will promote low/no carbon emitting vehicles.

In Delhi, large-scale switch has taken place from petrol and diesel to Compressed Natural Gas (CNG) with over 50,000 vehicles having already been converted.

7) Industry

This sector has made significant advances in the conservation of energy. Government policies, campaigns by associations of industry and strategic decisions by firms have all contributed to sizeable improvements in the intensity of energy use in industries.

- The major energy-consuming sectors are steel, cement, caustic soda, brick, aluminium and electric power generation. Measures to improve energy efficiency include:

  a. Promotion of fuel-efficient practices and equipment

  b. Replacement of old and inefficient boilers and other oil-operated equipment.

  c. Fuel switching and technology upgradation

- In the cement industry, specific energy intensities declined from 900 kcal/kg thermal energy to 800 kcal/kg and 120 KWh/tonne electrical energy to 90 KWh/tonne with a shift from low capacity energy inefficient wet plants to high capacity energy efficient dry process during the 1980s. New Indian plants are among those with the lowest power consumption internationally.
- In the fertilizer industry, the overall specific energy consumption and capacity utilization of ammonia plants have improved from 14.8 Gcal/mt and 63 per cent respectively, for the year 1979-80 to 10.9 Gcal/mt and 90 per cent respectively, during 1996-97.

8) Agriculture

Some efforts to mitigate climate change in the agricultural sector have also been undertaken.

- Standardization of fuel-efficient pump sets and rectification of existing pump sets.
- Rationalization of power tariffs.
- Better cultivation practices which will help in reducing N_2O emissions

9) Power sector

India has a diverse mix of power generation technologies with coal dominating, and a significant contribution by large hydro.

- Reforms in the power sector and targeted technology improvements have helped to enhance the combustion efficiency of conventional coal technology, leading to conservation of coal and savings in emissions.
- Power sector reforms include regulatory restructuring, corporatization, privatization and unbundling of state-owned utilities. The 1998 Regulatory Commissions Act empowers commissions to rationalize electricity tariffs and promote environmentally benign policies.
- Corporatization is altering state electricity boards from state ownership and administration to business-like corporations, as defined by the Indian Company Act, 1956.
- The Indian Electricity Act of 1910 and the Electricity Act of 1948 have been amended to permit private participation in the generation and distribution of power.
- Privatization in transmission has been encouraged by the recognition of exclusive transmission companies.

ADAPTATION TO CLIMATE CHANGE

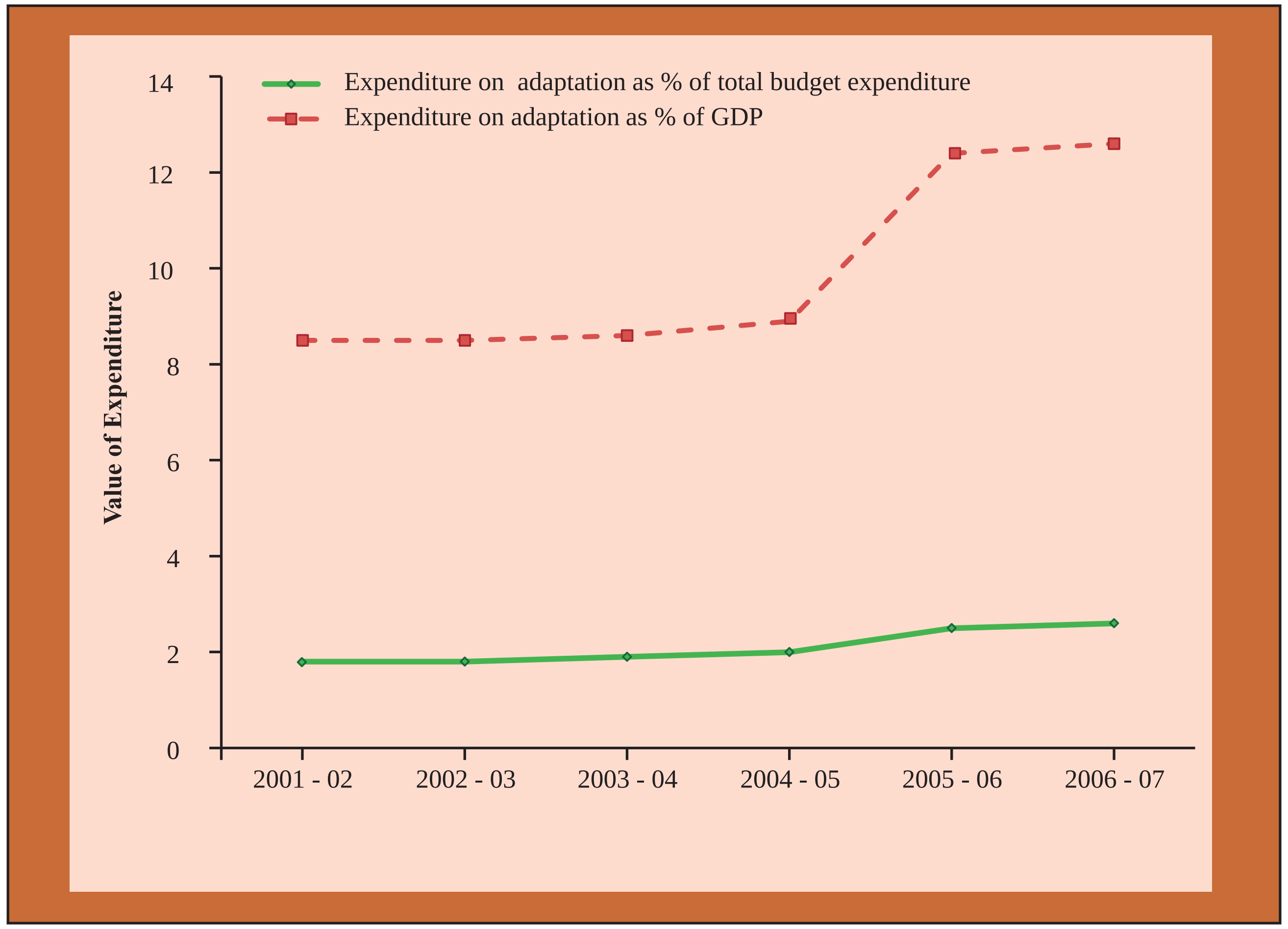
Adaptation will be necessary to address impacts resulting from warming which is already unavoidable due to past emissions. A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits and costs, but these are not fully understood.

Climate change will lead to an increase in extreme weather events causing floods, drought

Adaptation Expenditure

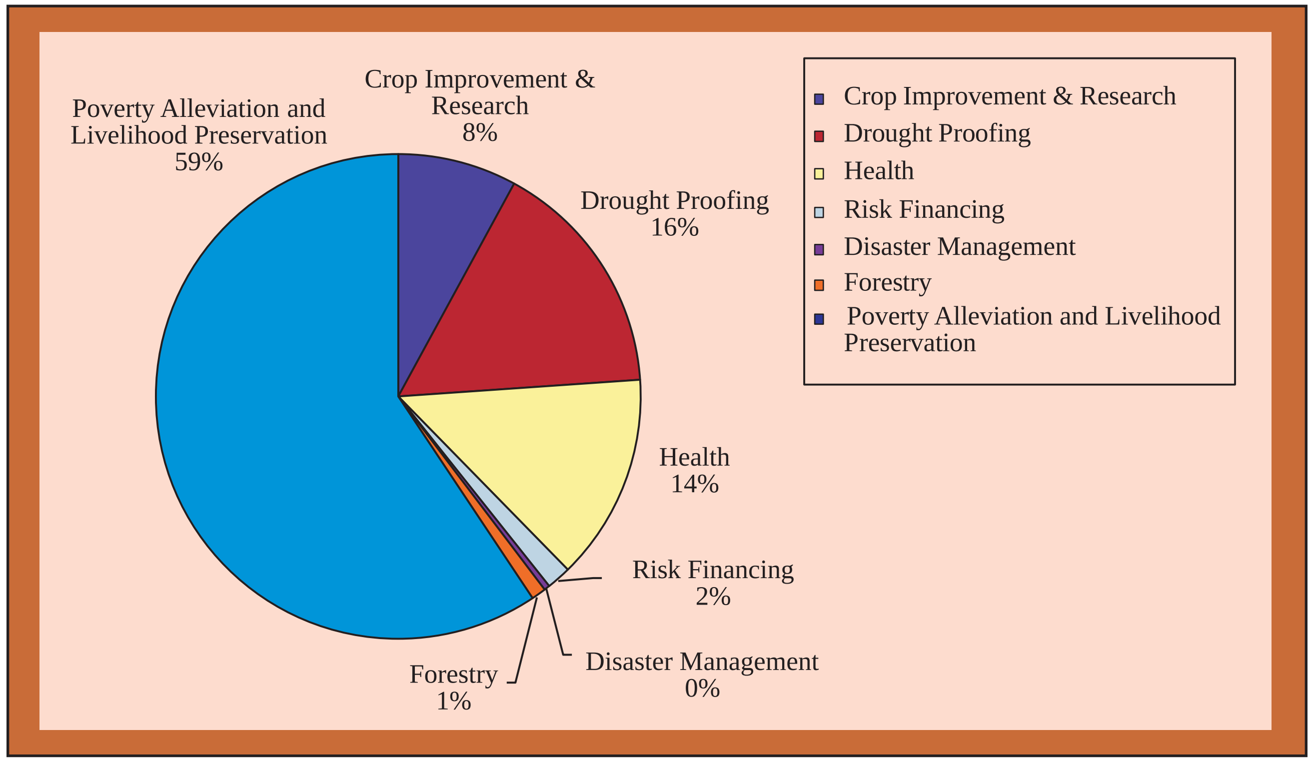
The adverse impacts of current climate already threaten the livelihoods of many Indians, especially the poorest. Current government expenditure on adaptation to climate variability, as shown in the Figure 3.1.7, already exceeds two per cent of the GDP, with agriculture, water resources, health and sanitation, forests, coastal zone infrastructure and extreme weather events, being specific areas of concern (Figure 3.1.8).

Figure 3.1.7: Expenditure on Adaptation Programmes in India



Source: National Action Plan on Climate Change, 2008, India

Figure 3.1.8: Relative Expenditures on Major Adaptation Schemes by Thematic Area



Source: National Action Plan on Climate Change, 2008, India

Major Components of Adaptation

The broad areas where adaptation programmes have been developed include:

- ***Crop improvement and research:*** It includes technical issues such as development of arid-land crops and pest management, as well as capacity building of extension workers and NGOs to support better and vulnerability reducing practices.
- ***Drought proofing and flood control***: It includes measures to minimize the adverse effects of drought on production of crops and livestock, and on productivity of land, water and human resources, so as to ultimately lead to drought proofing of the affected areas. This also includes the overall development and improvement in the socio-economic conditions of the resource poor and disadvantaged sections inhabiting the affected areas.
- ***Health improvement and prevention of diseases:*** The prime objective of this is surveillance and control of vector born diseases such as Malaria, Kala-azar, Japanese Encephalitis, Filaria and Dengue, and to provide emergency medical relief in the case of natural calamities and train and develop human resources for these tasks.
- ***Risk-financing:*** It includes risk-financing to support adaptation to climate impacts. The crop insurance scheme supports the insurance of farmers against climate risks, and the Credit Support Mechanism facilitates the extension of credit to farmers, especially in instances such as crop failure due to climate variability.
- ***Disaster Management:*** The National Disaster Management Programme provides grants-in-aid to victims of disasters, and manages disaster relief operations. It also supports pro-active disaster prevention programmes, including dissemination of information and training of disaster management staff.
- ***Poverty alleviation and livelihood preservation:*** It includes support for income diversification, as well as minimum employment guarantees in order to enable sustainability of livelihoods, including help in response to loss of livelihood due to the adverse impact of climate.

Key Constraints to Adaptation Measures

Effective adaptation and adaptive capacity in Asia, particularly in South Asia, will continue to be limited by several ecological, socio-economic, technical and political constraints, spatial and temporal uncertainties associated with forecasts of regional climate, low levels of awareness amongst decision-makers, limited national capacities in climate monitoring and forecasting and the lack of coordination in the formulation of responses.

Impacts of climate change may occur beyond certain thresholds in the ability of some ecosystems to adapt without dramatic changes in their functions and resilience. The inherent sensitivity of some ecosystems, habitats and even species with extremely narrow ranges of bio-geographic adaptability will also limit the options and effectiveness of adaptation.

- **Poverty**

  Poverty has been identified as one of the greatest barriers to developing adaptive capacity. The poor, usually, have low adaptive capacity due to their limited access to information, technology and other capital assets, making them highly vulnerable to climate change. Poverty also constrains adaptation in other sectors. Poverty, along with infrastructural limitations and other socio-economic factors, could also limit efforts to conserve biodiversity in India. Adaptive capacity in countries where there is a high incidence of poverty, will likely remain limited.
- **Inadequate Awareness**

  Insufficient information and knowledge on the impacts of climate change and responses of natural systems to climate change will continue to hinder effective adaptation, particularly in India. The limited studies on the inter-connections between adaptation and mitigation options, costs and benefits of adaptation, and trade-offs between various courses of actions will also likely limit adaptation initiatives. The deficiency in available information and knowledge will continue to make it difficult to enhance public perception of the risks and dangers associated with climate change. In addition, the absence of information on adaptation costs and benefits makes it difficult to identify the best adaptation option. This limiting factor will be most constraining in developing countries, where systems for monitoring and research on climate, and responses of natural and human systems to climate are usually lacking.
- **Lack of Political Motivation**

  The slow change in the political and institutional landscape in response to climate change could also be a major limitation to future adaptation. The existing legal and institutional framework in India remains inadequate to facilitate implementation of comprehensive and integrated response to climate change in synergy with the pursuit of sectoral development goals.

NATIONAL ACTION PLAN ON CLIMATE CHANGE

India released its National Action Plan on Climate Change (NAPCC) on 30th June, 2008 to outline its strategy to meet the challenge of climate change. The National Action Plan advocates a strategy that promotes, firstly, the adaptation to climate change and secondly, further enhancement of the ecological sustainability of India's development path.

Approach to Climate Change

The National Action Plan recognizes that climate change is a global challenge and that it should be successfully addressed through a globally collaborative and cooperative effort based on the basis of the principle of equity. The Action Plan expresses India's willingness to play its role as a responsible member of the international community and to make its contribution. However, it emphasizes that this requires not only sustainable production processes, but also sustainable life styles across the globe. In this effort, every citizen of the planet should have an equal share of the planetary atmospheric space. The Action Plan suggests that the long-term convergence of per capita GHG emissions is the only equitable basis for a global agreement to tackle climate change. The Action Plan assures the international community that India's per capita GHG emissions would not exceed the per capita GHG emissions of developed countries, despite India's developmental imperatives.

Domestic Action

India's National Action Plan stresses that maintaining a high growth rate is essential for increasing the living standards of the vast majority of people in India and reducing their vulnerability to the impacts of climate change. Accordingly, the Action Plan identified measures that promote the objectives of sustainable development of India while also yielding to benefits for addressing climate change. Eight National Missions, which form the core of the National Action Plan, represent multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. The focus is on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation. While several of these programmes are already a part of the current actions, the Action Plan seeks to enhance them in scope and effectiveness and implement them in an accelerated manner through time bound plans.

National Missions

1. **National Solar Mission** aims at increasing the share of solar energy in the total energy mix through development of

Drought-a major concern of climate change new solar technologies, while attempting to expand the scope of other renewable and non fossil options such as nuclear energy, wind energy and biomass.

2. **National Mission for Enhanced Energy Efficiency** comprises four new initiatives, namely - a market based mechanism for trading in certified energy savings in energy intensive large industries and facilities, accelerating the shift to energy efficient appliances in designated sectors, demand side management programmes in all sectors by capturing future energy savings, and developing fiscal instruments to promote energy efficiency.
3. **National Mission for Sustainable Habitat** attempts to promote energy efficiency in buildings, management of solid waste and nodal shift to public transport including transport options based on biodiesel and hydrogen.
4. **National Water Mission** has as its objective, the conservation of water, minimizing wastage and ensuring more equitable distribution both across and within states.
5. **National Mission for Sustaining the Himalayan Ecosystem** is aimed at evolving management measures for sustaining and safeguarding the Himalayan glacier and mountain ecosystem.
6. **National Mission for a Green India** focuses on enhancing ecosystem services and carbon sinks through afforestation on degraded forest land, in line with the national policy of expanding the forest and tree cover to 33 per cent of the total land area of the country.
7. **National Mission for Sustainable Agriculture** would develop strategies to make Indian agriculture more resilient to climate change, with new varieties of thermal resistant crops, credit and insurance mechanisms and improving productivity of rainfed agriculture.
8. **National Mission on Strategic Knowledge for Climate Change** is intended to identify the challenges of, and the responses to, climate change through research and technology development and ensure funding of high quality and focused research into various aspects of climate change.

Other Initiatives

Apart from the eight National Missions, the National Action Plan also envisages other initiatives aimed at enhancing mitigation and adaptation. These include:

- Research and development in the area of ultra super critical boilers in coal-based thermal plants.
- Integrated gasification combined-cycle technology to make coal based power generation efficient
- Setting up more combined cycle natural gas plants.
- Promotion of nuclear energy through adoption of fast breeder and thorium based thermal reactor technology in nuclear power generation.
- Adoption of high-voltage AC and high-voltage DC transmission to reduce technical losses during transmission and distribution.
- Setting up small and large scale hydro power projects.
- Promotion of renewable energy technologies such as biomass combustion and gasification based power generation.
- Enhancement in the regulatory/tariff regimes to help mainstream renewable based sources in the national power system.
- Promotion of renewable energy technologies for transportation and industrial fuels.

In addition, the Action Plan envisages effective disaster management strategies that include mainstreaming disaster risk reduction into infrastructure project design, strengthening communication networks and disaster management facilities at all levels, protection of coastal areas, provision of enhanced public health care services and assessment of increased burden of disease due to climate change. The Action Plan also highlights the role of Central Government, State Governments and local

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Flood in Bihar

bodies in putting in place appropriate delivery mechanisms and building adequate capacity and knowledge in the relevant institutions for effective adaptation and mitigation action.

Institutional Mechanism

The National Missions are to be institutionalized by the respective Ministries and will be organized through inter-sectoral groups. Appropriate mechanisms including public-private partnerships and civil society actions will be devised, as suited, for effective delivery of each individual Mission's objectives. The work is to be coordinated by the Ministry of Environment and Forests.

International Cooperation

National Action Plan looks forward to enhanced international cooperation under the United Nations Framework Convention on Climate Change. It renews India's pledge to play an active role in multilateral cooperation in addressing climate change based on the principle of 'Common but Differentiated Responsibilities and Respective Capabilities'. The Action Plan acknowledges that in the move towards a low carbon economy, technology has a vital role to play. Models and mechanisms for technology transfer will need to incorporate key elements such as appropriate funding modalities and approaches, facilitative IPR environment, and enhancing the absorptive capacity within developing countries. Some reforms in the carbon market, such as mainstreaming the bundling and programmatic CDM, also need to be carried out multilaterally.

The Action Plan emphasizes that international cooperation should aim at enhanced implementation of the UNFCCC by minimizing the negative impacts of climate change through suitable adaptation measures, providing fairness and equity in actions and measures, and ensuring concessional financial flows from the developed countries and access to technology on affordable terms.

India's National Action Plan on Climate Change will evolve on the basis of new scientific and technical knowledge, and in response to the evolution of the multilateral climate change regime including arrangements for international cooperation.

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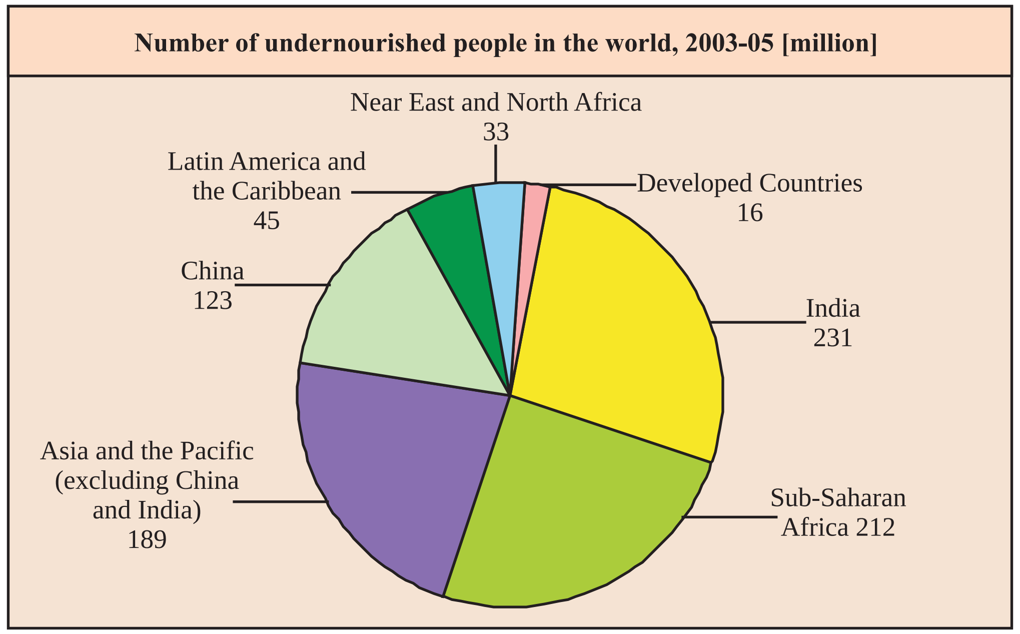
FOOD SECURITY

Today, there is marketable surplus of food grains in India. The prevalence of widespread hunger is not due to the non-availability of food in the market, but due to lack of adequate purchasing power amongst the rural and urban poor. This observation can be further extended to link it with the issue of nutritional security. Inadequate purchasing power, in its turn, is due to insufficient opportunities for gainful employment. The famine of jobs and of purchasing power is becoming the primary cause for the famine of food in the households of the poor. Worldwide, 848 million people suffered from chronic hunger in 2003-05, this number is slightly higher than the 842 million people who were undernourished in 1990-92 (FAO, 2008).

The vast majority of the world's undernourished people live in developing countries, which were home to 832 million chronically hungry people in 2003-05. Of these people, 65 per cent live in only seven countries - India, China, Democratic Republic of the Congo, Bangladesh, Indonesia, Pakistan and Ethiopia. India has an undernourished population of around 231 million (Figure 3.2.1).

Figure 3.2.1 : Status of Nutrition in the World



Source: State of Food Insecurity in World 2008, FAO

After registering impressive gains during 1990-92 and the mid-1990s, progress in reducing hunger in India has stalled since about 1995-97. The high proportion of undernourished in India in the base period (24 per cent), combined with a high population growth rate, means that India has had a challenging task in reducing the number of undernourished. The increase in the number of undernourished in India can be traced to a slowing in the growth (even a slight decline) in per capita dietary energy supply for human consumption since 1995-97. On the demand side, life expectancy in India has increased from 59 to 63 years since 1990-92. This has had an important impact on the overall change in population structure, with the result that in 2003-05 the growth in minimum dietary energy requirements had outpaced that of dietary energy supply.

The combination of the declining per capita growth rate in total dietary energy supply and higher per capita dietary energy requirements resulted in an estimated 24 million more undernourished people in India in 2003-05 compared with the base period. The increased food needs of the ageing population amount to about 6.5 million tonnes per year in cereal equivalent. Nevertheless, the prevalence of hunger in India decreased from 24 per cent in 1990-92 to 21 per cent in 2003-05, marking a progress towards meeting the MDG hunger reduction target.

The uncertainties of food security are linked to and compounded by their vulnerability from the uncertainty of sustenance/ production, livelihoods, accessibility to health and education services, etc. An important fact about hunger and food insecurity in India is that the growth of the number of malnourished people is in absolute terms rather than a percentage.

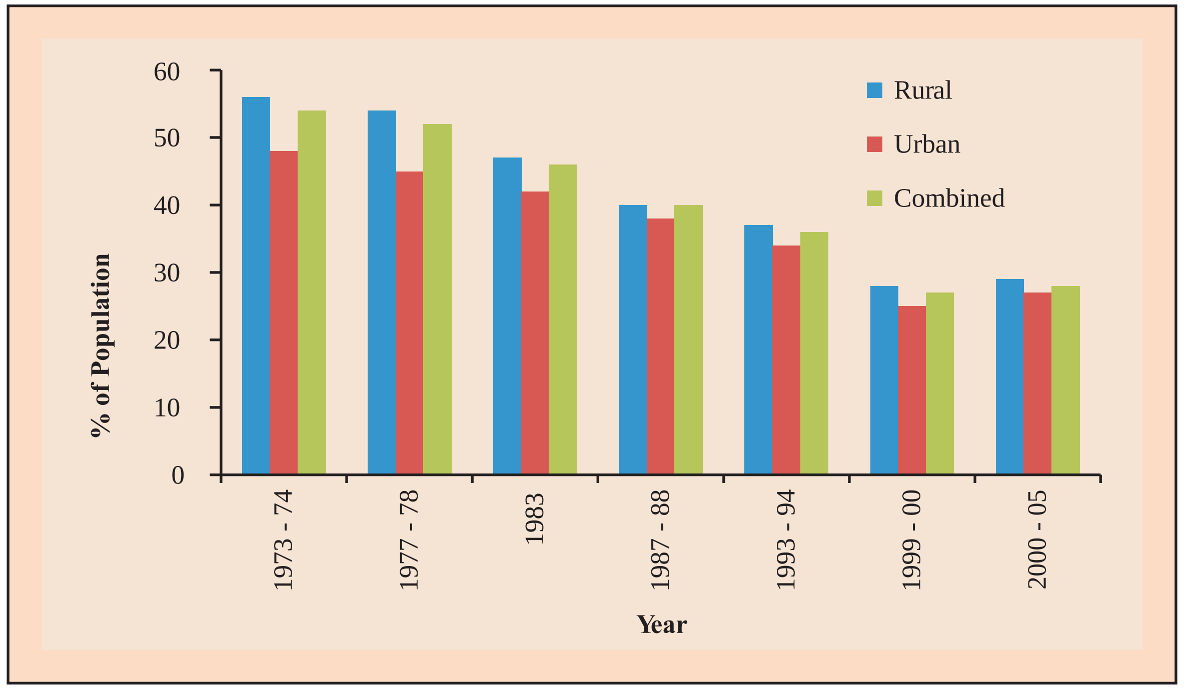
This fact makes the problem of food insecurity in India a complicated one. It highlights the fact that hunger in India is not necessarily a function of underproduction, bad monsoons or the fall in buffer stocks. In fact, India today finds itself in a paradoxical situation of having food grain stocks with the Food Corporation of India (FCI) standing at an all time high of 63.1 million tonnes in July 2002 (*Patnaik, 2003*). This exceeds the requirements for food security by about 20 million tonnes, yet above 200 million people go hungry and about 50 million are on the brink of starvation (*Goyal, 2004*). The existence of food stocks above buffer requirements has not translated into availability and in 2001, a per capita availability of 151 kg per annum was lower than the level in the late 30s and around the average for the time period corresponding to World War II, which included the Bengal famine of 1943 (Patnaik, 2003).

PRESSURES

Poverty

The National Sample Survey Organization (NSSO) constructed three income groups - bottom, middle and top; for these groups the per capita expenditure on cereal, non-cereal and total calorie intake for the years 1970 to 1989, 1990 to 1998, 1998 to 2000 was estimated. For the bottom income group, expenditure on cereals has fallen from 0.10 per cent per annum to -1.38; it is worse for non-cereals where the expenditure has decreased from 2.81 per cent per annum to 0.96 per cent per annum. The figures of different levels of poverty in the above study are useful: Between 1993-94 and 1999-2000, the proportion of extremely poor fell from 2.0 to 0.8, very poor from 11.7 to 8.2; moderately poor from 22.1 to 18.3 and the 'poor' as defined by below poverty line from 36.8 to 26.5 (Figure 3.2.2).

Figure 3.2.2: Percentage of Population Below Poverty Line



Source: Compendium of Environment Statistics - India, 2007

Table 3.2.1: Comparison of Poverty Estimates Based on Uniform Recall Period

	1993-94 (%)	2004-05 (%)
Rural	37.3	28.3
Urban	32.4	25.7
Total	36.0	27.5

Source: Annual Report 2007-2008, Planning Commission of India

Table 3.2.2: Comparison of Poverty Estimates Based on Mixed Recall Period

	1999-2000 (%)	2004-05 (%)
Rural	27.1	21.8
Urban	23.6	21.7
Total	26.1	21.8

Source: Annual Report 2007-2008, Planning Commission of India

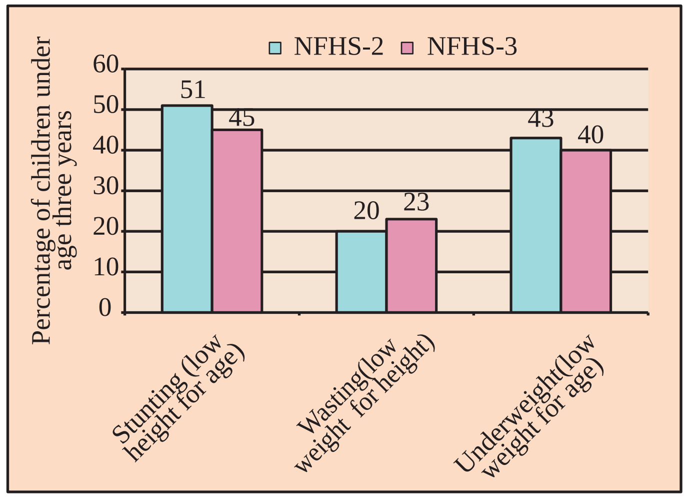
Predictably, the percentage of poor in rural areas is highest amongst the agricultural labour, followed by the self-employed. According to National Nutrition Monitoring Bureau (NNMB) data, 37.4 per cent of adult females and 39.4 per cent of males suffer from chronic energy deficiency. NSS data on poverty and alternate estimates by other scholars concluded that poverty reduction was less than 3 per cent between 1993-94 (50th NSS) and 1999-2000 (55th NSS).

Undernutrition is particularly serious in rural areas, in the lower wealth quintiles, among scheduled tribes and scheduled castes, and among those without education.

Almost half the children under age five are stunted, or too short for their age, which indicates that they have been undernourished for some time. 20 per cent are wasted, or too thin for their height, which may result from inadequate recent food intake or a recent illness. 43 per cent are underweight, which takes into account both chronic and acute undernutrition. More than half the children under age five are underweight in Madhya Pradesh, Jharkhand and Bihar.

Children in rural areas are more likely to be undernourished, but even in urban areas, almost two out of five children suffer from chronic undernutrition. Girls and boys are equally likely to be undernourished. Children's nutritional status in India has improved slightly since NFHS-2 by some measures but not by all measures. Children under age three (the age group for which nutritional status data are available in NFHS-2) are less likely to be too short for their age today than they were seven years ago, which means chronic undernutrition is less widespread, but they are slightly more likely to be too thin for their height, which means acute undernutrition is still a major problem in India (Figure 3.2.3).

Figure 3.2.3: Trends in Children's Nutrition Status in India



Source: NFHS-3, 2005-2006

Increased Food Consumption

The Indian food basket has changed drastically since 1973-74. Both the expenditure on and the quantity of food consumed indicate that the share of cereals in the food basket has decreased in rural and urban areas, while the share of other items has increased.

Energy derived from food has also decreased considerably. The National Council of Economic and Applied Research's (NCEAR) estimate of nutrition for rural and urban areas is less than NSSO's estimates by 53 kCal. As one moves from poorer to richer households, per capita consumption of cereals reaches a plateau whereas in rural areas as one moves to better-off classes, consumption increases. Consumption is dominated by rice and wheat. Other cereals such as bajra, jowar, maize, barley and ragi are consumed only in rural areas and that too in tiny amounts. Per capita monthly expenditure in rural areas was Rs 399 of which 83 per cent was for cereals and 13.6 per cent for other food items. The recommended daily intake of proteins is 60 gm per person per day of which the rural areas get barely 60 per cent. This data is for 1993-94. There is no reason to assume that the situation has improved. The situation is far worse today with rising prices and low yields of pulses, the main protein source in India.

The 59th round of the NSS, concludes that for farming households at the all India level, the average monthly per capita consumption was Rs 503, less by Rs 9 for rural households as a whole across regions and income groups. This was Rs 155 above the rural poverty line of Rs 349 per capita per month in 2003. The farming households spent Rs 278.74 on all food items as against Rs 298.57 for all rural households. Except for cereal consumption, farming households' consumption of other food items like pulses, vegetables, fruits, eggs, fish and meat was consistently lower than that of rural households in general.

Food Prices - Main Concern

Income growth, climate change, high energy prices, globalization, and urbanization are converging to drive food prices higher, threatening livelihoods and nutrition of poor people in the developing countries, says a new report from the International Food Policy Research Institute (IFPRI).

"Food prices have been steadily decreasing since the Green Revolution, but the days of falling food prices may be over," said Joachim von Braun, lead author of the report and director general of IFPRI. "Surging demand for feed, food, and fuel have recently led to drastic price increases, which are not likely to fall in the foreseeable future, due to low stocks and slow-growing supplies of agricultural outputs. Climate change will also have a negative impact on food production, compounding the challenge of meeting the global food demand, and potentially exacerbating hunger and malnutrition among the world's poorest people."

Food security is vital for human sustenance

Table 3.2.3: Minimum Support Price (Rs. Per Quintal) of Wheat/ Paddy for the Last Five Years (2002-03 to 2006-07)

Marketing year	Wheat (rabi)	Paddy (kharif)	
		Common	Grade 'A'
2002-03	620	530 +*20.00	560 +*20.00
2003-04	620 +*10.00	550	580
2004-05	630	560	590
2005-06	640	570	600
2006-07	650.00 +50.00(Bonus)	580.00 +40.00(Bonus)	610.00 +40(Bonus)
*Note : - * Drought relief announced by the Govt. of India*			

Source: Food Corporation of India, 2007

Economic growth in India is changing the spending patterns and consumer preferences from staple crops to resource intensive processed food and high-value agricultural products, including vegetables, fruits, meat, and dairy. Surging demand for biofuels as an alternative energy source are further pressurizing food prices. It lists four dimensions in the characterization of food security:

(i) the ability to improve and maintain the level of acquirement;

(ii) the ability to cope with shocks;

(iii) the ability to improve and maintain the level of utilization and;

(iv) the ability to cope with shocks to the utilization.

Land Degradation

Permanently degraded lands are growing at an annual rate of 6 Mha. globally, affecting the livelihoods of millions of people, concentrated mainly in the developing and poor countries. Land degradation seriously undermines the livelihood opportunities, thus leading to poverty, migration and food insecurity.

In India, erosion rates are reported to be in the range of 5 to 20 tonnes/hectare (up to 100 tonnes/hectare). Nearly 150 Mha. are affected by water erosion and another 18 Mha. are affected by wind erosion annually in India. Thus, erosion leads to

Bamboo Seedlings

impoverished soil on one hand, and silting up of reservoirs and tanks on the other. This degradation induced source of carbon emissions also contributes to far reaching global warming consequences. If the current production practices are continued, India will face a serious food shortage in the near future. 65 per cent of arable land in India is rainfed and the increasing demand for food and feed has to be met with the increased production in the rainfed areas, as there is very little scope for expansion of cultivable area or irrigation facilities.

At present, approximately 68.35 Mha. of land is lying as wasteland, of this approximately 50 per cent is non-forest land which can be made fertile again if treated properly. Rajasthan has the highest component of degraded land, followed by Madhya Pradesh, Maharashtra, Uttar Pradesh, Gujarat, Andhra Pradesh and Karnataka.

Where land has been subjected to light or moderate degradation, the same level of inputs will give lower outputs. These may be reduced crop yields or lower livestock production. Relatively little data is available on reduction in production as a result of water and wind erosion.

Fragility of Agriculture

With respect to agricultural production, there are wide fluctuations, but an overall downward trend exists, including some negative patches, the only exception being 2003-04, when favourable monsoon was witnessed. However, the growth rate dipped again to 0.7 per cent in 2004-05 (*India budget 2006*). The advanced estimates of national income released by the Central Statistical Organization (CSO) in February 2006, give the figure of 2.3 per cent for agriculture and allied sectors' growth. Although India accounts for 21.8 per cent of the global paddy production, our yields are less than those in most countries (Table 3.2.4).

The decline in the agriculture dependent portion of the population has been modest, from 73.9 per cent in 1972-73 to 60.2 per cent in 2000. The relative productivity of agriculture is less than one fourth of that in non-agricultural sector. The yield of food crops and non-food crops over the years depict that crop production in general has suffered. The dominance of wheat and rice among food crops and lower importance given to other so-called coarse cereals has several implications – lower area under these crops, lower production, and shift in consumption to more rice and wheat and the declining importance of traditional coarse cereals in the national policy.

The increase in the yield per hectare for rice, wheat and coarse cereals in the past 50 years is around 200 per cent, but the difference lies in absolute numbers; rice yield was 2,051 kg per ha and for wheat the yield was 2,707 kg per ha whereas for coarse cereals it was 1,228 kg per hectare. In terms of production of food grains, the index moved up till the 1990s but after 2000, it became negative. As for yields per hectare, improvements lasted only till the beginning of 2000. There is a significant rise over the entire period from the early decades in the area under cultivation and production of non-food crops, thereby pointing to an

Two years old restored site at Corbett Tiger Reserve after eradication of Lantana

Table 3.2.4 : Average Annual Growth (%) in Agriculture Sector

Five Year Plan	Overall GDP Growth Rate (at Constant Prices)	Agriculture and Allied Sectors
Seventh Plan (1985-1990)	6.0	3.2
Annual Plan (1990-92)	3.4	1.3
Eighth Plan (1992-97)	6.7	4.7
Ninth Plan (1997-2002)	5.5	2.1
Tenth Plan (2002-07)		
2002-03	3.8	-6.9
2003-04 (P)	8.5	10.0
2004-05 (Q)	7.5	0.7
2005-06 (A)	8.1	2.3

P: Provisional, Q: Quick estimates, A: Advance estimates
Note: Growth rates prior to 2001 based on 1993-94 prices and from 2000-01onwards based on new series at 1999-2000 prices.

Source: Central Statistical Organisation, 2007

Table 3.2.5: Percentage Change in Production of Food Grains

Crops	1999-2000*	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Rice	17.96	-5.53	8.96	-29.96	18.65	-6.50	9.43	1.67	3.45
Wheat	34.73	-9.60	4.25	-10.66	8.81	-5.11	1.02	8.52	3.51
Coarse Cereals	-14.61	2.41	6.86	-28.00	31.61	-12.37	1.76	-0.41	16.76
Total	19.46	-5.73	6.89	-21.89	17.56	-7.05	5.11	3.88	5.99
Pulses	4.17	-21.23	17.20	-20.13	25.50	-13.56	1.94	5.70	3.79
Total Food grains	18.47	-6.60	7.54	-21.73	18.13	-7.48	4.91	3.99	5.85

* Decadal change over 1989-90

Source: Ministry of Agriculture, 2009

Table 3.2.6: Index Numbers of Area, Production and Yield of Food Grains in India

Year	Area	Percentage change	Production	Percentage change	Yield	Percentage change
Weights			**62.92**			
1949-50	78.0	NA	51.5	NA	70.3	NA
1959-60	91.5	14.8	64.9	20.6	75.6	7.0
1969-70	97.3	6.0	81.6	20.5	87.5	13.6
1979-80	98.5	1.2	87.5	6.7	88.7	1.4
1980-81	99.8	1.3	104.9	16.6	105.1	15.6
1989-90	99.9	0.1	139.1	24.6	135.5	22.4
1999-2000	97.0	-3.0	169.7	18.0	159.8	15.2
2000-01	95.4	-1.7	158.4	-7.1	152.8	-4.6
2001-02	96.7	1.3	172.5	8.2	164.1	6.9
2002-03	89.7	-7.8	140.4	-22.9	143.2	-14.6
2003-04	97.3	7.8	172.0	18.4	165.3	13.4
2004-05	94.6	-2.9	159.9	-7.6	156.5	-5.6
2005-06	95.8	1.3	169.2	5.5	162.3	3.6
2006-07	97.5	1.7	175.9	3.8	180.4	10.0
2007-08	97.7	0.2	186.8	5.8	191.1	5.6

Base: Triennium ending 1981-82= 100
NA: Not Available

Source: Ministry of Agriculture, 2009

Rice production shot up from around 20 million tonnes in the early 1950s to almost 90 million tonnes in 1999-2000 and 93.34 million tonnes in 2001-02. Not only has the production of rice and wheat reached a plateau but has even declined in absolute numbers. Production of coarse cereals doubled in the five decades. Commercial crops have recorded a huge increase, most prominently for tea, sugar-cane and to a lesser extent, coffee. Unfortunately the yield of these export crops is also slowing down and decreasing in the post 2000 period.

Box 3.2.1: 'Our Agriculture is in Doldrums'

Recent data on lower consumption of food and diversion to non-food items is an expression of the financial squeeze the poor face in the light of lower incomes, due to poor returns from agriculture, and inadequate availability of critical pubic services, especially in health and education. This forces the poor to forgo food to meet other urgent requirements. From a pre-reform growth rate of output 2.51 per cent, input 2 per cent and value added for agriculture 2.62 per cent, the post-reform growth figures are: output 1.69 per cent, input 1.84 per cent and value added 1.85 per cent. The anti-agriculture bias in policy is clear [Chand 2006]. Both the share in gross cultivated area under foodgrains and value added have been on the decline. Inevitably farmers' income reflect this sorry state. According to Chand, the growth rate of average income per worker has declined from 0.696 in the late 1970s and early 1980s to 0.29 in 2003-04.

There was a decline in the share of agriculture's capital formation in GDP from 2.2 per cent in late 1990s to 1.7 per cent in 2004-05. Some reversal has taken place in 2005 when the share of public investment in gross investment rose to 29.2 per cent in 2004-05. This enhancement is expected to help towards agricultural diversification, agricultural marketing, strengthening national schemes for repair and maintenance and restoration of water bodies.

Psychotria henryana : an indigenous species

There are many factors limiting agricultural production, like the availability of energy, decreasing fertilizer response, limitation in terms of the genetic improvement of crops, degradation of the resource base, dependence on monsoon for irrigation, floods and drought.

Climate Change

Changing rainfall patterns are likely to affect India's food security. Extreme events, such as droughts, torrential rains, flash floods, cyclones and forest fires could become more common. In the past fifty years, there have been around 15 major droughts, due to which the productivity of rainfed crops in drought years was adversely affected.

Floods are another major cause of food emergencies. Sharp seasonal differences in water availability can also increase food insecurity. In India, more than 70 per cent of annual rainfall occurs during the three months of the monsoon, when most of it floods out to sea. Farmers who lack irrigation facilities must contend with water scarcity through much of the year and also the threat of crop failures when the monsoons fail.

Climate change over the long-term, in particular global warming, could affect agriculture in a number of ways - the majority of which would threaten food security for the world's most vulnerable people:

- The overall predictability of weather and climate would decrease, making planning of farm operations more difficult.
- Climate variability might increase, putting additional stress on the fragile farming systems.
- Climate extremes, which are almost impossible to plan for, might become more frequent.
- The sea level would rise, threatening valuable coastal agricultural land, particularly in low lying small islands.
- Biological diversity would be reduced in some of the world's most fragile environments, such as mangroves and tropical forests.
- Climatic and agro-ecological zones would shift, forcing farmers to adapt, and threaten natural vegetation and fauna.
- The current imbalance of food production between cool and temperate regions as well as tropical and sub-tropical regions could worsen.
- Distribution and quantities of fish and seafoods could change dramatically, wreaking havoc in established national fishery activities.

STATE

- The percentage decadal growth rate of the population varies widely between the states. However, the density of population has increased over the decades to exert pressure on our natural resources. The total fertility rate in some states like Kerala, Tamil Nadu and Goa is below the replacement level, whereas in Meghalaya and Bihar it is above four percentage points.
- The percentage of grazing land has come down over the years, though the decline in forest area is not apparent. The change in the net sown area is surprisingly negative in the past five years in some states like Karnataka and Tamil Nadu, perhaps because prime agricultural land has been shifted for non-agricultural uses. Cropping intensity and irrigation intensity have been increasing continuously. Cropping pattern has been diversified to include non-food crops. Land degradation has been fairly high in Gujarat and Nagaland. In some of the North-Eastern States, wasteland is as high as 50 per cent of the total geographical area.
- The ratio of rainfall to half of the potential evapo-transpiration shows that, in states such as Orissa, Bihar and Uttar Pradesh, two crops may be grown with the available rainwater. However, better utilization of rainwater for crop growth requires moisture conservation techniques. This aspect needs further research. Smaller rivers show more utilization levels, close to 100 per cent. Watersheds of river basins have degraded considerably, leading to a decline in the water flow.
- Groundwater exploitation has increased in the past decade, reaching dangerous levels of over-exploitation in states like Punjab, Haryana and Tamil Nadu. There is an urgent need to control this situation.
- Though the forest cover appears to have increased marginally in recent years, fruit crops and plantations have encroached on forest land. It is important to conserve prime forests.
- The increase in air and water pollution from chemicals and greenhouse gases has been causing a decline in agricultural production in recent years. Climate change is projected to have adverse effects, particularly in developing countries, and, in the case of India, the impact is expected to be severe in the coastal areas. Fluctuations in rainfall may increase, causing floods and droughts more often than before. These will have negative impact on agricultural production.
- There is a large scope for improvement in agricultural yields, given the variations across states in natural resource endowments and adoption of technology. Market forces influence the use of natural resources. In India, though input and output prices are instrumental in determining the total agricultural production, there are a number of other non-price factors that play an important role.
- Strategies for sustainable livelihoods will have to be chalked out for each State to achieve the path of sustainable food production and sustainable livelihood security. Poverty alleviation, by using the existing natural resource potential, is the key issue for Madhya Pradesh. Similarly, the requirements of Orissa, and to some extent Bihar, are increasing land productivity, diversification of agriculture, improving infrastructure and basic amenities, and providing market linkages. Removing pressure on land and water and conserving natural resources for sustainable

water supply are essential in Tamil Nadu and restoration of forests and protection of natural resources in Andhra Pradesh, Rajasthan, and Gujarat.

MEASURES TO ENSURE FOOD SECURITY

India's food security policy was crafted with an aim to attain food self-sufficiency by making basic food grains available to all its citizens at affordable prices. To make this possible and to oversee its implementation, the Food Corporation of India (FCI) was set up under the Food Corporations Act 1964. The FCI procures food grains from farmers at the government declared Minimum Support Price (MSP), which is a long-term guarantee to ensure minimum production, stocks them in its warehouses, and then makes them available at affordable rates to the people through the Public Distribution System (PDS), which was restructured into the Targeted Public Distribution System (TPDS) in 1997, at an issue price, which is different for those above and below the poverty line.

Besides the TPDS, the government has implemented numerous other programmes aimed at food security, which include the Integrated Child Development Scheme (ICDS) for providing nutrition and healthcare services to children and pregnant women, the Antyodaya Anna Yojana for providing affordable food to Below Poverty Level (BPL) households, and the Mid-day Meal Scheme.

At the same time, the government has been suppressing market prices through extensive restrictions and pricing controls on the free trade in foodgrains, and by providing input subsidies to farmers, such as on water, power and fertilizers to compensate for that.

Over the years following independence, India has successfully been able to transform itself from a foodgrain importing country to a food self-sufficient country with adequate buffer stocks to see itself through a year or two of drought. The general incidence of poverty has also fallen, but a lot still needs to be done as, according to a 2000 National Sample Survey, more than 25 per cent of the population still lives below the poverty line.

The challenge that stares the government in the face is fully implementing the TPDS and making it accessible to the deserving groups. It also has to develop effective social security nets for vulnerable population groups, especially during moments of crisis such as droughts, earthquakes or cyclones. Food security implementation can also be tied to other development projects on health, employment and education. To meet these demands, a large number of voluntary organizations are aiding the government in providing assistance and in developing networks and models for effective food and nutritional security. Food security is an important step towards national economic development as no country can prosper if one-fourth of its people have to worry about where their next meal will come from.

National Food Security Mission

The National Food Security Mission has been launched recently as a centrally sponsored scheme. The objective is to increase production and productivity of wheat, rice and pulses on a sustainable basis so as to ensure food security of the country. The approach is to bridge the yield gap in respect of these crops through dissemination of improved technologies and farm management practices. It is envisaged to focus on districts which have high potential but relatively low level of productivity performance at present. There will be a series of programmatic interventions, efforts to reach resource-poor farmers and continuous monitoring of various activities. Panchayati Raj institutions will play a central role, not only in selection of beneficiaries and identifying priority areas but also in the entire gamut of activities of the Mission. A strong component of project management and monitoring and evaluation will steer the scheme for achieving the Mission's objectives.

The National Food Security Mission has three components :

(i) National Food Security Mission - Rice (NFSM-Rice)

Man ploughing an agriculture field

(ii) National Food Security Mission - Wheat (NFSM-Wheat)

(iii)National Food Security Mission - Pulses (NFSM-Pulses)

The National Food Security Mission (NFSM) is currently running in 17 States of the country including Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

The SAARC Food Bank

The Agreement on Establishing the SAARC Food Security Reserve came into force on 12 August 1988. It had a Reserve of 2,41,580 tonnes of food grains (a combination of rice and wheat) (Table 3.2.7). However, the Reserve was not utilized despite the SAARC member states suffering food emergencies. As such, the question of the non-operationalization of the Reserve remained a subject of concern for the Association. It was, therefore, felt necessary to evolve mechanisms to make the SAARC Food Security Reserve operational.

In view of the emerging global situation of reduced food availability and a worldwide rise in food prices, a meeting of the Agriculture Ministers of the SAARC member states was held in New Delhi, India in November 2008, to evolve and implement people-centred short to medium term regional strategy and collaborative projects that would, among others, lead to:

- Increase in food production;
- Investment in agriculture and agro-based industries;
- Agriculture research and prevention of soil health degradation;
- Development and sharing of agricultural technologies;
- Sharing of best practices in procurement and distribution; and
- Management of the climatic and disease-related risks in agriculture.

This will also emphasize on early drawing up of the SAARC Agriculture Perspective 2020.

Table 3.2.7 : Assessed Shares of Food Grains for the SARRC Food Bank

Member Country	Shares of food grains for the reserve (in metric tonnes)
Afghanistan	------*
Bangladesh	40,000
Bhutan	180
India	1,53,200
Maldives	200
Nepal	4,000
Pakistan	40,000
Sri Lanka	4,000
Total:	**2,41,580***

* Assessed share of Afghanistan is to be decided by the First Meeting of the SAARC Food Bank Board and reflected accordingly in this Schedule

Source: South Asian Association for Regional Coorporation, 2007

Scope of the Food Bank has been expanded beyond emergencies. The Bank would act as a regional food security reserve for the SAARC member countries during normal time food shortages and emergencies. The Agreement contains broad principles for determination of price. The prices, terms and conditions of payment in respect of the food grains would be the subject of direct negotiation between the concerned member countries based on the guidelines for price determination to be approved by the Food Bank Board periodically. The Agreement sought to rationalize and improve the provisions on the procedures for withdrawal and release of food grains. It delineates the role of the Board to administer functioning of the Food Bank and its policymaking, distinct from the designated Nodal Point(s) responsible for transacting the entire business at the national level related to operations of the Food Bank.

Organic Farming - *A Possible Solution to ensure Economically Sustainable Agriculture*

Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. Organic production systems are based on specific standards precisely formulated for food production and aim at achieving agro ecosystems, which are socially and ecologically sustainable. It is based on minimizing the use of external inputs through the use of on-farm resources efficiently, as compared to industrial agriculture. Thus, the use of synthetic fertilizers and pesticides is avoided.

The strongest feature of organic agriculture is its reliance on fossil-fuel free and locally-available production assets and working with natural processes, which increases cost-effectiveness and resilience of agro-ecosystems to climatic stress.

As per a Food and Agriculture Organization (FAO) study of mid 2003, India had 1,426 certified organic farms producing approximately 14,000 tonnes of organic food/products annually. In 2005, as per the Govt. of India figures, approximately 1,90,000 acres (77,000 hectares) were under organic cultivation. The total production of organic food in India as per the same reference was 1,20,000 tonnes annually, though this largely included certified forest collections.

In India, a common problem faced by organic farmers is the lack of a ready market and often unremunerative prices for their produce. In many cases, the farmer does not receive timely payments from middlemen, including organic food traders. Buyers of organic food, on the other hand, face difficulty in sourcing organic produce, at least at reasonable prices. Supplies are often erratic or unreliable, and in some cases, buyers cannot be sure whether the produce is indeed organic.

The spread of organic and agro-ecological farming (OF) methods in developing countries has raised a debate on whether its large scale adoption will increase or decrease global food security. This will, however, depend on a number of socio-economic factors, together with the relative yield levels of various conventional farming systems. Relative yields again depend on a number of agro-ecological factors and the characteristics of farming systems before conversion.

In areas with intensive high-input agriculture, conversion will most often lead to a reduction in crop yields per ha by 20-45 per cent in crop rotations, integrated with leguminous forage crops. In many areas with low input agricultural systems, farmers have little incentive or access to use the chemical fertilizers and pesticides, and yields may increase when agro-ecological principles are introduced.

RECOMMENDATIONS

1. Population stabilization
2. Boosting agriculture science and technology. Eventually, rising agricultural productivity will drive economic growth
3. Securing property rights and access to finance
4. Encouragement of child-friendly village/town movement
5. Land resources conservation and enhancement
6. Establishment of a water security system
7. Management of forests and preservation of biodiversity
8. Atmosphere and climate management
9. Administration of common property resources
10. Sustainable intensification and diversification of farming systems and value-addition
11. Formation of a State Coalition for Sustainable Food Security
12. Conflict prevention and resolution mechanisms, and democracy and governance based on principles of accountability and transparency in public institutions and the rule of law to empower the vulnerable members of society.

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Organic Farming : Taking a Green U-turn

Paper making from waste cloth rags : A sustainable livelihood

WATER SECURITY

Water security is emerging as an increasingly important and vital issue for India. Many Indian cities are beginning to experience moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Another concern in the region is the growing competition over shared water resources. These shortages would be further aggravated by receding of glaciers and dwindling fresh water resources.

Water stress is likely to be a major impact of climate change, with flows of some of India's major rivers such as the Indus and Brahmaputra projected to fall by as much as a quarter. Conflict over freshwater resources can strain relationships between various states sharing these resources. In the future, diminishing and degraded freshwater resources could lead to internal instability in the country.

WATER AVAILABILITY

The two main sources of fresh water in India are rainfall and the snowmelt of glaciers in the Himalaya. Although reliable data on the snow cover in India is not available, it is estimated that some 5,000 glaciers cover about 43,000 sq. km in the Himalayas with a total volume of locked water estimated at 3,870 km^3. Considering that about 10,000 sq. km of this is located in Indian territory, the total water yield from snowmelt contributing to the river run-off in India may be of the order of 200 km^3/year .

India receives an average annual precipitation of approximately 4,000 bcm in the form of rainfall and snow. After accounting for percolation, evaporation and other losses, less than 50 per cent (1,869 bcm) is the total surface flow, including regenerating flow from groundwater and the flow from neighbouring countries. In view of the constraints of topography, uneven distribution over space and time, water storage technologies, and inter-state issues, the total utilizable quantity of water is estimated to be 1,122 bcm/year, of which 690 bcm and 431 bcm are utilizable surface and groundwater, respectively.

Current and Future Water Requirements

In 1990, the total water withdrawal was estimated at 552 bcm i.e. 30 per cent of the country's renewable water resources (1869 bcm). The contribution from surface water was 362 bcm, while the groundwater withdrawal was estimated at 190 bcm.

Approximately 460 bcm was used for irrigation while 25 bcm was used for domestic needs. About 19 bcm and 15 bcm were used for energy and industrial purposes respectively.

Currently, more than 80 per cent of the 750 bcm water used in India is for irrigation. The balance 20 per cent is used to meet domestic, energy, industrial and other requirements.

With the rapidly growing population, along with industrial and urbanization activities, the demand for water is expected to increase even faster. Estimates indicate that by the year 2025, the total water demand of 1050 bcm will be very close to the total utilizable water resources of 1,122 bcm in the country. Though projections are not available beyond 2025, it is evident that the country may have to face an acute water crisis unless clear and strategic measures are adopted now.

It is pertinent to note that more attention is also required to scientifically assess the water requirements for ecosystems security. Today, approximately 40 per cent (748 bcm) of available water resources is considered to be unutilizable due to a variety of factors. Probably, this is a blessing in disguise since that water must be catering to the requirements of the ecosystems.

Box 3.3.1: Water Needs of Ecosystems

The water needs of ecosystems are not always recognized, since many people do not regard water for eco-systems as a social and economic use. Yet, access to fresh water is an indisputable need for the maintenance and functioning of valuable ecosystems and landscapes in which human activities are an integral part. Ecosystems are also important in securing human health, because they provide services that are fundamental to our life support systems – such as pest control and detoxification and decomposition of waste. They contribute to the production of food (crops and fish), medicines and other goods. They provide water treatment, recreation and waterway transport. Also, terrestrial ecosystems help balance rainwater infiltration, ground water recharge and river flow regimes.

Accelerating population growth and unsustainable consumption and production patterns have increased the demand for water. In the greater competition for water, ecosystems and biodiversity tend to be the losers. But people are the losers too. Activities that reduce biodiversity jeopardize economic development and human health through losses of useful materials, genetic stocks, and potential medicines. As ecosystems and biodiversity get degraded, their ability to lend resilience to the biosphere declines, and communities and human health suffer. The decline in the quantity and quality of water flow has reduced the productivity of many terrestrial, aquatic, and coastal zone ecosystems and led to loss of biodiversity. In remote areas, the degradation of ecosystems has devastated fishing, agriculture, and grazing and undermined the survival potential of rural communities relying on these activities.

Source: World Water Council & Earthscan

Temporal Challenge

Almost 80 per cent of the rainfall occurs in the four monsoon months from June to September. Even within these four months, most of the rainfall occur as few spells of intense rain. It is estimated that in Himalayan rivers, where there is some flow due to snowmelt also, about 80 per cent of the total annual flow takes place within these four monsoon months. In peninsular rivers, where there is no contribution from snowmelt, monsoon flow accounts for more than 90 per cent of the annual flow.

In this context, retention and storage of water becomes imperative. More important is the scale at which retention or storage activities are undertaken. Large dams have their fair share of adverse social and environmental impacts, besides causing conflicts between riparian States. In today's context, large storage structures may be attempted only after their benefits are weighed carefully against their social and ecological costs.

On the other hand, the country has large numbers of traditional water harvesting structures. Unfortunately, most of them are dilapidated, silted or have been encroached upon due to the breakdown of the traditional community-based management systems and neglect by the concerned departments.

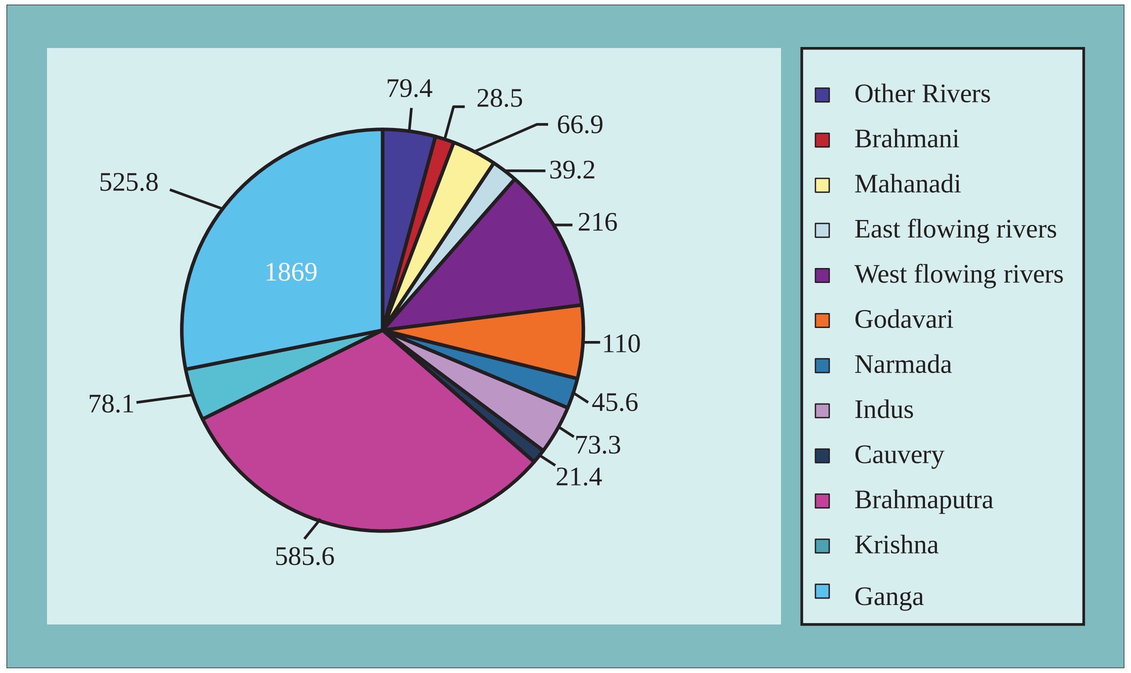
Revival of these traditional water harvesting structures, coupled with modern watershed management systems including large scale afforestation and regeneration of degraded lands (covering 30 per cent of the country), small structures like check dams, gully plugs and other systems can significantly enhance the surface water retention and storage capacity and also recharge the groundwater aquifers.

Spatial Challenge

Precipitation in India is not uniformly distributed and varies from less than 100 mm/year in Rajasthan to more than 2,500 mm/year in Assam. Consequently, despite the current availability, water is not evenly distributed or used around the country. Brahmaputra and Barak basin, with 7.3 per cent of the geographical area and 4.2 per cent of the country's population, have 31 per cent of the annual water resources.

Catchment Area : An important element of watershed management

Figure 3.3.1 : Basin-wise Water Resource Potential (unit:bcm)



Source: Central Water Commission, 2007

Against a national per capita annual availability of 2,208 m^3 of water, the average availability in Brahmaputra and Barak is as high as 16,589 m^3, while it is as low as 360 m^3 in the Sabarmati basin. The per capita annual water availability for the rest of the country, excluding Brahmaputra and Barak basin, works out to about 1,583 m^3 (Figure 3.3.1).

Water availability less than 1,000 m^3 per capita is considered by international agencies as indicating scarcity conditions. Cauvery, Pennar, Sabarmati, east flowing rivers and west flowing rivers are some of the basins with scarcity conditions.

In majority of river basins, current utilization is significantly high and is in the range of 50-95 per cent of utilizable surface resources. But, in rivers such as Narmada and Mahanadi, percentage utilization is only 23 and 34 per cent respectively. In several basins, there is also an overdrawal of groundwater leading to lowering of groundwater tables and even salt water incursions.

If the average national per capita availability of 2,000 m^3 is to be maintained, given the bourgeoning population, the only river in North India with significant surplus water to meet future needs of the country is the Brahmaputra. Since Bangladesh also draws water from this river, it may not be easily possible to tap its full potential. In peninsular India, the Godavari, Brahmani, Mahanadi and Narmada, besides regions of Tapti and Tadri may have surplus water. Inter-linking of rivers has been proposed to address the spatial challenge of water availability. Besides its questionable techno-economic feasibility, the associated ecological damages of river linking may be irreversible.

While at the country level, there may not appear to be an immediate problem of water availability, several basins (e.g. Sabarmati) are already under severe stress and face scarcity situations. With increasing demands, the situation is only going to be aggravated unless appropriate basin level measures are attempted now.

PRESSURES

Population Stress

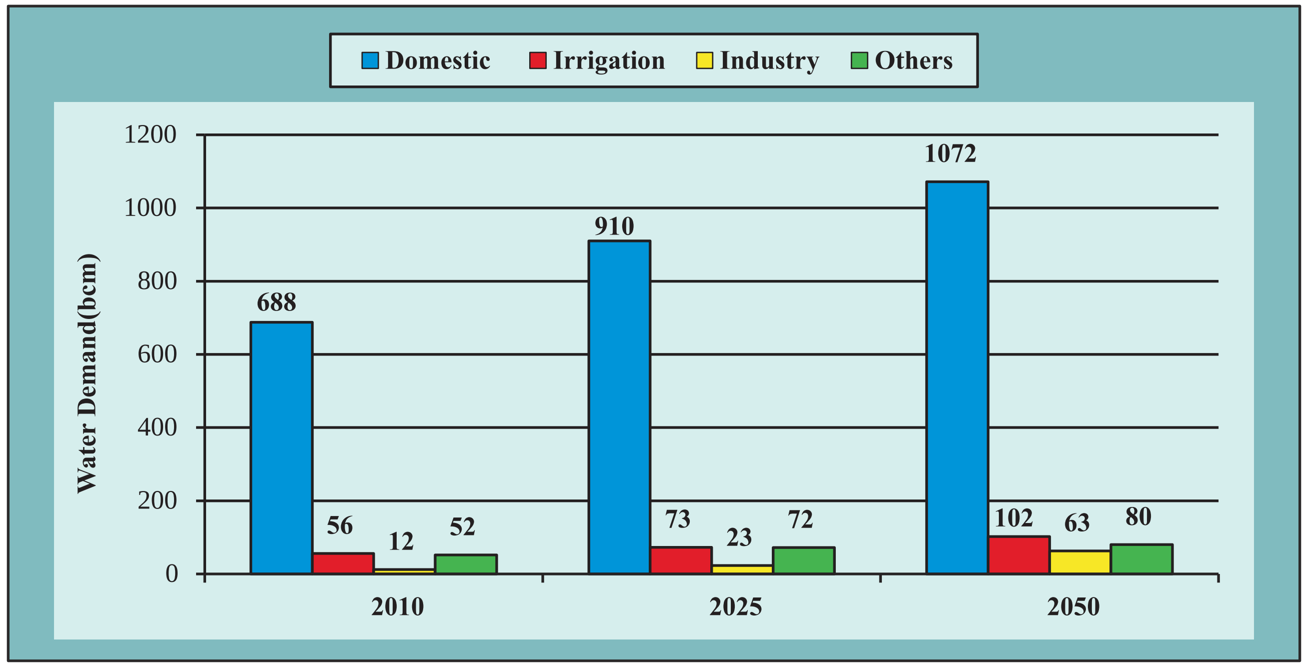
India's population is around 1,028 million as on 1st March, 2001.The population is growing at the rate of about 17 million annually which means a staggering 45,000 births per day and 31 births per minute. The population of India is expected to stabilize at around 1,640 million by the year 2050. As a result, gross per capita water availability will decline from 1,820 m^3/ yr in 2001 to as low as 1,140 m^3/yr in 2050. Total water requirement of the country for various activities around the year 2050 has been estimated to be 1,450 km^3/yr. This is significantly more than the current estimate of utilizable water resource potential (1,122 km^3/yr) through conventional development strategies. Therefore, when compared with the availability of approximately 500 km^3/yr at present, the water availability around 2050 needs to be almost trebled. Various options have been considered, in quantitative terms, as possible sources to augment the anticipated deficit. It is argued that due to considerations of gestation period and capital requirements, rainwater harvesting and water-conservation measures must receive the highest priority, followed by renovation and recycling to be followed by intra-basin and then inter-basin transfers in the last phase. But, investigations and planning processes for all options must begin immediately.

Irrigation Requirements

In India, the primary use of water other than the domestic, is for agriculture. As more food will be needed in the future to feed the growing population, there will be greater demands placed on the region's water supply. Requirement is likely to increase in future as agriculture is extremely dependent on adequate freshwater supply.

About half of the water that is used for irrigation is lost to seepage and evaporation. Irrigation is also a major concern for India as over 30 per cent of the total cropland is under irrigation. While irrigation is vital for increasing crop yields, it can also be extremely dangerous when mismanaged and could result in erosion, water-logging and salinization of the soil, rendering it less productive or uncultivable. Poorly managed irrigation can also result in water pollution and spread of water-borne diseases.

Figure 3.3.2: Projected Annual Requirement of Water (in Different Sectors)



Source: Compendium of Environmental Statistics - India, 2007

Rapid Industrial Growth

Another important factor that influences the state of water security in India, is the extent of industrialization. In India, the maximum utilization was 5 per cent in 2000 (FAO 2000). Industrial activity requires large amounts of freshwater for activities such as boiling, cleaning, air-conditioning, cooling, processing, transportation and energy production. As the country rapidly industrializes, greater quantities of water will be required.

The positive side of this trend is that water used in industrial processes can be recycled, unlike in agriculture where very little of it is actually consumed.

Domestic usage of water

Table 3.3.1: Water Requirements for Different Uses in India

Uses	Year	Year - 2010			Year - 2025			Year - 2050		
(Quantity in bcm)	1997-98	Low	High	%	Low	High	%	Low	High	%
Surface Water :										
Irrigation	318	330	339	48	325	366	43	375	463	39
Domestic	17	23	24	3	30	36	5	48	65	6
Industries	21	26	26	4	47	47	6	57	57	5
Power	7	14	15	2	25	26	3	50	56	5
Inland Navigation	-	7	7	1	10	10	1	15	15	1
Flood Control	-	-	-	0	-	-	0	-	-	0
Environment (1) Afforestation	-	-	-	0	-	-	0	-	-	0
Environment (2) Ecology	-	5	5	1	10	10	1	20	20	2
Evaporation Losses	36	42	42	6	50	50	6	76	76	6
Total	**399**	**447**	**458**	**65**	**497**	**545**	**65**	**641**	**752**	**64**
Ground Water :										
Irrigation	206	213	218	31	236	245	29	253	344	29
Domestic & Municipal	13	19	19	2	25	26	3	42	46	4
Industries	9	11	11	1	20	20	2	24	24	2
Power	2	4	4	1	6	7	1	13	14	1
Total	**230**	**247**	**252**	**35**	**287**	**298**	**35**	**332**	**428**	**36**
Grand Total	**629**	**694**	**710**	**100**	**784**	**843**	**100**	**973**	**1180**	**100**
Total Water Use :										
Irrigation	524	543	557	78	561	611	72	628	817	68
Domestic	30	42	43	6	55	62	7	90	111	9
Industries	30	37	37	5	67	67	8	81	81	7
Power	9	18	19	3	31	33	4	63	70	6
Inland Navigation	0	7	7	1	10	10	1	15	15	1
Flood Control	0	0	0	0	0	0	0	0	0	0
Environment (1) Afforestation	0	0	0	0	0	0	0	0	0	0
Environment (2) Ecology	0	5	5	1	10	10	1	20	20	2
Evaporation Losses	36	42	42	6	50	50	6	76	76	7
Total	**629**	**694**	**710**	**100**	**784**	**843**	**100**	**973**	**1180**	**100**

Source: Central Water Commission, 2007

Climate Change

In the context of anticipated global warming due to increasing atmospheric greenhouse gases, it is necessary to evaluate the possible impact on freshwater resources of the country. Potential impacts of global warming on water resources include enhanced evaporation, geographical changes in precipitation intensity, duration and frequency (together affecting the average run-off), soil moisture, and the frequency and severity of droughts and floods. Future projections using climate models point to an increase in the monsoon rainfall in most parts of India, with increasing greenhouse gases and sulphate aerosols.

Relatively small climatic changes can have huge impact on water resources, particularly in arid and semi-arid regions such as North-West India. This will have impacts on agriculture, drinking water, and on generation of hydroelectric power, resulting in limited water supply and land degradation. Apart from monsoon rains, India uses perennial rivers which originate in the Hindukush and Himalayan ranges and depend on glacial melt-waters. Since the melting season coincides with the summer monsoon season, any intensification of the monsoon is likely to contribute to flood disasters in the Himalayan catchment. Rising temperatures will also contribute to a rise in the snowline, reducing the capacity of these natural reservoirs, and increasing the risk of flash floods during the wet season. Increase in temperatures can lead to increased eutrophication in wetlands and fresh water supplies (Table 3.3.1).

IMPACT

Most human activities whether domestic, agricultural or industrial have an impact on water and the ecosystems. World Health Organization statistics indicate that half of India's morbidity is water related. Water borne diseases can be, to a large extent, controlled by managing human consumption and production patterns. It is therefore pertinent to have an understanding of human activities, including water management initiatives, and their impacts on water and the environment.

Domestic Water Pollution

Waste management systems have not been able to keep pace with the huge volumes of organic and non-biodegradable wastes generated daily. As a consequence, garbage in most parts of India is unscientifically disposed and ultimately leads to increase in the pollutant load of surface and groundwater courses. On the other hand, the large population of the poor in India do not have much choice but to live off the natural resource base and pollute the environment in the process. They deforest for food, fuel, fodder and fibre and pollute the water sources on which they depend, since they cannot afford access to sanitation services.

Domestic water use today, though a small fraction of the total water requirement, is under-priced for political reasons. This leads to a considerable waste of the precious resource and inadequate revenues for operation and maintenance. Low revenues result in deterioration of the supply infrastructure and further loss of the resource due to system inefficiencies.

In most parts of the country, waste water from domestic sources is hardly treated, due to inadequate sanitation facilities. This waste water, containing highly organic pollutant load, finds its way into surface and groundwater courses, very often close to dense pockets of human habitation from where further water is drawn for use. Considerable investments will be required to install treatment systems in at least the 500 major cities and towns of the country. Coupled with investment requirements, are the difficulties of mobilizing consumers to pay for centralized systems. Estimates indicate that it is viable to set up decentralized treatment systems for clusters of approximately 100 to 200 households where it is possible to convince users to pay for efficient services. Incentives like soft loans may be provided to these initiatives.

Industrial Water Pollution

The Industrial sector, contributing to about 20 per cent of the national income, accounts for about 8 per cent of the current water use. With rapid industrialization and urbanization, the water requirement for energy and industrial use is estimated to rise to about 18 per cent (191 bcm) of the total requirements in 2025.

Poor environmental management systems, especially in industries such as thermal power stations, chemicals, metals and minerals, leather processing and sugar mills, have led to discharge of highly toxic and organic wastewater. This has resulted in pollution of the surface and groundwater sources from which water is also drawn for irrigation and domestic use. The enforcement of regulations regarding discharge of industrial wastewater and limits to extraction of groundwater needs to be considerably strengthened, while more incentives are required for promoting waste water reuse and recycling.

Agricultural Water Pollution

Two-thirds of India's farm production comes from one-third of its land which is irrigated. The rest is from rainfed areas that employ large populations. In order to meet the increasing demand for food and farm employment, India has to increase the area under irrigation, and enhance productivity in both irrigated and rainfed areas.

For the agricultural sector, water and electricity for irrigation are subsidized for political reasons. This leads to wasteful flood irrigation rather than adoption of more optimal practices such as sprinkler and drip irrigation. Cropping patterns and farming practices also do not necessarily encourage the judicious use of water. Conservative estimates indicate that the same quantity of irrigation water used today can irrigate double the current area with optimized irrigation and farming practices.

With limited revenues and budgetary support, the state engineering departments are unable to operate and maintain the irrigation systems efficiently, leading to increasing deterioration of the structures and systems over time. Consequently, there are further water losses due to breaches and seepage, resulting in water logging and salinity. Water quality is further affected due to the overuse of chemical fertilizers and pesticides.

MEASURES TO ADDRESS WATER INSECURITY

The environmental challenges of water resources development and management in India are expected to manifest themselves more explicitly and rapidly in the coming years. These environmental challenges may be addressed through four broad approaches:

- Improving efficiencies and minimizing losses
- Recharging groundwater aquifers
- Abatement and treatment of pollution
- Reuse and recycling of wastewater

Due to the complexity and urgency of the environmental challenges, these approaches need to be simultaneously pursued. However, it is evident that an essential prerequisite for water and human security is ecological security. Hence, water resource planning in India has to urgently estimate the requirements of water for ecosystem security.

In each of these approaches, appropriate policy, institutional, technological and economic interventions and instruments may be adopted. Most of these instruments have fortunately been tried or tested at least on a pilot scale in India. The challenge is to institutionalize systems for these interventions and instruments to work on a large scale.

Improving Efficiencies and Minimizing Losses

A major bane of the water resources infrastructure in India is the inefficiencies and losses in the system. This characteristic is pervasive across water systems for agriculture, industry, domestic or other requirements. Crude estimates indicate that improvements in efficiency can reduce up to 40 per cent of current losses. Unfortunately, efficiency is still more an exception rather than the norm.

System inefficiencies result in high rates of unaccounted-for-water (UFW) which has two components: (a) physical losses due to leakages and (b) administrative losses due to illegal tapping and under-registration. Both components contribute roughly equally to UFW. The percentage of physical losses is influenced not only by the deterioration of the network, but also by the total amount of water used, system discharge, and the degree of supply continuity. The percentage of administrative losses depends on the degree of effort exerted in identifying illegal connections and metering.

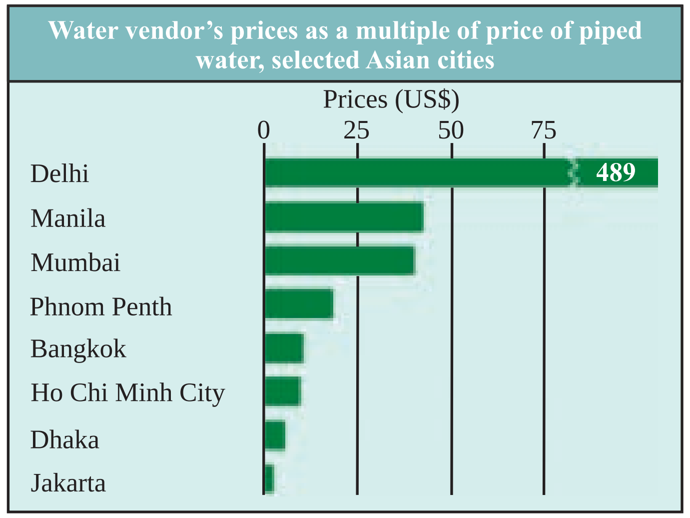
Reasons for poor services and high levels of UFW include inappropriate technology and lack of spare parts, poor organizational structures, lack of trained staff, absence of career opportunities and motivation, insufficient funds, tariff and collection systems, lack of policy frameworks and non-involvement of the users. The approach for reducing UFW includes improved operation and maintenance and sound management practices - not confined to the technology aspects but also priority causes, such as institutional and financial constraints, and negative political interference.

The major financial constraints in reducing UFW are (a) very low water charges - requiring continual subsidization of operations and maintenance (O&M) by state governments, and (b) partly as a consequence of the weak revenue generation, persistently inadequate allocations for O&M, most of which go to staff salaries leaving negligible funds for actual maintenance work.

Proper metering and pricing of water will be a first step in inducing greater conservation of water by both agricultural and domestic users. It is often claimed that the poorest cannot afford to pay, so prices need to be a lot lower. But there are two powerful arguments against this. Firstly, in many developing countries, the main beneficiaries of low water prices are not the poorest but the middle classes, because it is the middle classes who have access to piped water. The poorest often pay far more to private water vendors. Secondly, setting prices too low removes the incentive to use water wisely (Figure 3.3.3).

Check dam in Bundelkhand : Small is sustainable

Figure 3.3.3 : The Concept of the 'Poor Pay More'



Source: UN; Asian Development Bank

Some of the other possible interventions and instruments include:

- Increasing agricultural power tariffs to establish incentives for groundwater and power conservation.
- Enabling transfer and reuse of water between sectors through economic incentives and legislations.
- Contracting out operations of water supply systems, maintenance of irrigation canals and collection of water fees to community based organizations, NGOs, private sector or a combination of these.
- Promotion of water conservation methods such as sprinkler and drip irrigation equipment, on-farm works and other land-improvement investments.

Box 3.3.2: A Look at India's Water Harvesting Practices

Traditional structures include : Zing, Kul, Naula, Kuhl, Khatri, Apatani, Zabo, Cheo-oziihi, Bamboo-drip irrigation, Dongs, Dungs, Ahar-pyne, Bengal's Inundation channels, Dighis, Baolis, Kunds, Kuis, Baoris, Jhalaras, Nadi, Tobas, Tankas, Khadins, Vav, Virdas, Talab, Saza kuva, Johads, Bandh, Pat, Rapat, Chandela Tank, Bundela Tank, Katas, Cheruvu, Kohli Tanks, Bhandaras, Phad, Kere, The Ramtek Model, Surangam, Korambu, Eri, Ooranis, Jackwells.

Contemporary structures include - Artificial Glaciers, Nadis, Polymer Kundis, Chaukas Jaldhar Model, Tudum Monga, Networking of Farm Ponds, Horizontal Roughening Filter.

Rainfall in India occurs during short spells of high intensity (as most of the rain falls in just 100 hours out of 8,760 hours in a year). Due to such short duration of heavy rains, most of the rainwater tends to flow away rapidly, leaving very little for recharge of groundwater. Measures to recharge groundwater aquifers include:

- Promotion of watershed management practices, which have proved to be an effective means of recharging groundwater, improving soil fertility and enhancing productivity.
- Repair and revival of traditional water-harvesting and conveyance structures and community based management systems
- Incentives, like subsidy on property tax, may be provided to individuals who adopt water harvesting practices in their premises
- Modified baselines (including environmental parameters), monitoring systems and the associated metrics, tools and techniques for integrated planning and management of groundwater.
- Creation of water markets that encourage water trading among and within sectors. This would mean that the users have an incentive to invest adequate resources and efforts to maintain the value of the water resources they own to maximize benefits over longer time horizon, thus promoting groundwater recharge measures.

Estimates by the Centre for Science and Environment indicate that upto 300 bcm (approximately half of the current demand) can be captured through effective rainwater harvesting and watershed management. Even if this may be an overestimate, the fact remains that it is possible to harvest a significant quantum through these initiatives to meet requirements.

Abatement and Treatment of Pollution

Pollution abatement and treatment measures that may be adopted include:

- Capacity building of farmers for improvement in application of water, fertilizers and pesticides through better extension of irrigated agronomy knowhow. This will help in greatly reducing contamination of water sources by agricultural chemicals.
- Investments in canal lining to reduce seepage that results in water-logging and salinity. Seepage holes may be designed as required to provide for basin recharge.
- Reclamation of salinity affected lands.
- Introduction of fiscal incentives for improving environmental quality through:
  - Rebates on excise duty / customs duty / sales tax on machinery and equipment used for pollution abatement or adoption of clean technologies.
  - Accelerated depreciation allowances to encourage adoption of clean technologies.
  - Soft loans/subsidies for setting up common effluent treatment plants and recycling and conservation activities.
  - Application of 'polluter pays' principle through pollution taxes, penalties and price structures.
  - Support for innovations in development of pollution abatement and treatment technologies through setting up of zero-pollution industrial estates.

Box 3.3.3 : Polluters Pay Principle – Supreme Court

A monitoring Committee on Hazardous Waste, set up by the Supreme Court, has looked into the allegation of pollution created by Coca Cola, which distributed its sludge to farmers at Plachimada, Palakkad, where the soft drink giant has a bottling unit. The committee came to the conclusion that Coca Cola will have to take quick measures to ensure water supplies to all the people in the vicinity of the plant. In order to reduce the withdrawal of groundwater, both the units are directed to install reverse osmosis systems to ensure that the use of public water for effluent treatment is returned to its original condition for reuse. This recommendation has to be implemented within six months.

Reuse and Recycling of Waste Water

There are several examples across the country where waste water has been reused or recycled for applications like crop irrigation, industrial use and groundwater recharge. Reused water has been used in farming, or diverted to irrigate forests. An additional advantage to these applications, is the recharge of groundwater. Industrial and commercial activities such as cooling applications, which do not require drinking water standards, are also potential users of reclaimed water. Reclaimed water can be applied to aquifer recharge areas like retention ponds from where it can percolate into the soil.

To ensure that these practices are adopted, policy measures that are required include:

- Zoning cum incentive scheme designed to encourage reuse and recycling of waste water from one industry for processes in another (internalize the externalities).
- Support for innovative technologies and capacity building of private sector for design and implementation of water recycling and reuse technologies.

Box 3.3.4 : Reuse and Recycling of Water within and among Sectors

1. Chennai Petroleum Corporation Limited

Conserving Water: CPCL has identified alternate sources for its raw water needs. As a unique project, it has invested nearly Rs. 24 crores on reclamation of city sewage by employing tertiary treatment, followed by reverse osmosis process. The salient features of this unique project are:

- The project is the first of its kind in Asia, in magnitude and end-use application
- The capacity of the plant is 2.5 MGD (475 m^3/hour), and caters to about 40 per cent of the refinery's raw water requirements.
- Benefits of conserving water to CPCL as well as the society at large are:
- Resource saving: 2.5 MGD of metro water is saved and diverted to city population.
- Pollution angle: disposal of 2.5 MGD sewage and its effects on the environment are averted.
- Revenue of the State Government: the sale of sewage generates additional revenue for the State Government.
- Continuous refinery operations: Even during water scarcity, continuous operations of the refinery are ensured with alternate sources of water.
- Substantial chemical savings: Quality of reclaimed sewage from RO plant is far superior to metro raw water. Hence huge quantities of chemicals are saved in DM plant regeneration.
- Cleaner Water: Two effluent treatment plants with state-of-the-art technology are operating to meet the Minimum National Standards (MINAS), prescribed for petroleum refinery effluents.
- Maximum quantity of treated effluents are being reused within the refinery complex for fire-water makeup, 'Green Belt' development and construction activities. They are also used as service waters for chemical preparations, floor washings and toilet flushings.
- For zero discharge of treated effluents, CPCL has initiated Pilot Plant studies on recycling of treated effluents from its refinery campus.

2. Jubilant Organosys Limited

Jubilant Organosys Ltd. is the largest speciality chemicals company of India which strongly believes in the sustainability of growth. It has four modern global scale manufacturing facilities located at Bhartiagram, Gajraula (100 kms from Delhi), Nira (near Pune, Maharashtra), Samalaya (near Vadodara, Gujarat) and Nanjangud (near Mysore, Karnataka). Effluent collected from various plants can be classified as biodegradable and non-biodegradable. The biodegradable effluents, emanating primarily from the distilleries at the Gajraula and Nira facilities, are treated in modern effluent treatment plants to reduce polluting ingredients to acceptable levels. Currently, a part of this treated effluent is used for crop irrigation and bio-composting, and within three years, the entire quantity will be used for crop irrigation and bio-composting purposes.

Sewage Treatment Plant with attractive surroundings at Chandan Nagar in West Bengal

Condition of Powai Lake before and after revival

The core water challenge is one of 'governance'. While infrastructure development needs to be pursued and cannot be neglected, the focus has to be on the judicious use of available water resources at the local level, with community participation and management. A prerequisite for this would be capacity building of all stakeholders including planners, designers, engineers and civil society.

Opportunities and Priorities

The core challenge of water resources development and management in India is one of governance. The institutions needed to ensure efficient and equitable distribution of water are crumbling or do not exist. With growing population and increasing economic activity, the pressures on this basic but increasingly scarce resource have grown much faster than the ability of communities and higher level jurisdictions to cope with them. The bulk of the day-to-day environmental and social problems in India's cities and villages emanate from this core challenge. The solution lies in how quickly and how well these communities learn to decentralize their management systems and mobilize community ownership and participation in decision making.

Operationally, the environmental challenges include:

- Improving efficiencies and minimizing losses in extraction, transport and use of water.
- Addressing the spatial and temporal variations of available rainfall and devising the means to optimize its availability, now and for the future.
- Planning and designing water-related projects as environmental improvement opportunities to maximize the overall benefits – not simply to minimize negative impacts.
- Internalizing waste water minimization, reuse and recycling as an integral feature of all water related projects. Most projects have tended to increase supplies, without adequate attention to demand side management.
- Ensuring adequate reserves for ecosystem requirements.
- Supporting scientific assessments and incorporating the analysis into projects.

Promote integrated water resource management approach

The need for integrated water resource management is widely and frequently called for but rarely implemented due to the differences in conceptual understanding and analysis, coupled with implementation hurdles in bringing together powerful agencies with strong domain expertise, but with a tendency of protecting their 'turf' rather than working together. Despite the complexity of the issues, existing conceptual frameworks are good enough to be the basis for much better results than are commonly produced today. To ensure effective water resource management, following measures should be taken:

- The water needs of the poor and underserved must be given the highest priority through the preparation of a comprehensive policy and regulatory framework aimed at integrated management systems that can ensure rational and equitable allocation of resources.
- The water requirements for eco-system services and security need to be scientifically assessed and incorporated into the analysis of all water resource management projects.
- Industrial, agricultural and municipal water systems should be designed to take full advantage of innovative approaches structured to maximize delivery and minimize waste such as zero emission systems, controlled irrigation and 24x7 drinking water supplies.
- Water resource management must go well beyond environmental impact assessment and minimizing externalities to becoming integral components of national and local action to improve the environment and human security.
- The information base and analytical framework for integration of water resource management needs to be continually revised and updated in the light of experience and made widely available through intensive programmes for the education and training of planners, designers, engineers and civil society.
- Integrated planning and action will also require modified baselines (including environmental parameters), monitoring systems and the associated metrics, tools and techniques.

Vigorously pursue decentralization and community water management initiatives

India has built extensive infrastructure over the past 50 years for managing the nation's water resources. Some of the structures that comprise it are rightly considered major marvels of engineering. Yet, the country's water problems have not been solved and in many cases, they have been aggravated. There exists considerable debate on whether this is in spite of this massive investment or because of it. One thing is clear however-large-scale public sector operations are often not very accountable to the citizen or amenable to his or her sense of ownership. This has meant that they often suffer from neglect, leading to poor financial returns, inadequate income to cover the costs of upkeep and maintenance and misuse, inevitably resulting in inefficiencies, water losses and environmental degradation.

Over a long period of India's history, water had been managed, very successfully, as a local resource. Unfortunately, the logic of the so-called economies of scale and the self-perpetuating momentum of the engineering sector radically changed all this. Over the past five or six decades, this logic has led to a quest for large projects, massive transfers of the resource over long distances and centralized management systems. The planning systems quickly became dominated by the predispositions of distant suppliers of water rather than of the local users.

Fortunately, the Constitution of India recognizes water as a 'state subject'. This opens the possibility of bringing it back under the control of local communities, which can ensure that it can be retained for as long as possible where it falls and used efficiently through local ownership and management. The government, through its investments, can help accelerate the decentralizing process:

- The constitutional authority provided by the 73rd and 74th Amendments to the Constitution, which empowers Panchayats and Urban Local Governments to manage their water resources must be used so as to create a sense of ownership among local communities and a culture of paying for a resource and its delivery.
- The issue of water ownership and rights will have to be revisited and options for transferring surface and groundwater rights defined. Mechanisms for transfer or reuse of water between sectors also need to be simplified.
- New guidelines and legislation are required for:
  - Creating institutions for water sharing and allocation including strengthening of regulatory powers
  - Water resource development, distribution and revenue collection including participation of the private sector, NGOs and community based organizations.
- Large-scale conservation measures like integrated watershed development need to be simplified and propagated widely to mobilize local ownership and promote food and livelihood security. At the same time, smaller projects, such as traditional water harvesting and conveyance structures and community-based management systems which are more in tune with local cultures and practices must be revived and popularized.

Foster local institutional development and capacity building

Robust local institutions are an essential prerequisite for decentralized management of water resources. They must also have access to higher level information and institutional support to manage these resources in an integrated manner. The highly effective community based institutions that used to exist in most parts of the country have today been replaced by the local offices of state level engineering departments. In some places, there also exist NGO and private sector initiatives, usually in the nature of experiments and pilot projects attempting to create and build local water management institutions.

No single type of institution can hope to manage the ever-growing complexities and challenges of water resource development and management. New types of multi-stakeholder institutional bodies will be required and innovative partnerships will have to be forged for this purpose. The task of building local institutions and their capacity across a country like India is immense.

- An aggressive, conscious effort is needed to define the roles of various participants in the multi-stakeholder processes associated with managing water resources:
  - Governance - Panchayati Raj Institutions, Gram Sabhas or Urban Local Bodies
  - Operations - community based organizations, NGOs, private sector, government agencies or a combination of these
  - Regulation - state or central government; community based
  - Financing - all these stakeholders as well as international agencies
- The knowledge and skill base of these local institutions will have to be strengthened for :
  - Integration of water resource management
  - Building of information and knowledge base
  - Internalizing cost recovery principles
  - Monitoring and conflict resolution mechanisms
- Operationally, the local institutions will need support in design and implementation of projects including :
  - Assessment of technological options
  - Management systems including unbundling of resource development, conveyance, distribution and revenue collection wherever appropriate

Box 3.3.5: Water Security – Financial Constraints

Operation and Maintenance (O & M) of the water distribution systems, reservoirs, canals and other infrastructure requires financial inputs from the central and state governments, although in some cases the cost of O & M is also shared by the users. In the past, allocation of funds has been inadequate to properly maintain the existing structures and many have fallen into disrepair with consequent losses in efficiency. Even current construction projects suffer from lack of funding and lengthy delays are not uncommon. With water consumption estimated to double in the next twenty years (World Bank, 1999), greater emphasis will have to be placed on the financial requirements of the water sector.

Due to its important contribution to the Indian economy, the agricultural sector receives greater attention in terms of financing and subsidies. Not surprisingly, irrigation has been the largest recipient of government funds. Over US$ 9 billion were spent in this area during the Eigth Plan and subsidies to this sector accounted for almost 0.3 per cent of the GDP during the 1994-95 fiscal year (World Bank, 1999). The Drinking Water and Sanitation Supply sector in both rural and urban areas has also been subjected to subsidies and rate structures that have not reflected the true cost of the resource and discouraged conservation.

For the most part, government spending in all water-related sectors is running at a deficit. Development of new water supply schemes and maintenance of older structures will continue to exhaust government funds while new issues, such as water pollution and scarcity, will require greater investment over the long term.

Promote economic instruments for efficient and sustainable water resource management

Though water is unquestionably a fundamental right of every human being, its growing scarcity severely jeopardizes the ability of citizens in many parts of India to exercise this right. The way water is currently used in agriculture, industry and the human habitat is not sustainable. Already, the scarcity of water in many areas of the country has become a major constraint on the economy, not to mention its highly negative impact on the health and well-being of people and the cause of community and inter-state conflict. Today's water management practices are definitely not sustainable.

Economic instruments are recognized as an essential component for efficient and sustainable management of resource. However, economic instruments are very often politically difficult to implement. The government of India can play a critical role in promoting appropriate economic instruments for the various components of water resource management to:

- Evolve pricing mechanisms for irrigation, urban and rural water supply systems that include the full cost of providing it. These should include the costs not only of the infrastructure, operations and maintenance, capital servicing, and other financial costs, but also the broader economic, ecological and social costs incurred in the process of acquiring, transporting and delivering it. At the same time, these pricing mechanisms have to be adjusted to ensure universal service provision, and especially to cater to the special needs of the poor and underserved.
- Demonstrate pilot projects in cooperative, enterprise and other institutional modes, with community participation, for providing water services to communities.
- Provide time-bound subsidies for development, testing and scaling up of tools and techniques (e.g. drip irrigation) for efficient use of irrigation water with the aim of enabling such practices to become economically viable and widely adopted without continuing subsidies.
- Evolve fiscal incentives like rebates on excise, customs and other duties, or tax exemptions for industrial operations that adopt pollution prevention and treatment measures, particularly for systems aimed at zero emission..
- Provide incentives to domestic water suppliers that integrate water reuse and recycling measures in their operations.
- Devise fiscal instruments such as taxes, penalties on industrial polluters for discharging effluents in water bodies based on the 'Polluter Pays' principle.
- Promote establishment of water markets that encourage water trading among farmers themselves and also with urban or industrial users.

Support innovative approaches to water resource management

The environmental and other challenges of water resource development and management in India require a whole range of innovative approaches. Some of the areas of innovation include:

- Technology packages for :
  - Up-gradation of traditional water harvesting and conveyance structures
  - Cost-effective systems for conjunctive use of surface and groundwater
  - Improved agriculture and irrigation practices to achieve 'more crop per drop'
  - Low-cost water purification systems
  - Water reuse and recycling systems
  - Zero emission industrial estates
- Water resources planning and management
  - Scientific assessment of water requirements for ecosystem security
  - Development of knowledge base and analytical framework for integrated water resource development
  - Institutional and financial mechanisms for decentralization of water resource management

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A lake in Tikamgarh District

ENERGY SECURITY

India is a developing country facing the critical challenge of meeting its rapidly increasing demand for energy. With over a billion people, India ranks sixth in the world in terms of energy demand. Its economy is projected to grow seven to eight per cent over the next two decades, spurring a substantial increase in demand for oil to fuel land, sea, and air transportation.

While India has significant reserves of coal, it is relatively poor in oil and gas resources. Its oil reserves amount to 0.5 per cent of the global reserves. The majority of India's oil reserves are located offshore in Mumbai and onshore in Assam. Due to the stagnating domestic production of crude oil, India imports approximately 70 per cent of its oil, much of it from the Middle East. Its dependence is growing rapidly. The World Energy Outlook, published by the International Energy Agency (IEA), projects that India's dependence on oil imports will grow to 91.6 per cent by the year 2020.

Primary energy demand grew at the rate of six per cent a year between 1981 and 2001 (Planning Commission, 2002), and India now ranks fifth in the world in terms of primary energy consumption. It accounted for about 3.5 per cent of the world's commercial energy demand in 2003.

Despite efforts to enhance domestic energy production and diversify fuel mix, India still faces energy and peak shortages of around 8 per cent and 12 per cent respectively, while a large section of the rural population continues to lack access to clean and efficient energy fuels to meet their daily requirements. As with many developing economies starting from a low per capita energy consumption point, India's consumption of 439 kg per capita is far below the world average of 1,688 kg per capita (Planning Commission, 2006). India, with over a billion people, only produces 660 billion KWh of electricity and over 600 million Indians have no access to electricity and limited access to other clean, modern fuels such as LPG and kerosene.

There has been significant improvement in the growth in actual generation of energy over the last few years. As compared to the annual growth rate of about 3.1 per cent at the end of the IXth Plan and initial years of the Xth Plan, the growth in generation during 2006-07 and 2007-08 was of the order of 7.3 per cent and 6.33 per cent respectively.

Box 3.4.1: Generation of Energy

The overall energy generation in the country has increased from 662.5 BU during 2006-07 to 704.47 BU during the year 2007-08. The category-wise generation performance is as follows:

Thermal	improved by	5.96%
Hydro	improved by	8.88%
Nuclear	declined by	12.83%
Bhutan imp.	improved by	75.34%

Overall growth rate recorded 6.33%

Source: Ministry of Power, 2008

STATUS OF ENERGY RESOURCES IN INDIA

1. PRIMARY SOURCES OF CONVENTIONAL ENERGY

a) Coal

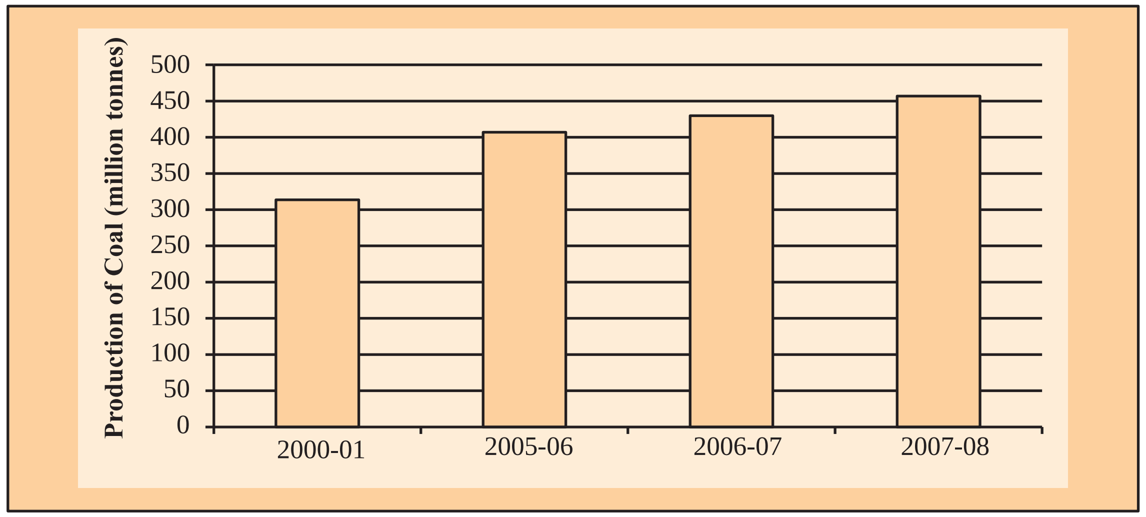
India is the world's third largest producer of coal. The principal deposits of hard coal are in the eastern half of the country, ranging from Andhra Pradesh, bordering the Indian Ocean, to Arunachal Pradesh in the extreme North-East. The eastern states of Chhattisgarh, Jharkhand. Orissa and West Bengal together account for about 77 per cent of India's coal reserves. As a result of exploration carried out to the depth of 1,200 metres by the GSI (Geological Survey of India), CMPDI (Central Mine Planning & Design Institute Ltd.) and MECL (Mineral Exploration Corporation Ltd.), a cumulative total of 253.30 billion tonnes of geological resources of coal have so far been estimated in the country as on 1.1.2006 (Table 3.4.1 and Figure 3.4.1).

Table 3.4.1 : State-wise Distribution of Coal Resources and its Categories

State	Coal resources in million tonnes			
	Proved	Indicated	Inferred	Total
Andhra Pradesh	8403	6158	2584	17145
Arunachal Pradesh	31	40	19	90
Assam	315	27	34	376
Bihar	0	0	160	160
Chhattisgarh	9570	27433	4439	41442
Jharkhand	36148	31411	6339	73898
Madhya Pradesh	7565	9258	2935	19758
Maharashtra	4653	2432	1992	9077
Meghalaya	117	41	301	459
Nagaland	4	1	15	20
Orissa	16911	30793	14295	61999
Uttar Pradesh	766	296	0	1062
West Bengal	11383	11879	4553	27815
Total	**95866**	**119769**	**37666**	**253301**

Source: Ministry of Coal, 2006

Figure 3.4.1: India's Production of Coal



Source: Ministry of Coal, 2008

The coal resources of India are available in sedimentary rocks of older Gondwana formations of peninsular India and younger tertiary formations of north-eastern region. Based on the results of regional / promotional exploration, where the boreholes are normally placed 1-2 km apart, the resources are classified into Indicated and Inferred categories. Subsequent detailed exploration in selected blocks, with boreholes placed less than 400 metres apart, upgrades the resources into more reliable 'Proved' category.

As a result of regional, promotional and detailed exploration by GSI, CMPDI and SCCL, the estimation of coal resources of India has reached 253.30 Bt (Table 3.4.2, Table 3.4.3 and Table 3.4.4).

Table 3.4.2 : The Formation-wise and Category-wise Coal Resources (in million tonnes) of India as on 1.1.2006

Formation	Proved	Indicated	Inferred	Total
Gondwana Coal	95399	119663	37297	252359
Tertiary Coal	467	106	369	942
Total	**95866**	**119769**	**37666**	**253301**

Source: Ministry of Coal, 2006

Table3.4.3: Type-wise and Category-wise Coal Resources (in million tonnes) of India as on 1.1.2006

Type of Coal	Proved	Indicated	Inferred	Total
(A) Coking				
Prime Coking	4614	699	-	5313
Medium Coking	11445	11751	1880	25076
Semi-Coking	482	1003	222	1707
Sub-Total Coking	**16541**	**13453**	**2102**	**32096**
(B) Non-Coking*	**79325**	**106316**	**35564**	**221205**
Total (Coking & Non-Coking)	**95866**	**119769**	**37666**	**253301**
* Including total coal of North Eastern Region				

Source: Ministry of Coal, 2006

Table 3.4.4: Estimates of Coal Resources (in million tonnes) in the Country during last 5 years

As on	Proved	Indicated	Inferred	Total
1.1.2002	87320	109377	37417	234114
1.1.2003	90085	112613	38050	240748
1.1.2004	91631	116174	37888	245693
1.1.2005	92960	117090	37797	247847
1.1.2006	95866	119769	37666	253301

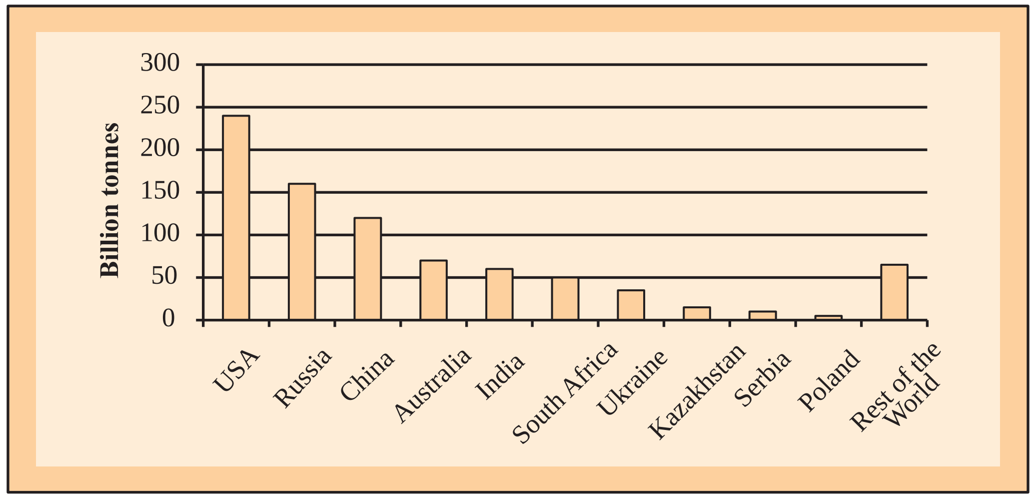
Source: Ministry of Coal, 2007

Lignite deposits mostly occur in the southern state of Tamil Nadu. India's geological resources of lignite are estimated to be some 36 billion tonnes, of which about 2.4 billion tonnes in the Neyveli area of Tamil Nadu are regarded as mineable under the presently adopted mining parameters. Annual production of lignite is currently in the region is 31 million tonnes, almost all of which is used for electricity generation (Table 3.4.4).

Although India's coal reserves cover all ranks - from lignite to bituminous, they tend to have high ash content and a low calorific value. The low quality of much of its coal prevents India from being anything but a small exporter of coal (traditionally to the neighbouring countries of Bangladesh, Nepal and Bhutan) and conversely, is responsible for sizeable imports (around 20 million tonnes per annum of coking coal and 17 million tonnes per annum of steam coal) from Australia, China, Indonesia and South Africa (Figure 3.4.2).

Coal is a major energy source catering to India's growing energy needs. It meets about 51 per cent of the country's commercial energy needs, and about 70 per cent of the electricity produced in India comes from coal. While the adoption of efficient coal-based power generation technologies (internal gasification combined cycle and ultra-supercritical) would reduce the environmental impacts from coal combustion, clean coal utilization needs to be adopted across the entire coal cycle through scientific mining practices followed by land reclamation, beneficiation of coal for ash reduction at source and transforming coal from its current form to cleaner energy forms via coal liquefaction, and coal gasification. Moreover, Coal Bed Methane (CBM) is an important clean energy option for the country and needs to be examined judiciously as a key alternative to the country's sustainable energy pathway.

Figure 3.4.2: Proved Recoverable Coal Reserves; The Top Ten Countries in the World



Source: World Energy Council Survey of Energy Resources, 2007

The Ministry of Petroleum and Natural Gas (MoPNG) has undertaken several initiatives to tap gaseous fuels other than natural gas. Proven Coal Bed Methane (CBM) is estimated to double India's proven gas reserves. The government has formulated a CBM policy to attract technology and investment for exploration and production of CBM from coal-producing areas. Already, 16 exploration blocks for CBM have been awarded to national oil companies and private companies, and exploration work in all these blocks is in progress. *In-situ* coal gasification can also release usable gas from in-extractable coal reserves below 600 meters depth and bring it to the surface without the accompanying ash, while providing the potential for injecting back the captured CO_2. Recoverable energy from one of the blocks (Mehsana-Ahmedabad) alone, with coal reserves of 63 billion metric tonnes in the form of gas, could be equivalent to 15,000 billion cubic metres of natural gas. Public sector oil and gas companies are collaborating with leading international organizations in this area (MoPNG, 2005).

b) Oil and Natural Gas

Within a proved amount in place of 1,652 million tonnes, the amount of proved recoverable reserves (as on 1st April 2005) is 786 million tonnes, of which 410 million tonnes is located offshore. Onshore reserves have risen by 13.3 per cent from the 332 million tonnes (as on 1st April, 2002) to 376 million tonnes, whereas offshore reserves have remained virtually unchanged. As on 1st April, 2006, further growth in onshore reserves to 387 million tonnes and a sharp drop in the offshore reserves down by 10 per cent to 369 million tonnes has been recorded.

For more than 60 years after its discovery in 1890, the Digboi oil field in Assam, in the North East of the country, provided India with its only commercial oil production field. This field was still functional in 2005, albeit at a very low level. Since 1960, numerous onshore discoveries have been made in the western, eastern and southern parts of India. In 2005-06, offshore fields provided almost 65 per cent of national oil output. Total production of oil (including gas-plant liquids) has fluctuated in recent years within a range of 36 to 38 million tonnes per annum. In 2005, India produced (in million tonnes) 32.5 crude oil, 1.4 natural gasoline and an estimated 2.4 gas-plant LPG, all of which was consumed internally.

Oil accounts for about one third of India's commercial energy consumption, and its share has been growing gradually in recent years. Although India has significant domestic oil reserves, it is a net oil importer. The Government of India has initiated such

Electricity for all : Not a distant dream steps, as to intensify domestic exploration and development efforts to explore new fields and increase the reserve base of the country to ensure oil security for the nation. The Hydrocarbon Vision 2025 laid down a phased programme for reappraising 100 per cent of the sedimentary basins of the country by 2025 (Planning Commission, 1999). The Directorate General of Hydrocarbons (DGH) has conducted a number of studies to upgrade information on the unexplored or the less explored regions in the country. Overseas acquisition of equity oil is another major strategy adopted to enhance the oil security of the country. The Government of India aims to produce 20 Mt per annum of equity oil and gas abroad by 2010.

The DGH has divided India's topography into 26 sedimentary basins, comprising 1.35 million km^2 of onshore area and 0.39 million km^2 of offshore area (up to 200 metre isobaths). Despite several developments in the country's hydrocarbon sector, several areas that may have hydrocarbon reserves are yet to be explored. In 1997-98, the Government of India announced its New Exploration Licensing Policy (NELP), with the twin objectives of enhancing domestic production by attracting private capital and foreign technology for the Indian upstream sector, and mapping the sedimentary basins of the country as extensively as possible. Under this framework, total freedom has been given to market crude oil in the domestic market and a company can bid directly without the participation of ONGC or OIL, as was mandatory earlier.

Although oil shale, in association with coal and also oil, is known to exist in the far northeastern regions of Assam and Arunachal Pradesh, the extent of the resource and its quality have not yet been determined. Currently oil shale, recovered with coal during the mining process, is discarded as a waste product. However, the Indian Directorate General of Hydrocarbons has initiated a project designed to assess the reserve and its development.

A sizeable natural gas industry has been developed on the basis of the offshore Mumbai gas and oil/gas fields. Proved reserves as on 1st April, 2005 have been reported by the Indian WEC Member Committee as 1,101 bcm, an increase of 46.6 per cent on the level reported in the 2004 Survey. The revised figure appears to be consistent with the series of 'proved and indicated balance recoverable reserves' published by the Ministry of Petroleum & Natural Gas, which shows 1,075 bcm for such reserves as on 1st April 2006. Strong growth in India's offshore reserves has been recorded from 584 bcm (63 per cent of total reserves) as on 1st April, 2004 to 761 bcm (69 per cent of total reserves) as on 1st April, 2005.

The Indian WEC Member Committee also reports that the proved amount of gas in place (of which the proved reserves constitute the recoverable portion) is 1,595 bcm. Marketed production is principally used as a feedstock for fertilizer and petrochemical manufacture, electricity generation and as industrial fuel. The recorded use in the residential and agricultural sectors is very small.

c) Nuclear Power

Nuclear power for civil use is well established in India. Its civil nuclear strategy has been directed towards complete independence in the nuclear fuel cycle necessary because it is excluded from the 1970 Nuclear Non-Proliferation Treaty (NPT) due to its acquiring nuclear weapons capability after 1970.

As a result, India's nuclear power programme has proceeded largely without fuel or technological assistance from other countries (but see later section). Its power reactors till the mid 1990s had some of the world's lowest capacity factors, reflecting the technical difficulties due to the country's isolation, but rose impressively from 60 per cent in 1995 to 85 per cent in 2001-02.

Nuclear power supplied 15.8 billion kwh (2.5 per cent) of India's electricity in 2007 from 3.7 GWe (out of a total of 110 GWe) capacity and this will increase steadily as imported uranium becomes available and new plants come on line. India's fuel situation, with shortage of fossil fuels, is driving the investment in nuclear energy. By 2050, nuclear energy is expected to contribute 25 per cent to total energy production i.e. one hundred times the 2002 capacity. Almost as much investment in the grid system as in power plants is necessary.

Between 2010 and 2020, further construction is expected to take the total gross capacity to 21,180 MWe. The nuclear capacity target is part of the national energy policy. This planned increment includes the initial 300 MWe Advanced Heavy Water Reactor (AHWR).

Box 3.4.2 : India's Nuclear Power Potential

- India has a flourishing and largely indigenous nuclear power programme and expects to have 20,000 MWe nuclear capacity on line by 2020. It aims to supply 25 per cent of electricity from nuclear power by 2050.
- Because India is outside the Nuclear Non-Proliferation Treaty, due to its weapons programme, it has been for 34 years largely excluded from trade in nuclear plant or materials, which has hampered its development of civil nuclear energy.
- Due to these trade bans and lack of indigenous uranium, India has uniquely been developing a nuclear fuel cycle to exploit its reserves of thorium.

2. RENEWABLE ENERGY

India is blessed with an abundance of sunlight, water and biomass. Vigorous efforts during the past two decades are now bearing fruit as people from all walks of life are more aware of the benefits of renewable energy, especially where decentralized energy is required in villages and in urban or semi-urban centres. India has the world's largest programme for renewable energy. The government created the Department of Non-conventional Energy Sources (DNES) in 1982. In 1992, a full-fledged Ministry of Non-conventional Energy Sources was established under the overall charge of the Prime Minister.

a) Hydropower

India's gross theoretical hydropower potential (2,638 TWh/year) and technically feasible potential (660 TWh/year) are amongst the highest in the world. The public utilities' total installed hydroelectric capacity exceeded 32,000 MW at the end of 2005, with a corresponding generation of 97.4 TWh, equivalent to 16 per cent of India's public sector electricity generation. The Indian WEC Member Committee reports that about 13 GW of hydro capacity was under construction at end-2005 and that a further 9 GW is planned. The largest hydropower plants currently under construction are Subansiri Lower (2,000 MW), Parbati II (800 MW) and Omkareshwar (520 MW).

Numerous other hydropower projects are under way or at the planning stage. In addition, 55 hydropower schemes have been designated as suitable for renovation and upgrading, which could eventually result in an increment of some 2,500 MW to India's generating capacity. Hydropower & Dams World Atlas reports that there are 420 small-scale hydropower plants in operation, with an aggregate installed capacity of about 1,423 MW; a further 521 MW of small scale capacity is under construction.

A view of Nathpa Jakhri Hydro Electric Power Station, Himachal Pradesh

b) Bioenergy

For India, biomass has always been an important energy source. Although the energy scenario in India today indicates a growing dependence on the conventional forms of energy, about 32 per cent of the total primary energy use in the country is still derived from biomass and more than 70 per cent of the country's population depends upon it for its energy needs.

India produces a huge quantity of biomass material in its agricultural, agro-industrial and forestry operations. According to some estimates, over 500 million tonnes of agricultural and agro-industrial residue is generated every year. This quantity, in terms of heat content, is equivalent to about 175 million tonnes of oil. A portion of these materials is used for fodder and fuel in the rural economy. However, studies have indicated that at least 150-200 million tonnes of this biomass material does not find

Table 3.4.5: Estimated Potential for Renewable Energy Technologies in India

Sl. No.	Source / Systems	Approximate Potential
1	Biogas Plants	120 lakh W
2	Improved Chulhas	1200 lakh W
3	Wind	45000 MW
4	Small Hydro Projects	15000 MW
5	Biomass	19500 MW
6	Biomass Gasifiers	NA
7	Solar PV	20 MW/sq.km
8	Waste to Energy	2500 MW
9	Solar Water Heating	140 Million sq.m Collector Area
NA: Not Available		

Source: Ministry of New and Renewable Energy, 2007 much productive use, and can be made available for alternative uses at an economical cost. These materials include a variety of husks and straws. This quantity of biomass is sufficient to generate 15,000 to 25,000 MW of electrical power at a typically prevalent plant.

In India, more than 2,000 gasifiers are estimated to have been established with a capacity in excess of 22 MW and a number of villages have been electrified with biomass gasifier based generators. MNRE has actively promoted research and development programmes for efficient utilization of biomass and agrowastes and further efforts are on in this direction.

c) Solar Energy

The Ministry of New and Renewable Energy (MNRE), formerly the Ministry of Non Conventional Energy Sources (MNES), working in conjunction with the Indian Renewable Energy Development Agency (IREDA) continues to promote the utilization of all forms of solar power as part of its drive to increase the share of renewable energy in Indian market. This promotion is being achieved through R&D, demonstration projects, government subsidy programmes, programmes based on cost recovery supported by IREDA, and also private sector projects. India receives a good level of solar radiation, energy equivalent of more than 5,000 trillion KWh/year.

Depending on the location, the daily incidence ranges from 4 to 7 KWh/m^2, with the hours of sunshine ranging from 2,300 to 3,200 per year. Solar thermal and solar photovoltaic technologies are both encompassed by the Solar Energy Programme that is being implemented by the Ministry. The Programme, regarded as one of the largest in the world, plans to utilize India's estimated solar power potential of 20 MW/km^2, and 35 MW/km^2 solar thermal. The country has also developed a substantial manufacturing capability, becoming a lead producer in the developing world.

India's overall potential for solar water heating systems has been estimated to be 140 million m^2 of collector area. Up to the present only about 1 million m^2 of collector area has been installed, a low level in comparison with the potential, and as compared with other countries, notably China. A Government scheme for 'Accelerated development and deployment of Solar Water Heating Systems in domestic, industrial and commercial sectors' has been introduced, with the object of promoting the installation of another million m^2 of collector area during financial year 2005-06 and 2006-07. The scheme offers a number of financial and promotional incentives, along with other measures of support. The installation of Evacuated Tube Collectors is being officially encouraged.

Solar Air Heating technology has been applied to various industrial and agricultural processes (e.g. drying, curing, regeneration of dehumidifying agents, timber seasoning, leather tanning). For space heating, many types of solar dryers have been developed for utilization in different situations. The Government provides financial support for solar air heating/drying systems, and also for solar concentrating systems such as the 160 m^2 parabolic dish concentrator recently installed for use in milk pasteurization at a dairy in Maharashtra.

Solar buildings have been promoted by the MNRE in an effort to increase the energy efficiency. The state government in Himachal Pradesh has actively promoted the incorporation of passive solar design into the building design.

The Solar Photovoltaic Programme (SPV), promoted by the Ministry for the past two decades, has been aimed particularly at rural and remote areas. Following the success of the country-wide SPV demonstration and utilization programme during the period of the IXth Plan, it was planned, with certain modifications, to continue it during the Xth Plan (2002-2007).

Of the approximately 80,000 villages not currently connected to the grid, about 18,000 are too remote to be considered. The Ministry has the objective that by 2010 they will all have access to power from renewable energy sources, with the Xth Plan providing electrification for the 5,000 of them. During 2005-06, the Ministry supported the supply of solar lanterns to certain un-electrified villages.

In a country where agriculture is a major component of the economy, the SPV Water Pumping Programme will continue to subsidize the large-scale use of PV-powered (1800 Wp) pumping systems for farmers. The Ministry is also implementing a programme for water-pumping windmills, small aerogenerators and wind-PV hybrid systems to enable the considerable Indian wind resource to be harnessed in conjunction with the available solar power. These applications will be fully researched and demonstrated prior to deployment in remote areas.

The MNRE is developing a chain of Akshay Urja Shops (previously called Aditya Solar Shops). These are showroom-cum-sales and service centres, initially established to sell solar energy products; their scope has now been widened to cover all renewable energy systems and devices. So far, 104 shops have been opened in 28 States and Union Territories, and the Ministry has planned for at least one such shop to exist in each district throughout the country.

Biofuel : A main source of cooking in rural India

d) Geothermal Energy

It has been estimated by the Geological Survey of India that the geothermal potential is in the region of 10,000 MWe, widely distributed between seven geothermal provinces. The provinces, although found along the West Coast in Gujarat and Rajasthan and along a West-Southwest - East-Northeast line, running from the west coast to the western border of Bangladesh, are most prolific in a 1,500 km stretch of the Himalaya. The resource is little used at the moment but the government has an ambitious plan to more than double the current total installed generating capacity by 2012. This would be achieved by utilizing both conventional fossil fuels and the range of renewable energies at India's disposal (bioenergy, hydro, geothermal, solar and wind). The Tattapani field in the far Northwest of the Himalaya is estimated to have a potential of one MW and if this could be developed it would substantially benefit the isolated villages in the mountainous areas. Direct utilization is almost entirely for bathing and balneological purposes but greenhouse cultivation of fruits could be developed extensively in future by harnessing this resource.

e) Wind Energy

The Indian Wind Power Programme was initiated in 1983-84 and a Wind Energy Data Handbook published in 1983 by the Ministry of New and Renewable Energy, served as a data source for early government initiatives. In 1985, an extensive Wind Resource Assessment was launched, which also signalled the beginning of concentrated development and harnessing of renewable sources of energy and, more specifically, of wind energy. To date, seven volumes of the Handbook on Wind Energy Resource Survey, containing a huge volume of accumulated wind data, have been published. It is being implemented through the state Nodal Agencies and the Centre for Wind Energy Technology (C-WET). C-WET, an autonomous R&D institution, established by the Ministry and based in Chennai, acts as a technical focal point for wind power development in India.

Estimates of the Indian wind resource have put it at about 45,000 MW, assuming 3 per cent land availability for wind farms requiring 12 ha/MW, at sites having adequate wind power density in excess of locations with abundant wind have been identified in the following ten states: Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and West Bengal. In terms of currently installed wind turbine capacity, India ranks fourth in the world after Germany, Spain and the USA. At the end of 2005, the figure stood at 4,434 MW. Tamil Nadu possessed over 57 per cent of the commercial plants.

By the end of September 2006, the installed capacity had already grown to 6,018 MW. Demonstration projects, which began in 1985, are being implemented in areas not already having projects but where potential for commercial development exists. In early 2006, total demonstration capacity amounted to 68 MW. Use is being made of wind-diesel hybrid projects where an area is dependent on diesel fuel. A project with a capacity of 2x50 KW has been commissioned in the Sagar Islands in West Bengal. Phase II (8x50 KW) of the project is expected to be commissioned shortly. The strong growth in the Indian wind energy market is expected to continue and even accelerate, as a result of a range of Government and State-led financial incentives (Table 3.4.6).

Table 3.4.6 : State-wise Wind Power Installed capacity

Sl No.	State	Wind Power Installed Capacity (MW)					
		2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
1	2	3	4	5	6	7	8
1	Andhra Pradesh	0.7	0.0	6.2	21.8	126.1	121.60
2	Gujarat	0.0	6.2	28.9	51.5	287.8	401.40
3	Karnataka	24.0	55.6	84.9	201.5	487.0	745.60
4	Kerala	0.0	0.0	0.0	0.0	2.0	2.00
5	Madhya Pradesh	0.0	0.0	0.0	6.3	35.1	54.90
6	Maharashtra	209.4	2.0	6.2	48.8	654.6	1283.70
7	Rajasthan	8.8	44.6	117.8	106.3	312.6	444.80
8	Tamil Nadu	44.0	133.6	371.2	675.5	2526.7	3216.10
9	West Bengal	0.6	0.0	0.0	0.0	1.1	1.10
10	Others	0.0	0.0	0.0	0.0	1.6	3.20
	Total	**287.5**	**242.0**	**615.2**	**1111.7**	**4434.6**	**6274.40**

Source: Ministry of New and Renewable Energy, 2007

f) Tidal Energy

The main potential sites for tidal power generation are the Gulf of Kutch and the Gulf of Khambhat (Cambay), both in the western state of Gujarat, and the Gangetic delta in the Sundarbans area of West Bengal, in eastern India. The tidal ranges of the Gulf of Kutch and the Gulf of Khambhat are 5 and 6 metres, the theoretical capacities 900 and 7,000 MW, and the estimated annual output approximately 1.6 and 16.4 TWh, respectively. The West Bengal Renewable Energy Development Agency (WBREDA) prepared a project report, for a 3.65 MW demonstration tidal power plant at Durgaduani Creek in the Sundarbans. This was followed by an environmental impact assessment study. In February, 2007, the WBREDA stated that it had engaged the National Hydroelectric Power Corporation to implement the Rs 400 million (approximately US$ 10 million) project on a turnkey basis, with the work likely to begin in the near future.

g) Wave Energy

The Indian Wave Energy Programme started in 1983 at the Indian Institute of Technology (IIT) under the sponsorship of the Indian Department of Ocean Development. Initial research identified the OWC as the most suitable for Indian conditions. A 150 KW pilot OWC was built onto the breakwater of the Vizhinjam Fisheries Harbour, near Trivandrum (Kerala), with commissioning in October 1991. The scheme operated successfully, producing data that was used for the design of a superior generator and turbine. An improved power module was installed at Vizhinjam in April 1996, which in turn led to the production of new designs for a breakwater comprising ten caissons with a total capacity of 1.1 MW. However, this does not appear to have been taken any further. The National Institute of Ocean Technology has succeeded IIT and continues to research wave energy, including the Backward Bent Duct Buoy (a variant of the OWC design).

h) Ocean Thermal Energy Conversion

Having an extremely long coastline, a very large EEZ area and suitable oceanic conditions, India's potential for OTEC is extensive. Conceptual studies on OTEC plants for Kavaratti (Lakshadweep Islands), in the Andaman and Nicobar Islands and off the Tamil Nadu coast at Kulasekharapatnam were initiated in 1980. In 1984, a preliminary design for a 1 MW (gross) closed Rankine Cycle floating plant was prepared by the Indian Institute of Technology in Madras at the request of the Ministry of Non-Conventional Energy Resources. The National Institute of Ocean Technology (NIOT) was formed by the governmental Department of Ocean Development in 1993 and in 1997, the government proposed the establishment of a 1 MW plant of earlier studies. NIOT signed a Memorandum of Understanding with Saga University in Japan for the joint development of the plant near the port of Tuticorin (Tamil Nadu). During 2001, the Department of Ocean Development undertook an exercise to determine the actions required to maximise the country's potential from its surrounding ocean. The result was a Vision Document and a Perspective Plan 2015 (forming part of the X[th] five year plan), in which all aspects of the Indian Ocean will be assessed, from the forecasting of monsoons through the modelling of sustainable uses of the coastal zone to the mapping of ocean resources, etc. It has been postulated that most of India's future fully-commercial OTEC plants will be closed cycle floating plants in the range of 10 to 50 MW (although 200 to 400 MW plants are not ruled out). Working with Saga University, NIOT had planned to deploy the 1 MW demonstration plant in March/April, 2003. However, mechanical problems prevented total deployment and the launch was delayed. Following the testing, it was planned to relocate the plant to the Lakshadweep Islands for power generation prior to full commercial operation from scaled-up plants. No further progress has been reported so far.

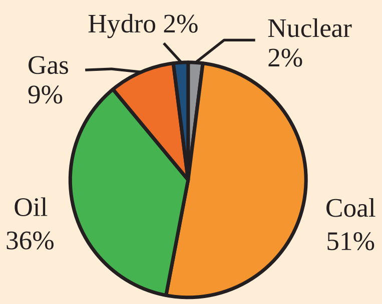
ENERGY CONSUMPTION

In recent years, India's energy consumption has been increasing at one of the fastest rates in the world owing to population growth and economic development (Figure 3.4.3). Primary commercial energy demand grew at the rate of 6 per cent between 1981 and 2001 (Planning Commission 2002). India ranks fifth in the world in terms of primary energy consumption, accounting for about 3.5 per cent of the world commercial energy demand in the year 2003. Despite the overall increase in energy demand, per capita energy consumption in India is still very low compared to other developing countries. Despite the increasing dependency on commercial fuels, a sizeable quantum of energy requirement (40 per cent of total energy requirement), especially in the rural household sector, is met by non-commercial energy sources, which includes fuelwood, crop residue, and animal waste, including human and draught animal power. However, other forms of commercial energy of a much higher quality and efficiency are steadily replacing the traditional energy resources being consumed in the rural sector.

Resource augmentation and growth in the energy supply has not kept pace with the increasing demand and, therefore, India continues to face serious energy shortages. This has led to increased reliance on imports to meet the energy demand.

Figure 3.4.3: Primary Energy Sources of India

Primary Energy Sources (%)



Source: Planning Commission of India, 2006

Table 3.4.7 : Renewable Energy: Estimated Potential and Cumulative Achievements as on 31.12.2007

Sl. No.	Source / Systems	Estimated Potential	Cumulative Achievements
I.	**Rural and Decentralized Energy Systems**	-	-
1	Family type Biogas Plants(nos.)	120 lakh	39.40 lakh
2	Solar Photovoltaic Programme	50 MW/Sq.km.	110 MWp
	i. Solar Street Lighting System	NA	69,549 nos.
	ii. Home Lighting System	NA	3,63,399 nos.
	iii. Solar Santam	NA	5,85,001 nos.
	iv. Solar Power Plants	NA	2.18 MWp
3	Solar Thermal Programme	NA	-
	i. Solar Water Heating Systems	140 million sq.m. collector area	2.15 million sq.m. collector area
	ii. Solar Cookers	NA	6.17 lakh
4	Wind Pumps	NA	1284 nos.
5	Aero-generator / Hydro Systems	NA	675.27 KW
6	Solar Photovoltaic Pumps	NA	7068 nos.
II.	**Remote Village Electrification**	**NA**	**3368 / 830 villages /hamlets**
III.	**Power from Renewables**	-	-
A.	*Grid-interactive renewable power*	*NA*	*NA*
7	Bio Power (Agro residues & Plantations)	16,881	605.80 MW
8	Wind Power	45,195	7,844.52 MW
9	Small Hydro Power (up to 25 MW)	15,000	2,045.61 MW
10	Cogeneration-bagesse	5,000	719.83 MW
11	Waste to Energy (Urban & Industrial)	2,700	55.25 MW
12	Solar Power	-	2.12 MW
	Total (in MW)	84,776	11272.13 MW
B.	*Captive/CHP/Distributed renewable power*	-	-
13	Biomass / Cogeneration (non-bagass)	-	95.00 MW
14	Biomass Gasfier	NA	86.53 MW
15	Energy Recovery from Waste	NA	23.70 MW
	Total	NA	205.23 MW
IV.	**Other Programmes**	-	-
16	Energy Parks	NA	504 nos.
17	Aditya Solar Shops	NA	269 nos.
18	Battery Operated Vehicle	NA	270 nos.

MW = Megawatt, KW = Kilowatt, KWp = Kilowatt peak, sq.m = square metre
NA: Not Available

Source: Annual Report 2007-08, Ministry of New and Renewable Energy

Agriculture Sector

Till the 1950s, use of tractors for agriculture was very limited. Tractor manufacturing in India started in 1961 with aggregate capacity to manufacture 11,000 tractors. Joint efforts made by the government and private sector have led to a steady increase in the level of mechanization over the years.

Given that rains are not always timely and evenly distributed, farmers prefer pump sets as a more reliable and assured source of irrigation; as a result, energization of pump sets have been increasing rapidly. As on 31[st] March 2004, 14.1 million pump sets had been energized. Maharashtra has the maximum number of energized pump sets (2.4 million), followed by Andhra Pradesh (2.3 million). Earlier, the average capacity of the pump sets was 3.68 KW and a pump set on an average consumed 6004 kWh of electricity in that year (Central Electricity Authority, 2005). However, owing to insufficient electricity supplies, some farmers have also procured diesel pump sets as a standby. In the recent past, concerted efforts of the government have led to the introduction of biomass and solar photovoltaic based pumping systems.

As a result of increased mechanization in agriculture, crop production and rural agro-processing emerged as one of the major consumers of commercial energy. The share of mechanical and electrical power in agriculture increased from 40 per cent in 1971-72 to 84 per cent in 2003-04. The availability of farm power per unit area (kW/ha) has been considered as one of the parameters of expressing the level of mechanization. Power availability for carrying out various agricultural operations has increased from 0.3 KW/ha in 1971-72 to 1.4 KW/ha in 2003-04).

Connected load in the agriculture sector in 2004 was estimated to be 51.84 GW, the number of consumers being 12.8 million. The electricity consumption in agriculture during 2003-04 was 87,089 GWh (second highest) or 24.13 per cent of the total electricity consumption. There was an increase of 3.08 per cent in the electricity sales to the agriculture sector in 2003-04 over 2002-03 (CEA 2005). Electricity consumption in agriculture sector has been increasing mainly because of greater irrigation demand for new crop varieties and subsidized electricity to this sector. Moreover, due importance is not given to proper selection, installation, operation, and maintenance of pumping sets, as a result of which they do not operate at the desired level of efficiency, leading to huge wastage of energy.

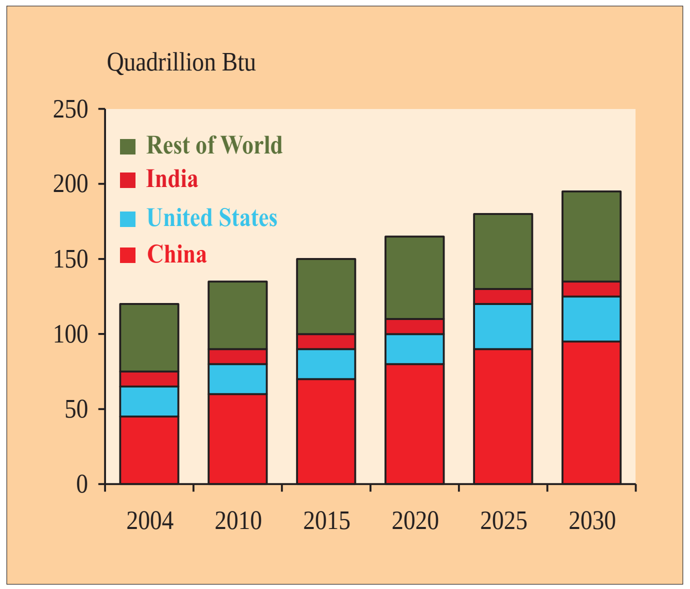
Agriculture (plantation/food) consumed 7,123 thousand tonnes of HSD (high-speed diesel) in 2003-04, accounting for 19.2 per cent of the total HSD consumption during the year. Consumption of LDO (light diesel oil) and furnace oil for plantation in 2003-04 was 44,000 and 2,43,000 tonnes,

Table 3.4.8: Power Supply Position in India

Year	Energy Requirement	Energy Availability (MU)	Energy Shortage (MU)	Energy Shortage (%)
1997-98	4,24,505	3,90,330	34,175	8.1
1998-99	4,46,584	4,20,235	26,349	5.9
1999-00	4,80,430	4,50,594	29,838	6.2
2000-01	5,07,216	4,67,400	39,816	7.8
2001-02	5,22,537	4,83,350	39,187	7.5
2002-03	5,45,983	4,97,890	49,093	8.8
2003-04	5,59,284	5,19,398	39,888	7.1
2004-05	5,91,373	5,48,115	43,258	7.3
2005-06	6,31,554	5,78,819	52,735	8.4
2006-07	6,90,587	6,24,495	66,092	9.6
2007-08 (upto Jan.'08)	6,08,804	5,54,248	54,556	9.0

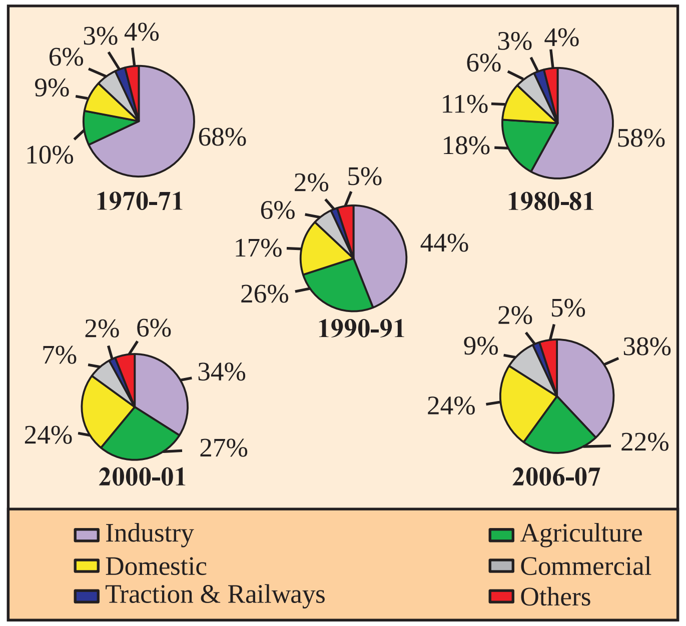
Source: Annual Report- 2007-2008, Ministry of Power

Figure 3.4.4: World Coal Consumption 2004-2030



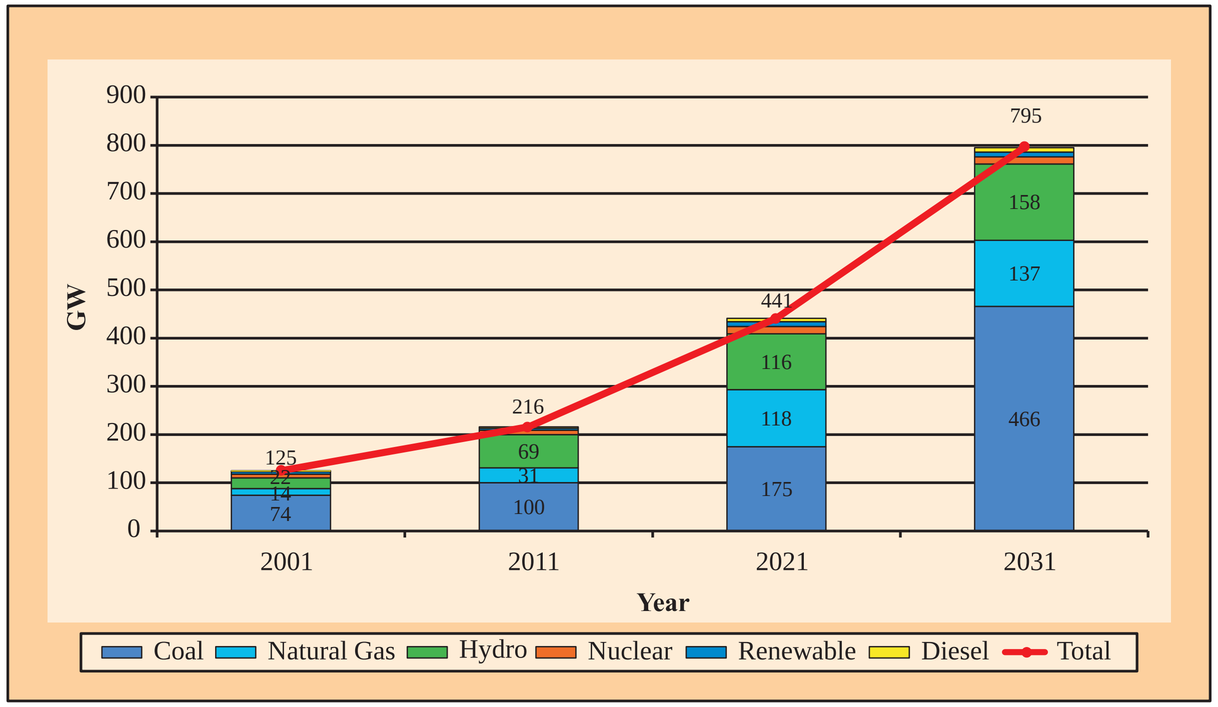
Source: 2004: Energy Information Administration (EIA), International Energy Annual 2004 (May - July 2006)

Figure 3.4.5: Sector-wise Consumption of Electricity in India



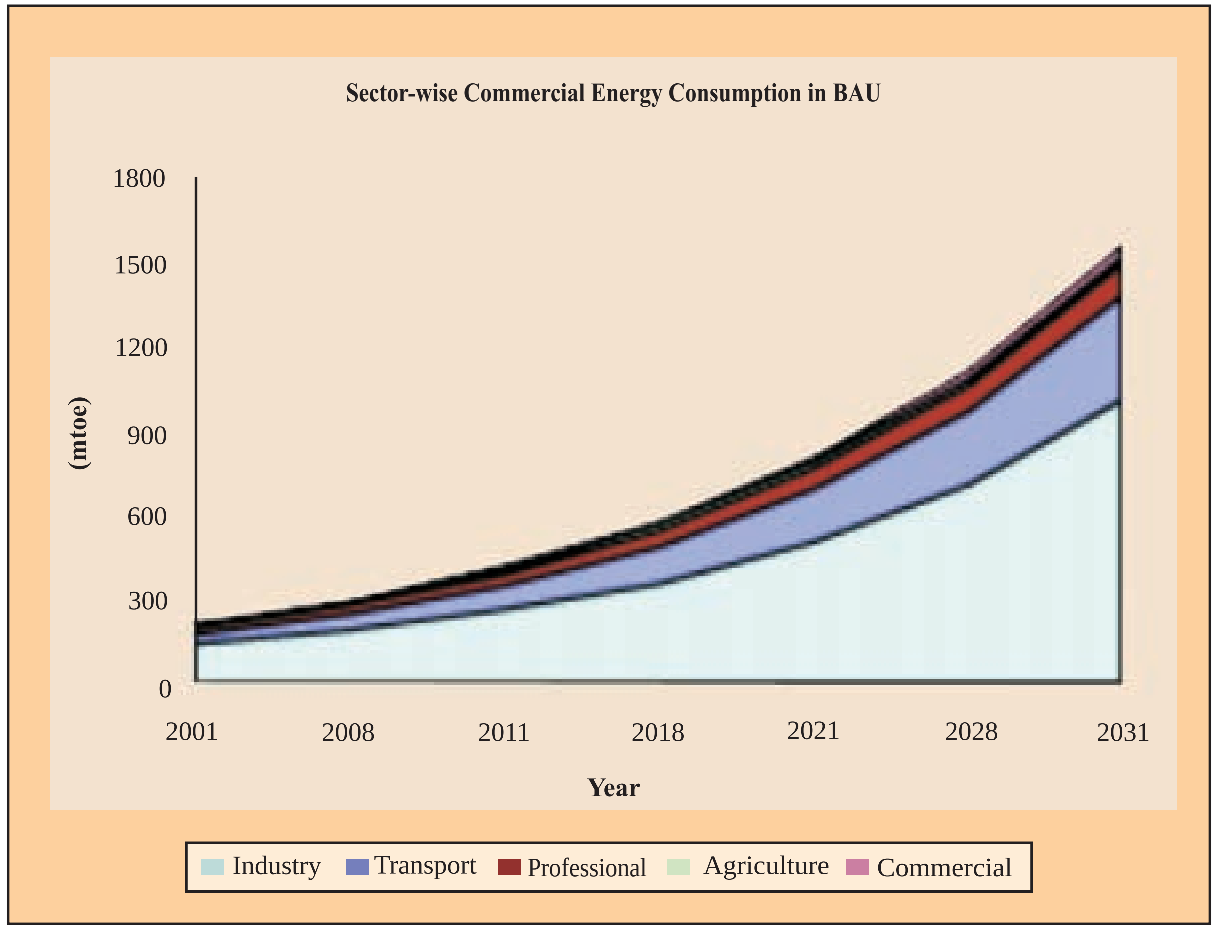
Source: Energy Statistics 2007, Ministry of Statistics and Programme Implementation

Figure 3.4.6: Projected Electricity Generation Capacity



Source: TERI, 2003

Figure 3.4.7: Projected Commercial Energy Consumption



Source: TERI, 2003

Hydro Power: A main source of energy in India

respectively, accounting for 2.7 per cent of the total LDO and 2.9 per cent of the total furnace oil consumed in the country. Consumption of furnace oil for transport (agriculture retail trade) in the agriculture sector was 94,000 tonnes (*Ministry of Power and Natural Gas 2004*). However, it is difficult to assess the total diesel consumption for agriculture from the available data.

The electricity consumption in agriculture sector was 22 per cent of the total electricity consumption during 2006-07 (Figure 3.4.5).

Industrial Sector

Of the total electricity consumed in 2006-07, industrial sector accounted for the largest share. The industrial sector uses about 50 per cent of the total commercial energy available in India. Of the commercial sources of energy, coal, lignite, oil and natural gas are mainly used. The Indian industrial sector is highly energy intensive and efficiency is well below that of other industrialized countries. Efforts are made on a regular basis to promote energy conservation in these countries as this will help reduce the cost of production.

There is considerable scope for improving energy efficiency in industries dealing with iron and steel, chemicals, cement, pulp and paper, fertilizers, textiles, etc. If such industries adopt energy conservation measures, it could lead to a substantial reduction in their cost of production. Energy management is very important and well planned actions can help reduce an organization's energy bills and minimize its impact on the environment. The two main energy management strategies are conservation and efficiency. This requires the establishment of a system of collection, analysis, and reporting on the organization's energy consumption and costs.

In the industrial sector, the major consumers of energy are fertilizer, textile, sugar, cement, and steel. It has been estimated that the total conservation potential of this sector is around 25 per cent of the entire energy used by it.

Domestic Sector

Of the total electricity consumed in 2006-07, industrial sector accounted for the largest share, followed by the domestic sector. Electricity consumption in domestic sector has increased at a much faster pace as compared to other sectors during 1970-71 to 2006-07.

Transport Sector

Transport sector accounts for the lion's share (50.4 per cent) of the total consumption of high speed diesel oil in India. In India, transportation energy use increases by an average of 4.4 per cent per year for light-duty vehicles, 2.9 per cent per year for passenger rail, and 3.4 per cent per year for buses.

INDIA'S INITIATIVES TOWARDS ENERGY SECURITY

In the recent years, the government has rightly recognized the energy security concerns of the nation and more importance is being placed on energy independence.

India is probably the only country in the world with a full-fledged ministry dedicated to the production of energy from renewable energy sources. The Indian government is promoting the use of ethanol made from sugar-cane and bio-diesel extracted from trees that are common in many parts of India, such as *Jatropha*, *Karanja* and *Mahua*. Additionally, India is emerging as a growing market for solar, wind and hydroelectric power.

The Government of India has an ambitious mission of 'Power for all by 2012'. This mission would require that our installed generation capacity should be at least 200,000 MW by 2012 from the present level of 144,564.97 MW. Power requirement will double by 2020 to 400,000MW.

Objectives

- Sufficient power to achieve the GDP growth rate of 8 per cent
- Reliable power
- Quality power
- Optimum power cost
- Commercial viability of power industry
- Power for all

Strategies

- Power Generation Strategy will focus on low cost generation, optimization of capacity utilization, controlling the input cost, optimization of fuel mix, Technology upgradation and utilization of non-conventional energy sources.
- Transmission Strategy will focus on development of National Grid including Interstate connections, technology upgradation and optimization of transmission cost.
- Distribution strategy to achieve distribution reforms with the focus on system upgradation, loss reduction, theft control, consumer service orientation, quality power supply commercialization, decentralized distributed generation and supply for rural areas.
- Regulation Strategy is aimed at protecting consumer interests and making the sector commercially viable.
- Financing Strategy to generate resources for required growth of the power sector.
- Conservation Strategy to optimize the utilization of electricity with the focus on demand side management, load management and technology upgradation to provide energy efficient equipment / gadgets.
- Communication Strategy for political consensus with media support to enhance public awareness.

Box 3.4.3: Rajiv Gandhi Grameen Vidhyutikaran Yojana (RGGVY): Progress

- A total of 27 states and their utilities have signed the Memorandum of agreement agreeing to the conditionalities for implementation of the programme as envisaged under RGGVY.
- CPSUs - Power Grid Corporation (India) Ltd. (PGCIL), National Thermal Power Corporation (NTPC), National Hydro-electric Power Corporation (DVC) - have been allotted 139 districts for implementation of RGGVY.
- At present, 235 projects are under implementation covering 67,012 unelectrified villages and 83.1 lakh BPL households at the awarded cost of Rs. 12,386.03 crore.
- In all 45,430 villages have been electrified and 18,25,508 connections to BPL households at the awarded cost of Rs. 12,386.03 crores.
- Franchisees are in place in 73,422 villages in 14 States.

Source: Economic Survey of India,2007-2008

Rural Electrification

Jharkhand, Bihar, Uttar Pradesh, Orissa, Uttranchal, West Bengal etc. are some of the states where significant number (more than 10 per cent) of villages are yet to be electrified.

- Number of Villages (1991 Census) - 593,732
- Villages Electrified (30^{th} May 2006) - 488,173
- Village level Electrification - 82.2 per cent

Subsidies

Several state governments in India provide electricity at subsidized rates or even free to some sections. This includes electricity for use in agriculture and for consumption by backward classes. The subsidies are mainly in the form of cross-subsidization, with the other users such as industries and private consumers paying the deficit caused by the subsidized charges collected. Such measures have resulted in many of the state electricity boards becoming financially weak.

Demand-side measures initiated by the Government

CDM Based CFL Scheme: The government has approved a scheme of Rs. 48 crores to promote replacement of incandescent bulbs with Compact Fluorescent Lamps (CFLs) by leveraging the sale of Certified Emission Reductions (CERs) under the Clean Development Mechanism (CDM) of Kyoto Protocol. The Bureau of Energy Efficiency (BEE) is coordinating voluntary efforts to provide high-quality CFLs to domestic consumers. This will reduce CO_2 emission and help avoid the consumption of 6,000 to 10,000 MW.

Energy Conservation Building Code (ECBC): The ECBC has been launched to reduce energy consumption in new commercial buildings.

Standards and Labeling Programme & Strengthening of SDAs: The government has approved a scheme for capacity building at the state level (with an approved cost of Rs 49.47 crores) and a Standards Labeling Programme to promote energy efficient equipments and appliances with an allocation of Rs. 47.71 crores.

CURRENT STATUS AND POTENTIAL OF CLEAN ENERGY

Integrated Energy Policy constituted by the Planning Commission has in its report (IEPR) estimated the requirement of primary energy supply to increase 3 to 4 times the 2003-04 level for an economy growing at around 8 to 9 per cent per annum over the next 25 years. The country's electricity generation capacity / supply would need to go up 6 to 7 fold from the current installed capacity of around 1.15 lakh MW during 2003-04 to between 7.8 to 9.6 lakh MW by 2031-2032 (end of XV Plan period). In addition, crude oil requirement would need to increase 4 to 4.5 fold from the 2003-04 consumption level of around 122 MMT to 486-548 MMT by 2031-2032.

(a) Enhancing Sustainable Development

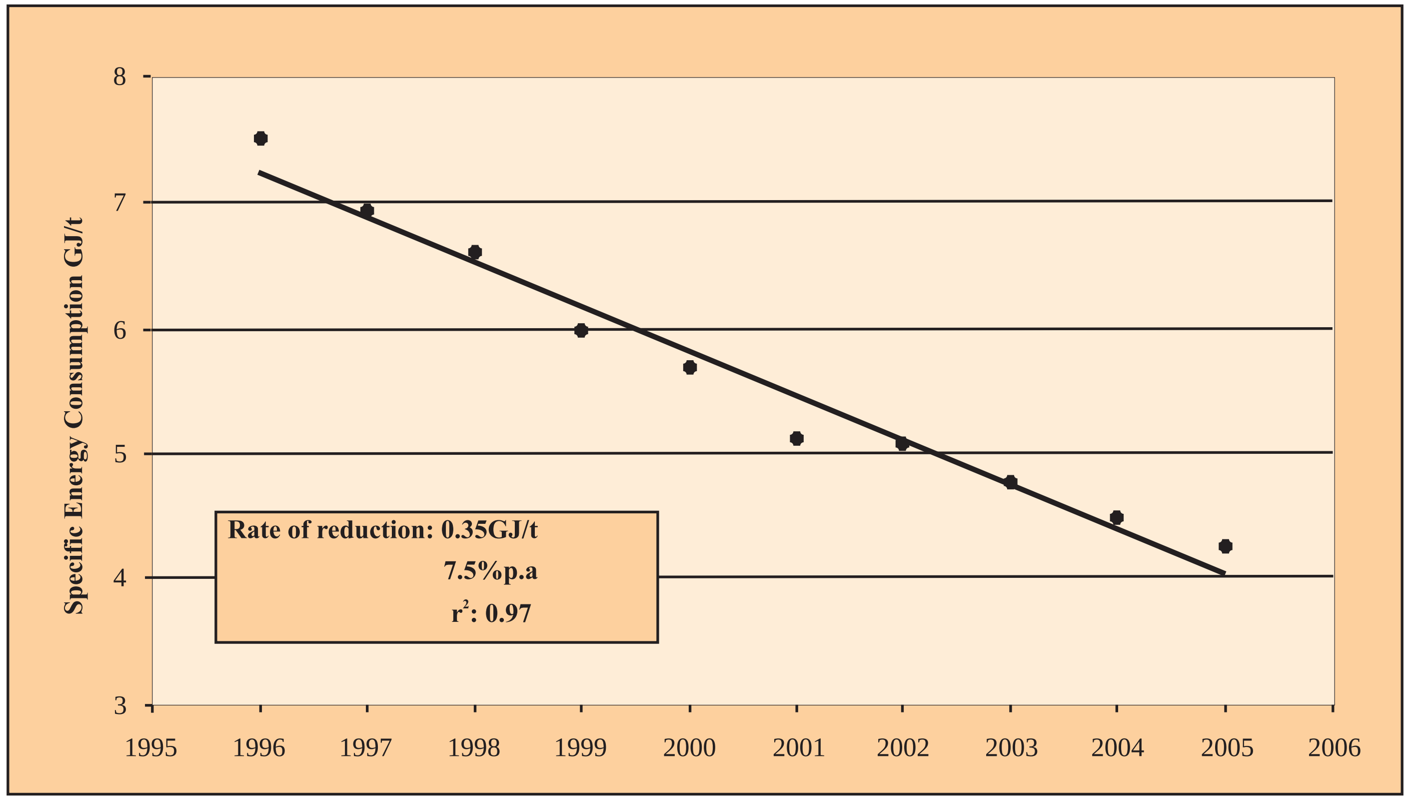
This reduced energy intensity, at the relatively low level of India's per-capita GDP, has been made possible by a range of factors, including India's traditionally sustainable patterns of consumption, enhanced competitiveness, pro-active policies to promote energy efficiency, and more recently, the use of Clean Development Mechanism to accelerate the adoption of clean energy technologies.

(b) Increased Industrial Energy Efficiency

Over the past decade, energy efficiency in Indian industry has increased steadily. In the major energy consuming industrial sectors, such as cement, steel, aluminum, fertilizers, etc., average specific energy consumption has been declining owing to energy conservation in existing units, and (much more) due to the new capacity. In almost every industrial sector, some of the world's most energy - efficient units are located in India.

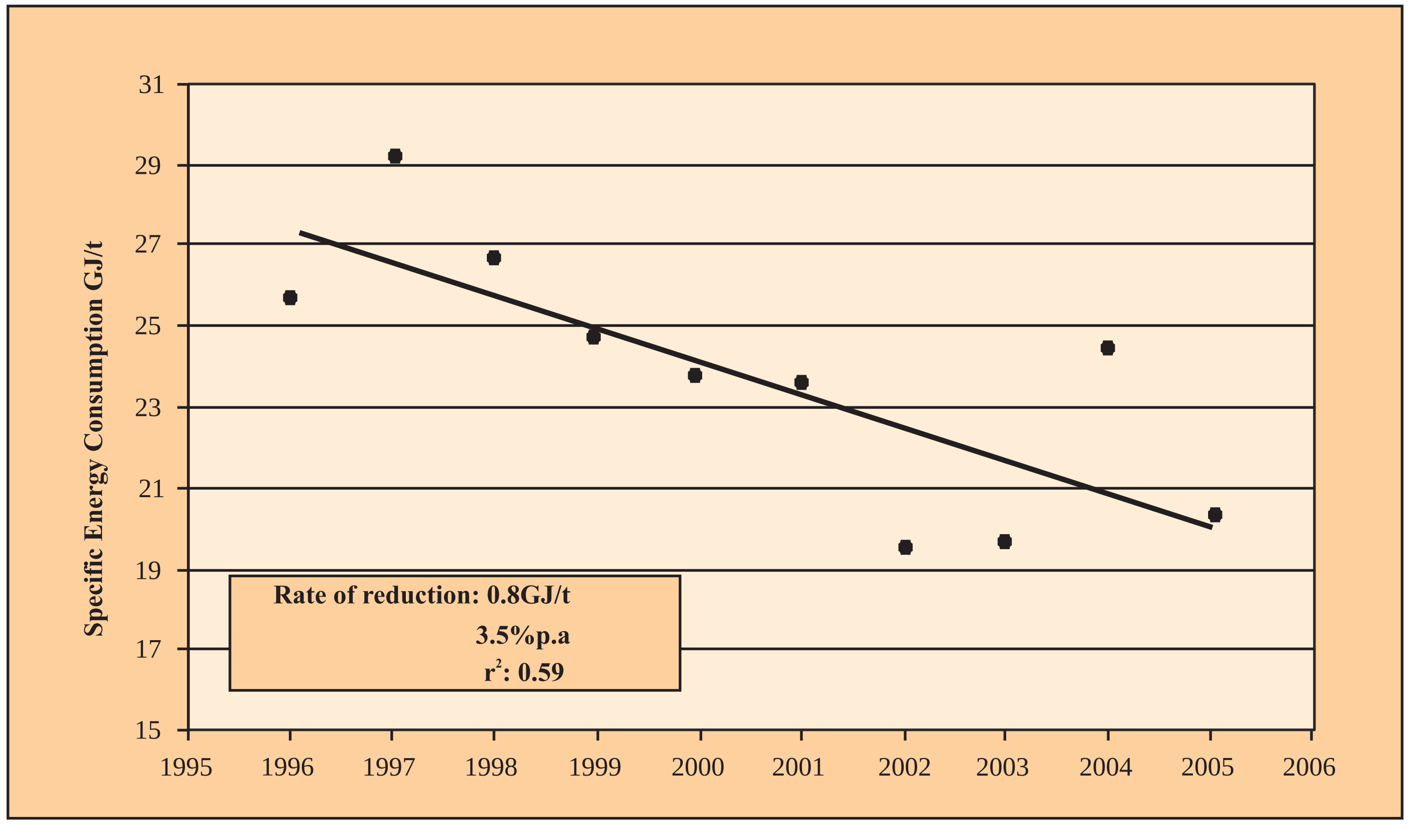
The specific energy consumption in cement, iron and steel plants in India has been declining rapidly. In the cement sector, the specific energy consumption of the most efficient plants is now comparable with the most efficient plants worldwide.

Figure 3.4.8: Trends in Thermal Specific Energy Consumption in the Indian Cement Sector



Source: India: addressing energy security & climate change, MoEF, MoP & BEE, 2007

Figure 3.4.9: Trends in Thermal Specific Energy Consumption in the Indian Iron & Steel Sector



Source: Bureau of Energy Efficiency,2006

Energy Conservation potential in the industrial sector of our nation has been projected between 30 to 40 per cent. Energy conservation measures range from simple good house-keeping practices to plant modernization.

To know the extent of energy that is being wasted, it is essential to know what amount of energy is being consumed. Monitoring industrial energy utilization on a continuous basis and relating it to the production is the first step of any energy conservation programme.

The industrial sector is a major energy-consuming sector accounting for about 50 per cent of the commercial energy available in the country. The total energy consumption, including non-energy uses about 103.1 mtoe. Of the commercial sources of energy, coal and lignite account for 56 per cent, oil and natural gas 40 per cent, hydroelectric power 3 per cent and nuclear power 1 per cent.

Table 3.4.9: Energy Conservation Potential in Indian Industries

Industries	Share of Energy in Production Cost (%)	Conservation Potential (%)
Refineries	1.0	8-10
Sugar	3.4	25-30
Ferrous Foundry	10.5	15-20
Textile	10.9	20-25
Petrochemical	12.7	10-15
Chloro-alkali	15.0	10-15
Iron & Steel	15.8	8-10
Fertilizers & Pesticides	18.3	10-15
Pulp & Paper	22.8	20-25
Glass	32.5	15-20
Ceramics	33.7	15-20
Aluminium	34.2	8-10
Cement	34.9	10-15
Ferro-alloys	36.5	8-10

Source: Gujarat Energy Development Agency, 2007

Table 3.4.10: Summary of Energy Related Laws and Policy Decrees

Year	Title	Main Thrust
2006	Rural Electrification Policy	Establishes a national goal for universal access, assigns responsibilities for implementation, and creates new financing arrangements.
2006	National Urban Transport Policy	Encourages integrated land use and transportation planning in cities.
2006	National Tariff Policy	Provides guidance on establishing power purchase tariffs by State Electricity Regulatory Commissions.
2005	National Electricity Policy	Provides guidance for accelerated development of the power sector.
2003	Electricity Act	Legislates a comprehensive reform and liberalization process for the power sector.
2001	Energy Conservation Act	Provides the legal framework and institutional arrangements for embarking on a national energy efficiency drive.
2001	Accelerated Power Development and Reforms Programme	Establishes intervention strategies for distribution reforms in the power sector.

Source: USIAD ECO-Asia Clean Development & Climate Programme, 2006

(i) Electricity from Renewable Sources

The Electricity Act, 2003, requires State Electricity Regulatory Commissions to specify a percentage of electricity that the electricity distribution companies must procure from renewable sources. This Act also notified preferential prices for electricity from renewable sources. This has significantly contributed to acceleration in renewable electricity capacity addition, and over the past three years, about 2000 MW of renewable electricity capacity has been added in India every year, bringing the total installed renewable capacity to over 11,000 MW. Of this, a little over 7,000 MW is based on wind power; India now has the fourth largest installed wind capacity in the world. The National Hydro Energy Policy has resulted in the accelerated addition of hydropower in India, which is now over 35,000 MW. The growth of electricity from renewable sources has been accelerated by the legislative mandate for its procurement.

(ii) Enhancing Efficiency of Power Plants

Coal is the mainstay of India's energy economy, and coal-based power plants account for about two-thirds of the total electric generation installed capacity of about 135,000 MW. In addition, the Electricity Regulatory Commissions are also linking tariffs to efficiency enhancement, thus providing an incentive for renovation and modernization. New plants are being encouraged to adopt more efficient and clean coal technologies, and four new plants under construction have adopted the more efficient supercritical technology for power generation.

(iii) Introduction of Labeling Programme for Appliances

An energy labeling programme for appliances was launched in 2006, and comparative star-based labeling has been introduced for fluorescent tube lights, air conditioners, and distribution transformers. The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. Almost all fluorescent tube lights sold in India, and about two-thirds of the refrigerators and air conditioners, are now covered by the labeling programme.

(iv) Energy Conservation Building Code

An Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the building's energy efficiency. Commercial buildings are one of the fastest growing sectors of the Indian economy, reflecting the increasing share of the service sector in the economy. Nearly one hundred buildings are already following the Code, and compliance with it has also been incorporated into the Environmental Impact Assessment requirements for large buildings.

(v) Energy Audits of Large Industrial Consumers

In March 2007, the conduct of energy audits was made mandatory for large energy-consuming units in nine industrial sectors. These units, notified as 'designated consumers' are also required to employ 'certified energy managers', and report energy consumption and energy conservation data annually.

(vi) Accelerated Introduction of Clean Energy Technologies through the CDM

Over 700 CDM projects have been approved by the CDM National Designated Authority, and about 300 of these have been registered by the CDM Executive Board. The registered projects have already resulted in over 27 million tonnes of certified CO_2 emission reductions, and directed investment in renewable energy and energy projects by reducing the perceived risks and uncertainties of these new technologies, thereby accelerating their adoption.

Clean Transport

Recognizing the merits of biofuels, Government of India has identified ethanol and biodiesel as the key focus areas. Both are in early stages of commercialization. In 2004, the government mandated five percent blending of petrol with ethanol, subject to certain conditions, following a Memorandum of Understanding between the Indian Sugar Mills Association and Indian Oil Corporation. An autonomous National Biodiesel Board is being created to promote, finance, and support organizations that are engaged in the field of oilseed cultivation and oil processing leading to biodiesel production. In 2005, the Government of India adopted the Biodiesel Purchase Policy. The policy prescribes that oil marketing companies in the public sector should purchase biodiesel of prescribed Bureau of Indian Standards (BIS) specification from registered authorized suppliers at a uniform price, to be reviewed every six months. Some public sector oil companies are already experimenting with various mixes of biodiesel with diesel in state transport buses, and are engaged in ongoing discussions with the automobile industry to share results.

The National Urban Transport Policy (NUTP) of the Ministry of Urban Development seeks to encourage integrated land use and transport planning in cities, and focuses on greater use of public transport and non-motorized modes by offering central financial assistance. The policy incorporates urban transportation as an important parameter at the urban planning stage.

The National Auto Fuel Policy of 2003 provides a roadmap for achieving various vehicular emission norms over a period of time and the corresponding requirements for upgrading fuel quality. While it does not recommend any particular fuel or technology for achieving the desired emission norms, it suggests that liquid fuels should remain the main auto fuels throughout the country and that the use of CNG/LPG be encouraged in cities affected by higher pollution levels so as to enable vehicle owners to have the choice of the fuel and technology combination.

Figure 3.4.10: Energy Labels for Refrigerators and Fluorescent Lamps

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Bio Methanation Plant at Chennai

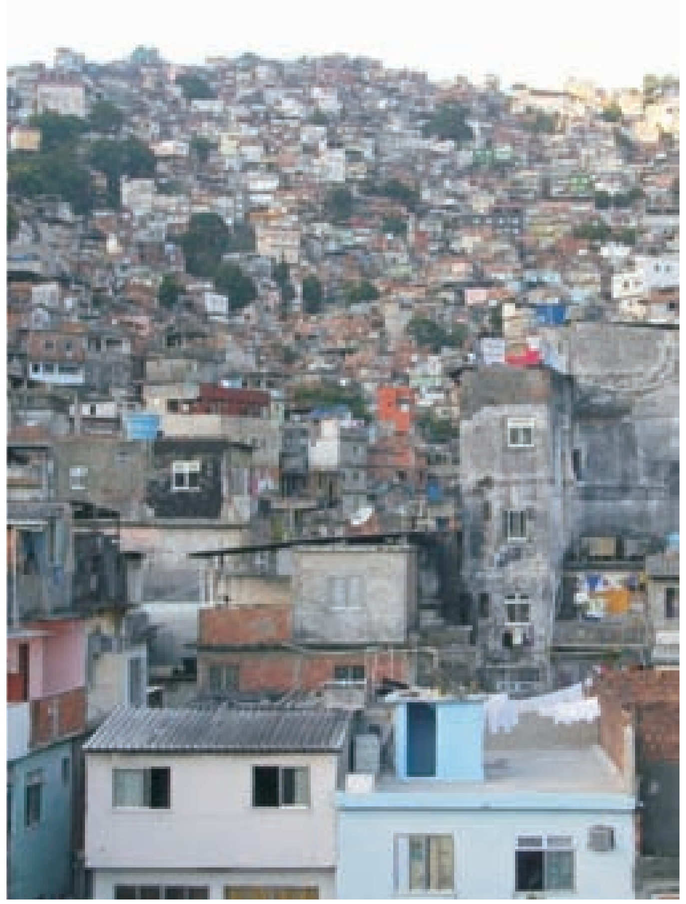
MANAGING URBANIZATION

Urbanization refers to the phenomenon in which an increasing proportion of the population lives in cities and the suburbs of cities. Historically, it has been closely connected with industrialization. When more and more inanimate sources of energy were used to enhance human productivity (industrialization), surpluses increased in both agriculture and industry. Increasingly larger proportions of population could live in cities. Economic forces were such that cities became the ideal places to locate factories and their workforce.

PATTERN AND TREND OF URBANIZATION IN INDIA

In 1901, only 11 per cent of the total population was urbanized. There were 1,834 towns and cities. By 1951, urban population had grown to 6.16 crore comprising 17.6 per cent of the total population. Thus from 1901 to 1951, the growth in urban population was 240 per cent while that from 1951 to 2001 was about 450 per cent. The rapid growth in the last few decades has been because of rapid industrialization and migration to urban areas, 50 per cent of which are from rural areas. The 2001 census of India depicts that of the total population of 1,028 million, about 72.2 per cent (742 million) live in rural areas and 27.8 per cent (285 million) in urban areas (Table 3.5.1).

a) The pattern and trend of urban population and number of towns in India during 1901 to 2001 depict that total urban population has increased more than ten times from 26 millions to 285 million, whereas the total population has increased less than five times from 238 million to 1,028 million from 1901 to 2001. A continuous increase has been noticed in the percentage of urban population from 11 per cent in 1901 to 17 per cent in 1951 to further 28 per cent in 2001. In the same fashion, the number of towns also increased from 1916 in 1901 to 2,422 in 1951 and then to 4,689 in 1991. This reveals the rapid urbanization process in India (Figure 3.5.1).



Urban housing needs proper planning

Table 3.5.1 : Pattern and Trend of Urbanization in India 1901-2001

Census Years	Number of Towns[2]	Urban Population (in million)	Percentage of Urban Population	Annual Exponential Growth Rate	Rate of Urbanization
1901	1916	25.9	10.8	-	-
1911	1908	25.9	10.3	0.0	-0.46
1921	2048	28.1	11.2	0.8	0.87
1931	2220	33.5	12.0	1.7	0.71
1941	2422	44.2	13.8	2.8	1.50
1951	3060	62.4	17.3	3.5	2.54
1961	2700	78.9	18.0	2.3	0.40
1971	3126	109.1	19.9	3.2	1.06
1981	4029	159.5	23.3	3.8	1.72
1991	4689	217.6	25.7	3.1	1.02
2001	5161	284.5[3]	27.8	2.7	0.82

[1]Excluding Assam in 1981 and Jammu and Kashmir in 1991

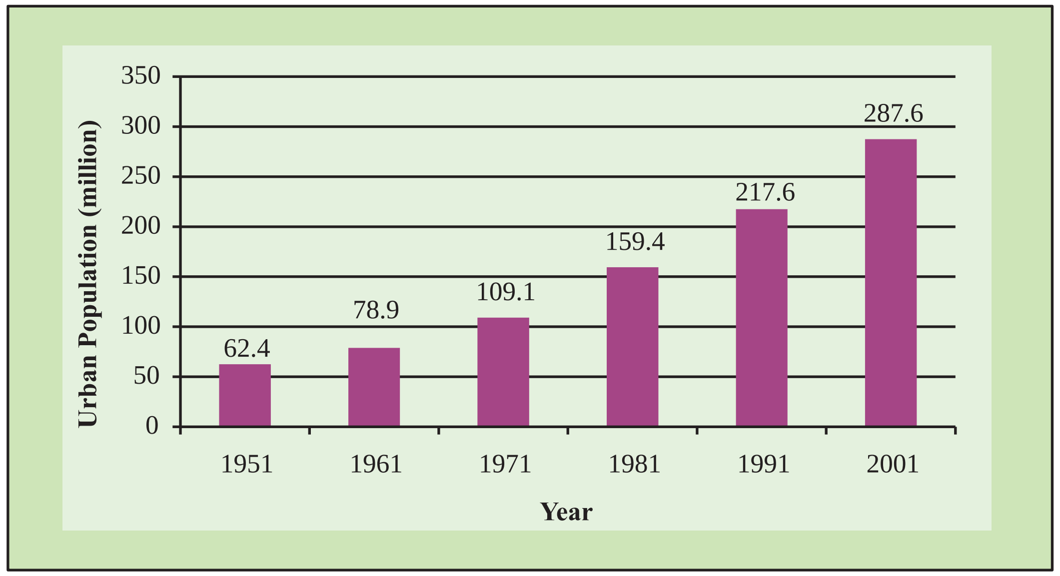
[2]Constituents of cities and towns of urban agglomerations have been counted as separate units

[3]Provisional Figures of 2001 Census

Source : Census of India, 2001

b) Percentage of Urban Population in India by Size-Class of Urban Centres, 1961-1991: The process of urbanization in India reflects a certain degree of skewness because of the fact that more than 60 per cent of the urban population of the country lives in Class I towns alone and the remaining below 40 per cent urban population lives in the smaller sized towns. An unremitting increase has been noticed for percentage of total urban population in Class I cities over the decades (1901 to 1991), while class IV, V and VI towns have experienced a continuous decline. However, class II and III towns have almost a constant percentage of total urban population over the decades. About three-fold increase has been observe in the percentage of total urban population in Class I cities, from 23 per cent in 1901 to 65 per cent in 1991. This depicts a huge concentration of urban population in large cities. The urbanization in India shows the pattern of 'inverted triangle' where majority of the urban population resides in the Class I cities.

Figure 3.5.1: Growth in the Size of Urban Population in India, 1901-2001



Source: Census of India, 2001

c) Growth in the Number of Million Plus (1,000,000 Population or more) Cities in India during 1901-2001: There was only one million plus city (Kolkata) in 1901 in India. It became two in 1911 (Mumbai added) and remained as such till 1941. Million plus cities increased to five in 1951 and continued to increase after this to became 23 in 1991 and currently, it is 35 as per 2001 census. Total population also increased in the million plus cities from 1.51 million in 1901 to 107.88 million in 2001. The percentage decadal growth rate in the total population of million plus cities was highest (121 per cent) during 1941 to 1951, because of the incidence of partition. After independence also, the decadal growth rate was more than 50 per cent in each decade. This illustrates the realistic situation of exhausted growth in the million plus cities. Looking at the percentage of total population of India residing in million plus cities, it reveals that it has increased drastically from less than 1 per cent in 1901 to 3 per cent in 1951 and further to 8 per cent in 1991. Again, the percentage of total urban population of India residing in million plus cities has also increased drastically from 6 per cent in 1901 to 19 per cent in 1951 and further to 33 per cent in 1991 (Table 3.5.2).

Table 3.5.2: Growth in the Number of Million Plus (1,000,000) Population (or More) Cities in India during 1901-2001

Census Years	Number of Cities with more than one million Population	Population (in million)	Per cent Increase	Population of million cities as percentage of India's	
				Total Population (in million)	Urban population (in million)
1901	1	1.51	-	0.6	5.8
1911	2	2.76	82.8	1.1	10.7
1921	2	3.13	13.4	1.3	11.1
1931	2	3.41	8.95	1.2	10.2
1941	2	5.31	5.71	1.7	12
1951	5	11.75	21.3	3.3	18.8
1961	7	18.10	54.0	4.1	22.9
1971	9	27.83	53.8	5.1	25.5
1981	12	42.12	51.3	5.2	26.4
1991	23	70.67	67.8	8.4	32.5
2001	35	107.88	52.8	10.50	37.8

[1]Excludes Assam in 1981 and Jammu and Kashmir in 1991

Source: Census of India, 2001

d) Trend in Total Population and Annual Growth Rate in the Four Metropolitan Cities of India During 1901-2001: More than thirty fold increase has been noticed in the population of Delhi in 100 years, from 0.41 million in 1901 to 12.8 millions in 2001, whereas there has been 20 fold increase in Mumbai's population, from 0.8 million to 16.4 million during the same period. Chennai has experienced more than 10 fold increase (0.59 million to 6.4 million) in its total population during last 100 years whereas, Kolkata has experienced the lowest increase (less than nine fold) in its total population among the metropolitan cities in the last ten decades (Table 3.5.3).

The maximum growth rate has been noticed during 1941 to 1951, highest in Delhi (90 per cent), followed by Mumbai (76 per cent) and Chennai (66 per cent). However, Kolkata had noticed comparative low growth rate (29 per cent) during the same period. This was the era of partition in India when a huge influx of migration had taken place to big cities because of the communal riots. A large number of population joined the big cities after the insurrection. After independence, Delhi experienced the highest decadal growth rate (close to 50 per cent) in its total population in all the censuses (1951 to 2001), followed by Mumbai where the growth rate was about 40 per cent during those census years. However, Kolkata experienced continuous declining decadal growth rate from 1951 to 2001. On the other hand, Chennai has experienced a mixed pattern of high and low decadal growth rates during the last 50 years. Initially, Kolkata was the most populous city of India till 1981, but Mumbai surpassed it in 1991 Census. Again, Delhi is expected to cross the population of Kolkata in the Census of 2011 if both cities continue their growth rate patterns. Thus, it is evident with the table that Mumbai and Delhi metropolis are experiencing profuse growth in their population.

Table 3.5.3: Trend in Total Population (in 10,000s) and Annual Growth Rate (%) in the Four Metropolitan Cities of India: 1901-2001

Census Years	Mumbai	Growth Rate	Kolkata	Growth Rate	Delhi	Growth Rate	Chennai	Growth Rate	India	Growth Rate
1901	81.3	-	151.0	-	40.6	-	59.4	-	2384	-
1911	101.8	25.2	174.5	15.6	41.4	2.0	60.4	1.7	2521	5.7
1921	124.5	22.3	188.5	8.0	48.8	17.9	62.8	4.0	2513	-0.3
1931	126.8	1.8	213.9	13.5	63.6	30.3	77.5	23.4	2786	11.0
1941	168.6	33.0	362.1	69.3	91.8	44.3	92.1	18.8	3187	14.2
1951	296.7	76.0	467.0	29.0	174.4	90.0	153.1	66.2	3611	13.3
1961	415.2	39.9	598.4	28.1	265.9	52.5	192.4	25.7	4392	21.6
1971	597.1	43.8	742.0	24.0	406.6	52.9	305.8	58.9	5482	24.8
1981	891.7	49.3	919.0	23.9	622.0	53.0	428.9	40.3	6833	24.7
1991	1259.6	41.3	1102.2	19.9	942.1	51.5	542.2	26.4	8463	23.8
2001	1636.8	29.9	1321.7	19.9	1297.1	37.7	642.5	18.5	10270	21.4

Source: Census of India, 2001

According to the Census figures of 2001, the number of class I cities and class II towns was around 900. One of the conspicuous features of urbanization in India is the skewed distribution of population with as much as 28.3 per cent of the urban population in 35 metropolitan cities. Unregulated growth of urban areas, particularly over the last two decades, without infrastructural services for proper collection, transportation, treatment and disposal of domestic waste water led to increased pollution and health hazards. Fast urbanization has been followed by an increase in prosperity, resulting in a steep increase in waste generation.

Challenges of Urbanization

1) Urban Planning

- Many urban governments lack a modern planning framework.
- The multiplicity of local bodies obstructs efficient planning and land use.
- Rigid master plans and restrictive zoning regulations limit the land available for building, constricting cities' abilities to grow in accordance with changing needs.

2) Migration / Agglomeration

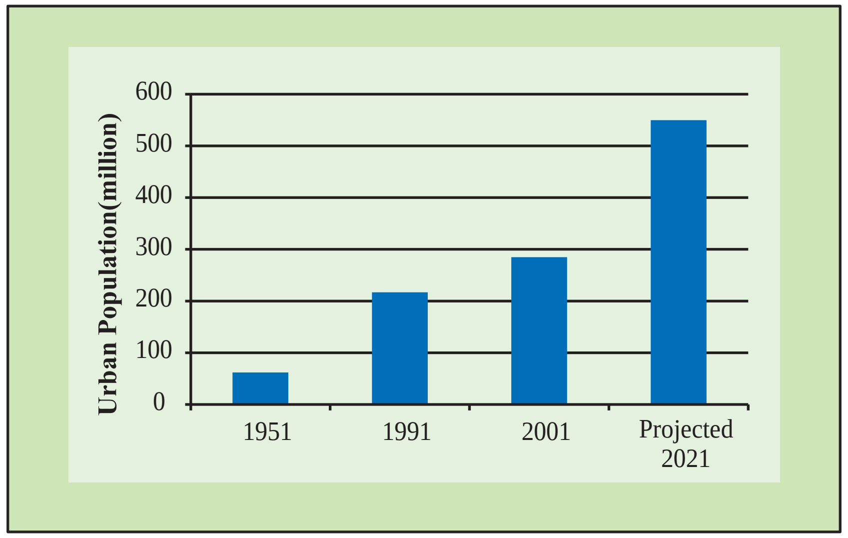
Urban agglomeration is a continuous urban spread constituting a town and its adjoining urban Out Growths (OGs) or two or more physically contiguous towns together and any adjoining urban outgrowths of such towns.

Following are the possible different situations in which urban agglomerations could be constituted:

i) A city or town with one or more contiguous outgrowths.

ii) Two or more adjoining towns with or without their outgrowths.

Figure 3.5.2: Projected Urban Population



Source: Central Public Health & Environmental Engineering Organization, 2007

iii) A city or one or more adjoining towns with their out growths, all of which form a continuous spread.

The data on migration in India as per Census 2001 shows that the total number of migrants has been 307 million. Out of these migrants by last residence, 258 million (84.2 per cent) have been intra-state migrants, those who migrated from one area of the state to another. Around 42 million (13.8 per cent) were interstate migrants and 6 million (2 per cent) migrated from outside the country (Table 3.5.4).

Table 3.5.4 : Number of Migrants by Place of Birth – India 2001

Sl. No.	Category	Migrations by Place of birth	Percentage
1	Total Population	1,028,610,328	-
2	Total Migrations	307,149,736	29.9
3	Migrants within the state of enumeration	258,641,103	84.2
4	Migrants from within the districts	181,799,637	70.3
5	Migrants from other districts of the state	76,841,466	29.7
6	Migrants from other states in India	42,341,703	13.8
7	Migrants from other countries	6,166,930	2

Source: Census of India, 2001

A rag picker collecting recyclable material at Marina Beach in Chennai, India

Opportunities in urban areas for employment, education, etc. have been a pull factor, attracting migrants from rural to urban areas and from smaller towns and cities to larger urban areas. There is also migration in the opposite direction from urban to rural areas due to various reasons. The migration during the last decade, i.e., migrants with duration of residence of 0-9 years at the place of enumeration, by various migration streams are summarized in the Table 3.5.5.

Table 3.5.5: Number of Intra-State and Inter-State Migrants in the Country (duration of residence 0-9 years) by Rural Urban Status – India 2001 by Rural Urban Status – India 2001

Rural Urban status of place of last residence	Rural urban status of place of enumeration		
	Total	Rural	Urban
Total	97,560,320	61,428,374	36,131,946
Rural	73,949,607	53,354,376	20,595,231
Urban	20,655,277	6,266,503	14,388,774
Unclassified	2,955,436	1,807,495	1,147,941

Source: Census of India, 2001

Out of about 98 million total intra-state and inter-state migrants in the country during the last decade, 61 million have moved to rural areas and 36 million to urban areas. Migration stream out of rural areas (73 million) to other rural areas was quite high (53 million) in comparison to migration from rural to urban areas (20 million). About six million migrants went to rural areas from urban areas. On the basis of net migrants by last residence during the past decade, i.e., the difference between in-migration and out-migration, in each state, Maharashtra stands at the top of the list, with 2.3 million net migrants, followed by Delhi (1.7 million), Gujarat (0.68 million) and Haryana (0.67 million) as per census 2001. Uttar Pradesh (-2.6 million) and Bihar (-1.7 million) were the two states with the largest number of net migrants migrating out of the state. There are various reasons for migration as per the information collected in Census 2001 for migration by last residence. Most of the female migrants cite 'marriage' as the reason for migration, especially when the migration is within the state. For males, the major reasons for migration are work, employment and education.

3) Housing

- Building regulations that limit urban density, such as floor space indexes, reduce the number of houses available, thereby pushing up property prices
- Outdated rent control regulations reduce the number of houses available on rent – a critical option for the poor
- Poor access to micro finance and mortgage finance limit the ability of low income groups to buy or improve their homes
- Policy, planning, and regulation deficiencies lead to a proliferation of slums
- Weak finances of urban local bodies and service providers leave them unable to expand the trunk infrastructure that housing developers need to develop new sites.

Commercial development in cities has led to increased construction activities

Table 3.5.6: Urban-Rural Breakup of Total Population, Number of Households and Houses

Sl. No.	Year	Total Population	No. of Households	No. of Houses
1	1981*			
	Total	655,287,849	119,772,545	121782109**
	Urban	157,680,171	28,905,949	29,897,491
	Rural	607,607,678	90,866,596	91,884,618
2	1991+	838,583,988	152,009,467	159425666**
	Total	215,771,612	40,418,141	43,518,317
	Urban	622,812,376	111,591,326	115,907,349
	Rural			
3	2001++	1,028,610,328	193,579,954	202973364#
	Total	286,119,689	55,832,570	58,514,738
	Urban	742,490,639	137,747,384	144,458,626
	Rural			

* Excluding Assam

\+ Excluding Jammu & Kashmir

** No. of occupied residential houses + No. of Census houses vacant at the time of house listing

++ India figures are final and exclude those of the three sub-divisions viz. Mao Maram, Paomata and Purul of Senapa district of Manipur as population Census 2001 in these 3 subdivisions were cancelled due to technical and administrative reasons although a population census was carried out in these subdivisions as per schedule

\# The occupied residential houses and vacant houses are based on Census 2001 house listing data

Source: Census of India, 2001

4) Service Delivery

- Most services are delivered by city governments with unclear lines of accountability.
- There is a strong bias towards adding physical infrastructure rather than providing financially and environmentally sustainable services.
- Service providers are unable to recover operations and maintenance costs and depend on the government for finance.
- Independent regulatory authorities that set tariffs, decide on subsidies and enforce service quality are generally absent.
- Most urban bodies do not generate the revenues needed to renew infrastructure, nor do they have the creditworthiness to access capital markets for funds.

5) Urban Health Problems

Urban health problems arise due to the food insecurity; malnutrition; overcrowded and unhygienic living conditions; pollution and lack of safe drinking water and sanitation. Migration leads to the spread of many communicable diseases. People may encounter diseases in the urban areas due to unsanitary conditions of temporary dwellings and slums. Furthermore, it is found that there are occurrences and distribution of a wide range of infectious diseases such as tuberculosis, hepatitis and pneumonia in urban slums. This has potentially wider impacts on life style, quality of housing, and diet or nutrition and may cause new disease patterns in the urban areas. Plastic and polythene bags, rotting food, paper, cloth, animal bones, cans, and glass are found in garbage piles in most of the cities.

The health of the urban poor is often worse than that of their rural counterparts. Child mortality rates among populations in the lowest income strata, for example, are higher in urban areas than in rural areas. Children from poor families who live in urban areas are also more likely to be underweight and experience stunted growth than their rural counterparts. Air pollution is another important health challenge for urban residents in India.

In Delhi, one out of ten school children have asthma. According to a World Bank - Asian Development Bank study, premature deaths due to air pollution in Indian cities were estimated to have increased by 30 per cent between 1992 and 1995. High levels of lead pollution in the air lead to stunted growth in children, as well as hyperactivity and brain damage.

6) Transport

Urban areas in India, which include a wide range of mega cities, and towns, are not all that fortunate in terms of intercity transportation. Transport, in this context, has been a victim of ignorance, neglect, and confusion. As far as the public transport system in Indian cities is concerned, dedicated city bus services are known to operate in 17 cities only and rail transit exists only in four out of 35 cities with population in excess of one million.

Transport demand in most Indian cities has increased substantially, due to increases in population as a result of both natural increase and migration from rural areas and smaller towns. Availability of motorized transport, increases in household income, and increases in commercial and industrial activities have further added to the transport demand. In many cases, the demand has outstripped road capacity.

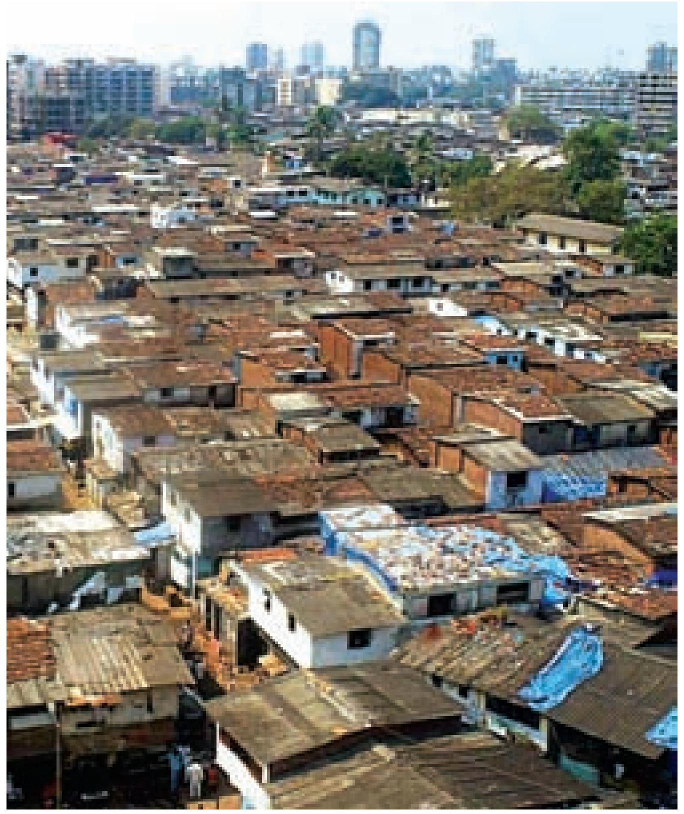
Greater congestion and delays are widespread in Indian cities and indicate the seriousness of transport problems. A high level of pollution is another undesirable feature of overloaded streets. The transport crisis also takes a human toll. Statistics indicate that traffic accidents are a primary cause of accidental deaths in Indian cities (Table 3.5.7).

The main reasons for these problems are the prevailing imbalance in modal split, inadequate transport infrastructure, and its sub-optimal use. Public transport systems have not been able to keep pace with the rapid and substantial increases in demand over the past few decades. Bus services in particular have deteriorated, and their relative output has been further reduced since passengers have turned to personalized modes and intermediate public transport.

7) Slums

The Govt. of India Slum Areas (Improvement and Clearance) Act of 1954 defines a slum as 'any predominantly residential area, in which light or sanitary facilities or any combination of these factors are detrimental to the safety, health or morals'. The vast majority of the people who migrated to the city were attracted by opportunities and comforts offered by modernization. They belonged to the working class and found it difficult to secure accommodation within their means. So, they squatted on every open space available, as near their workplaces as possible and put up huts with cheap building materials. In this way, slums grew in number and population.

For the first time, detailed data on slum areas in the country has been collected in Census 2001, particularly for cities/towns having a population of 50,000 or more based on the 1991 Census. The total slum population in the country is 40.3 million comprising 22.6 per cent of the total urban population of cities/towns reporting slums.



Bigger the city, bigger the slums

Table 3.5.7: Number of Persons Killed in Road Accidents by Truck/Lorry and Private Buses in Metro Cities (2005 and 2006)

City	2005				2006			
	Truck/Lorry		Private Bus		Truck/Lorry		Private Bus	
	Male	Female	Male	Female	Male	Female	Male	Female
Chennai	160	55	40	5	319	44	35	7
Delhi	110	9	99	20	99	6	97	15
Kolkata	6	0	22	4	10	0	34	3
Mumbai	78	12	11	7	102	15	32	7

Source: Ministry of Road Transport and Highways, 2007

Box 3.5.1: Salient Features of Slums as per Census 2001

- In all, 607 towns have reported slums.
- Total Slum Population returned as per provisional results of Census of India 2001 was 40,297,341, comprising 22.58 per cent of the total urban population of the cities/towns reporting slums.
- Largest slum population was registered in Maharashtra (10.64 million).
- The largest proportion of slum population in million plus cities was registered in Greater Mumbai (48.88 per cent) and the lowest in Patna (0.25 per cent).
- About one per cent of India's population lives in the slums of Maharashtra.
- Around six per cent of Maharashtra's population lives in slums of Greater Mumbai.
- The proportion of slum population out of the total population in cities/towns varied from 41.33 per cent to 1.81 per cent, the largest being Meghalaya (41.33 per cent) and lowest Kerala (1.81 per cent).
- Sex ratio (i.e. number of females per thousand males) of the slum population varied from 1,032 (Pondicherry) to 707 (Chandigarh), Kerala also returned high sex ratio (1,029).
- Proportion of children (0-6 years) among slum population in million plus cities was found to be the highest in Jaipur (18.11per cent) and lowest in Kolkata (9.35 per cent). Female literacy rate was also found to the highest, varying from 85.11 per cent (Meghalaya) to 40.09 per cent (Chandigarh).
- Literacy rate among slum population was found to be quite high, varying from 80.08 per cent (Meghalaya) to 55.46 per cent (Chandigarh). The male literacy rate varied from 91.05 per cent (Meghalaya) to 65.59 per cent (Chandigarh). Female literacy rate was also found to be high varying from 85.11 per cent (Meghalaya) and 65.59 per cent (Chandigarh).

Slum population is a serious problem in the mega-cities of India. A large population of Mumbai, Kolkata and Delhi lives in slums, despite of several Government housing policies. A continuous increase has been found in the percentage of slum population over the last three decades in the four metropolitan cities of India.

In 1981, 31 per cent population of Mumbai was residing in slums, and in 2001 nearly half of Mumbai's population (49 per cent) was living in slums. However, Kolkata and Delhi had not shown as severe condition as Mumbai. The proportion of slum population was 30 per cent and 18 per cent in 1981 in Kolkata and Delhi, which increased to 36 per cent and 23 per cent respectively. On the other hand, it is a somewhat positive sign for Kolkata and Delhi that in 2001 the proportion of slum population has decreased to 33 per cent and 19 per cent respectively. Although Chennai has the lowest slum population among the four metropolitan cities, yet it has experienced continuous increase in the slum population over the three decades. There was 14 per cent slum population in Chennai in 1981, which increased to 15 per cent in 1991 and further 18 per cent in 2001.

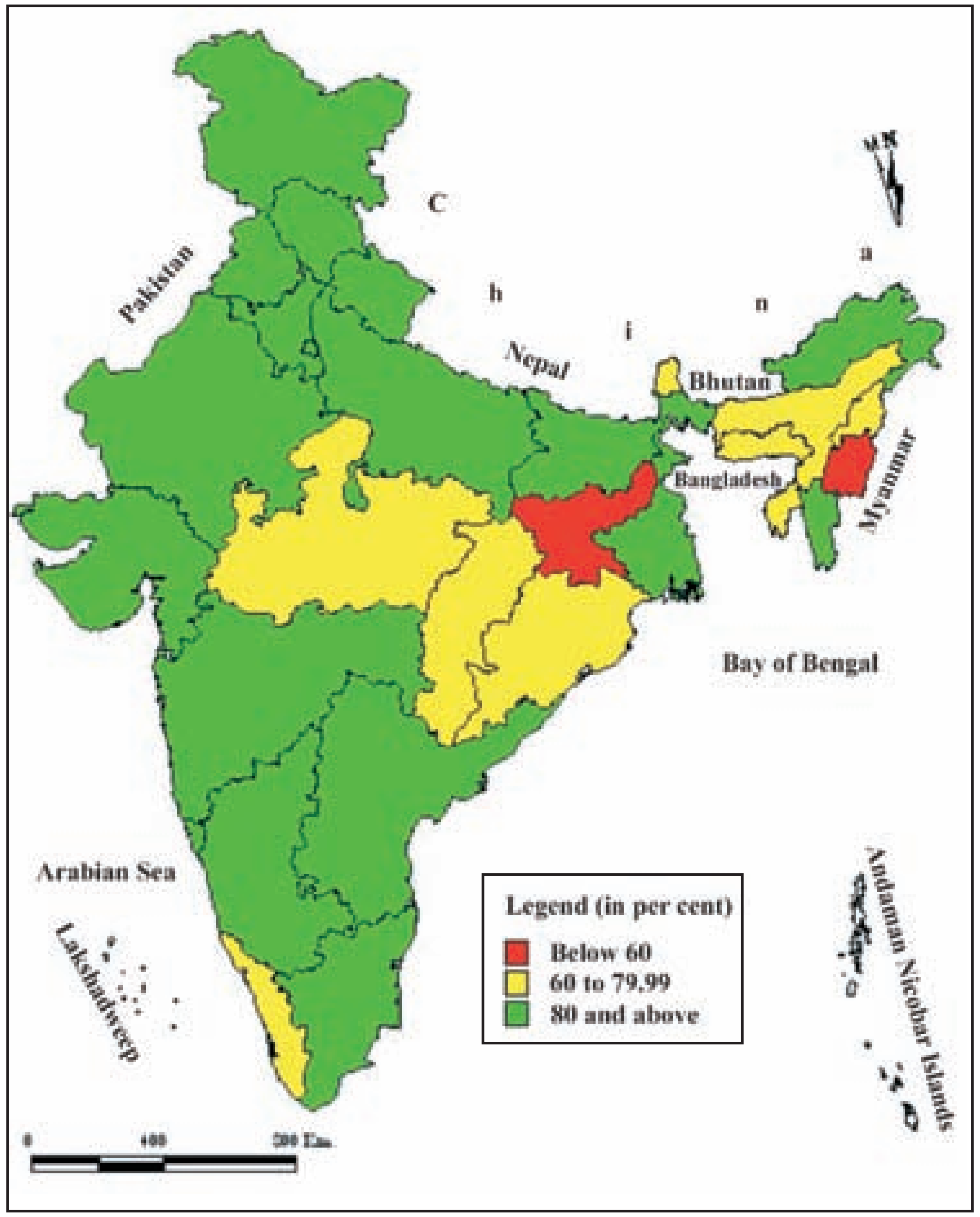
In India, major urban population resides in the slums, which are poorly equipped to meet the basic needs of water and sanitation of the dwellers. This results in people falling prey to various diseases and putting additional strain on the healthcare facilities in the area. Low incomes, illiteracy, and inaccessibility to development opportunities further complicate the problems. Slum dwellings have no ventilation or natural light and are most vulnerable. They suffer from dust, smoke, and noise pollution. Piles of garbage, potholes, stray animals, flies, and mosquitoes are a common sight in slums.

8) Availability of Safe Drinking Water

Access to safe drinking water remains an urgent need as about 70.5 per cent of the households in urban areas and 8.7 per cent in rural areas receive organized piped water supply and the rest have to depend on surface or groundwater, which is untreated (Figure 3.5.3). The diseases commonly caused due to contaminated water are diarrhoea, trachoma, intestinal worms, hepatitis, etc. The most common contamination in the water is from the disease bearing human wastes, which is usually detected by measuring faecal coliform levels. Inadequate access to safe drinking water and sanitation facilities leads to higher infant mortality and intestinal diseases.

Water quality is a true index of health

Figure 3.5.3: Households with Improved Source of Drinking Water in India



Source: National Family Health Survey-3, 2005-2006

Table 3.5.8: Availability of Safe Drinking Water Per Day in Metropolitan Cities of India (As per Nov., 2003)

Metropolitan Cities/Urban Agglomeration	Per Capita Water Supply (1 pcd)
Greater Mumbai	170
Kolkata	100
Delhi	155
Chennai	65*
Bangalore	100

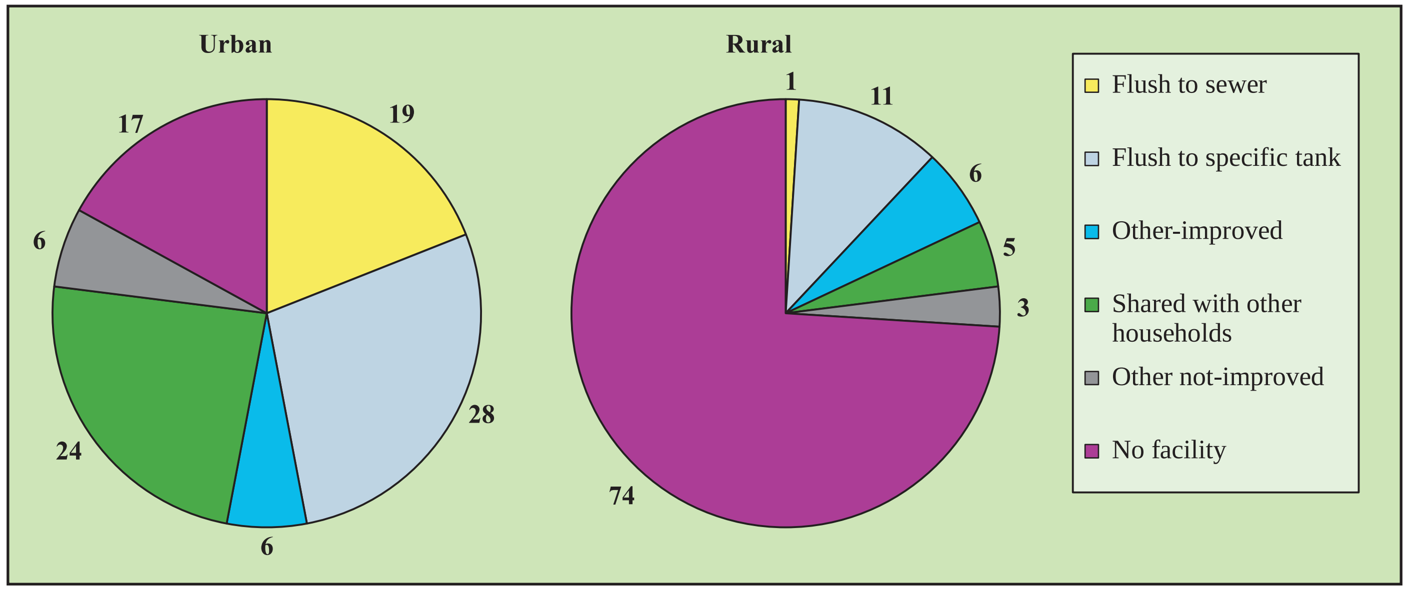
**Due to consecutive failure of monsoon, the availability of water during summer period is reported as 221 pcd.*

Source: Central Water Commission, 2005

9) Sanitation

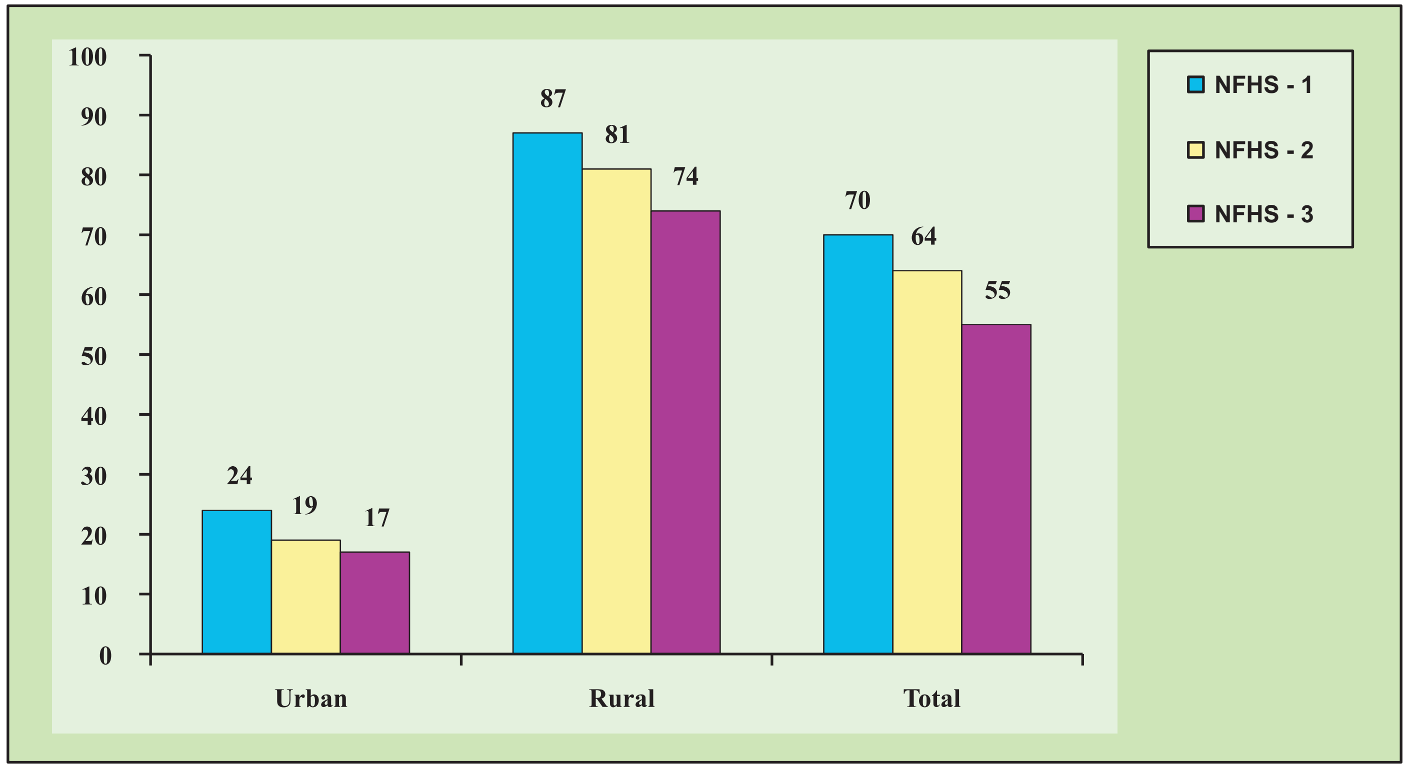
Analysis of coverage data from various sources shows that despite the acceleration of coverage under the Eighth Plan, only 19.2 per cent of rural households have a toilet. However, at the same time 80 per cent of all urban households in India have toilets, an increase from the 1990 figures of around 64 per cent . According to NFHS-3 (2005-2006), only 29 per cent of households have improved toilet facilities (which include toilet facilities with a flush, or a pour flush that is connected to a sewer system, septic tank or pit latrine, a ventilated improved pit (VIP) latrine, a biogas latrine, a pit latrine with slab and twin pit, composting toilet). Percentage of households having no toilet facility in urban India showed a steady decline from NFHS-2 (19 per cent) to NFHS-3 (17 per cent) (Figures 3.5.4 & 3.5.5).

Figure 3.5.4: Residential Toilet Facility



Source: National Family Health Survey-3, 2005-2006

Figure 3.5.5: Percentage of Households Having No Toilet Facilities



Source: National Family Health Survey-3, 2005-2006

The higher percentages of urban sanitation have largely been due to private initiatives at the household level and due to high concentration of household toilets in the larger urban metro cities.

As far as waste water drainage management is concerned, only 3.9 per cent of the total households in rural India have the closed drainage system of waste water while in urban India 34.5 per cent of the total households have closed drainage facility. There is very high percentage of urban households without any drainage system at all (approx. 22.1 per cent).

Box 3.5.2: Flush with Success

RURAL INDIA IS AWASH IN A SANITATION REVOLUTION
N. C. Saxena

Toilets are not an issue for you and me. But for millions in India's villages, the absence of a toilet is a reality. For many it's not even a need that is felt. For others, it is a question of financial priorities. Over 700 million people in India still live without proper sanitation. The resulting poor hygiene is responsible for approximately 1,000 children under five years dying every day due to diarrhoea alone. Poor hygiene, lack of sanitation and inadequate or unsafe water together contribute to about 88 per cent of diarrhoea deaths.

The fact is that sanitation issues did not command sufficient public investment till the end of the 1970s. A total of 108 million man-days, which is equivalent to Rs 12 billion, are lost every year due to sanitation related diseases. Sanitation acquired importance only in the 1980s when the Government of India encouraged the construction of household toilets in the villages under the Central Rural Sanitation Programme.

However, the programme did not become a major sucess as it promoted a single design at a single price and gave a high subsidy with limited funds available. As a result, the government was only able to allot one or two latrines per village and this often went to the prominent members.

The subsequent Total Sanitation Campaign has sought to increase toilet construction and usage by shifting to low subsidies and a greater stress on creating household involvement through awareness. Its sucess is evident from the fact that while in 1997-98, only about 1.3 million toilets were built, in 2003-04 the figure jumped to over 6 million, followed by over 9 million toilets being built in 2006-07. It is expected that the number of household toilets constructed during 2007-08 may actually exceed a crore.

The key to this sucess has been the involvement of the Panchayati Raj Institutions (PRI) under the Nirmal Gram Puraskar, the incentive award scheme. The PRIs have been motivated to promote sanitation in their community by influencing behavioural change and creating a demand. The Nirmal Gram Puraskar awards have seen an enormous increase in the number of awards from across the country from 40 PRIs awarded in 2004-05. Approximately, 30,000 PRIs have already applied for the award in 2008. All this has meant that states like West Bengal, Tamil Nadu and Andhra Pradesh are close to achieving the 'Millennium Development Targets'. While it is important to celebrate the gains made in increasing sanitation coverage nationwide, we must not forget that it is only the beginning, there is a long way to go before total sanitation is achieved. The challenge ahead is not only to maintain the momentum, but also to accelerate the pace of sanitation coverage.

Although 40 million households have been reached so far, there is still more than 70 million households across the country without toilets. The Total Sanitation Campaign and Nirmal Gram Puraskar have shown that sanitation is achievable. But before we turn the page, we must know that the campaign needs consistent and dedicated support. What we need is not a spring cleaning but a sea change conducted on a war footing.

(N.C. Saxena is a Former Secretary, Planning Commission)

10) Environmental Degradation

Due to uncontrolled urbanization in India, environmental degradation has been occurring very rapidly and causing worsening water quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes. The situation in metropolises like Mumbai, Kolkata, Chennai, Delhi, Bangalore, Kanpur, Hyderabad etc. is becoming worse every year. The problems of finding space and housing for all have been intensified. Slums have become an inevitable feature of major Indian metropolises. The concentration of ambient air pollutants in the metropolitan cities of India as well as many of the Indian cities is high enough to cause increased mortality. 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 municipalities and such other civic authorities that are responsible for management of the waste have not been able to cope with this massive task. This could be attributed to various reasons, including erosion of authority, inability to raise revenues and inadequate managerial capabilities.

a) Water

Wastewater Management

As per the latest estimate of Central Pollution Control Board, about 29,000 million litres/day of waste water is generated from class I cities and class II towns out of which about 45 per cent (about 13,000 MLD) is generated from 35 metro cities alone. Collection systems exists for only about 30 per cent of the waste water through sewer lines and treatment capacity exists for about 7,000 million litres/day. Thus, there is a large gap between generation, collection and treatment of waste water (Table 3.5.9).

A large part of uncollected, untreated waste water finds it way to either the nearby water bodies or gets accumulated in the city itself, forming cesspools. These cesspools exist in almost all urban centres and are a breeding ground for mosquitoes and also a source of groundwater pollution. The waste water accumulated in these cesspools gets percolated in the ground and pollutes the groundwater. Also, in many cities/towns, conventional septic tanks and other low cost sanitation facilities exist, but due to improper maintenance, these septic tanks become a major source of groundwater pollution. In many urban areas, groundwater is the only source of drinking water. Thus, a large population is at risk of being exposed to water-borne diseases of infectious (bacterial, viral or animal infections) or chemical nature (due to fluoride or arsenic). Water-borne diseases are still a great health concern in India.

Pollutants are being added to the groundwater system through human activities and natural processes. Solid waste from industrial units is being dumped near the factories, and is subjected to react with percolating rainwater and contaminate the groundwater. The problem of groundwater pollution in several parts of the country has become so acute that unless urgent steps for abatement are taken, groundwater resources may be irreversibly damaged. Essentially, all activities carried out on land have the potential to contaminate the groundwater, whether associated with urban, industrial or agricultural activities. Large scale, concentrated sources of pollution such as industrial discharges, landfills and sub-surface injection of chemicals and hazardous wastes, are an obvious source of groundwater pollution. Diffused sources can affect entire aquifers, and would be difficult to control and treat. The only solution to diffuse sources of pollution is to integrate land use with water management. Land use activity, along with activities that are a potential threat to groundwater is presented in the Table 3.5.10 given below .

Table 3.5.9 : Projected Population and Respectively Wastewater Generation in India

Year	Urban Population	Litres/Capita/Day	Gross Wastewater Generation (mld)
1977-78	60	116	7,007
1989-90	102	119	12,145
1994-95	128	130	16,662
2001	285	NA	NA
2011	373	NA	NA
2021	488	121 (Assumed)	59,048 (Projected)
2031	638	121 (Assumed)	77,198 (Projected)
2041	835	121 (Assumed)	1,01,035 (Projected)
2051	1,093	121 (Assumed)	132,253 (Projected)
NA: Not Available			

Source: Ministry of Environment & Forests, 2007

b) Air Pollution

The metropolitan cities of India suffer from extremely high levels of urban air pollution, particularly in the form of suspended particulate matter. Region-wise, urban air pollution is estimated to cause over 2,50,000 deaths and billions of cases of respiratory illnesses every year (*World Bank 2006*).

Air quality data suggests that the pollutant of most concern from the point of view of environmental health risk is the airborne particulate matter.

Costs to society arising from urban air pollution include damage to human health, buildings, and vegetation, lowered visibility and heightened greenhouse gas emissions. Of these, increased premature mortality and morbidity are generally considered to be the most serious consequences of air pollution, both on account of their human and economic impacts. It is common and appropriate, therefore, to use damage to human health as the primary indicator of the seriousness of air pollution.

c) Solid Waste Management

Total quantity of waste generated in the country (based on weighment exercise by local bodies) is not reported. However, Ministry of Urban Development, in its manual on solid waste management (year 2000), has estimated a waste generation of 1,00,000 MT (Figure 3.5.6 and Figure 3.5.7).

MSW generation in Indian cities (around 5,100 ULBs) is estimated to have increased from 6 million MB in 2006 (Central Pollution Control Board 2000, TERI 2001). In addition, Indian consumption of plastics is around 4 MTPA (million tonnes per annum). About 60 per cent of this comprise of polyolefin which is primarily used as packaging material. About 2.0 MTPA of the total consumption is generated as plastic waste, of which around 70 per cent is recycled, mostly by the informal sector. The decadal growth in consumption of plastics during 1991-2001 was around 14 per cent (*Indian Centre for Plastics in the Environment and Central Institute of Plastic Engineering*

Table 3.5.10 : Land-Use Activities and Their Potential Threat To Groundwater Quality

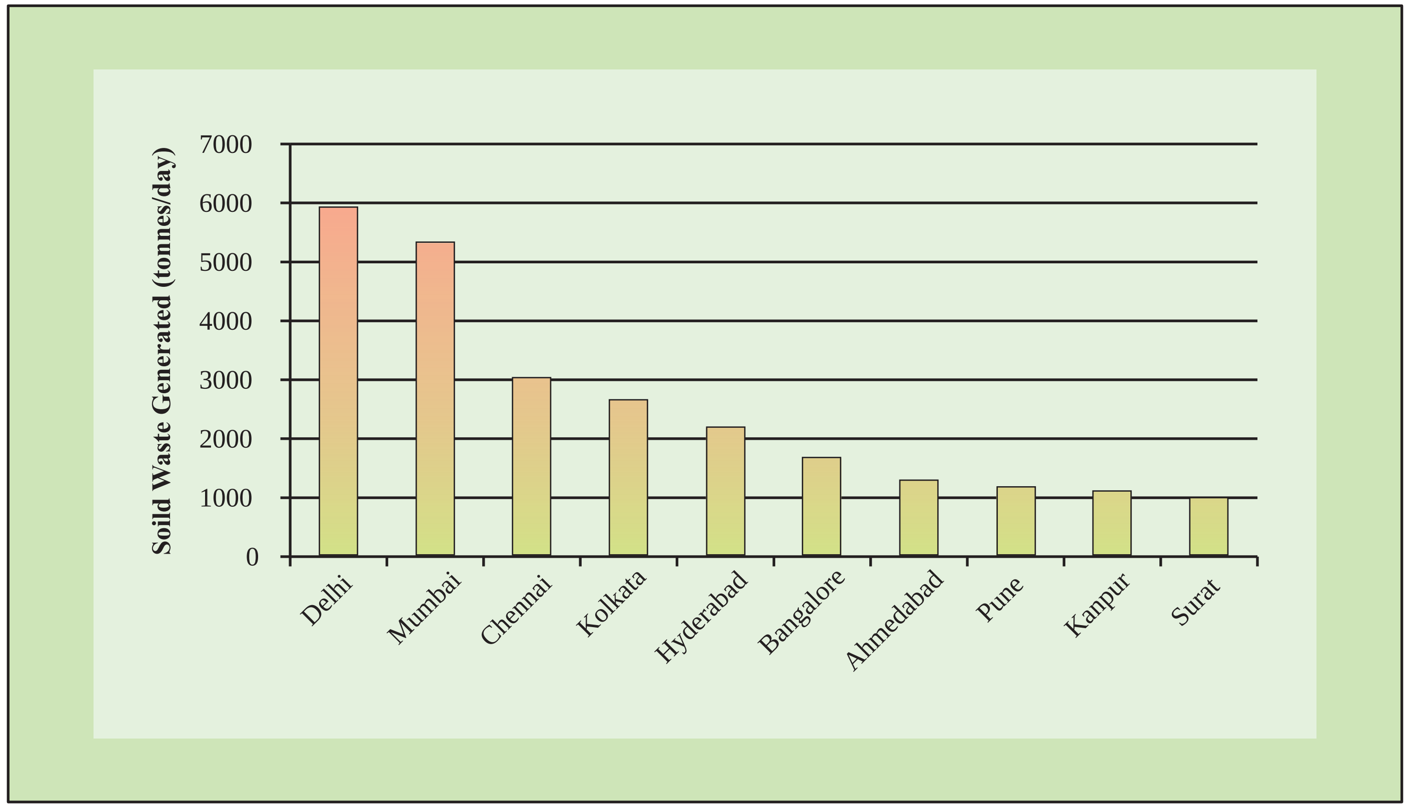
Land Use	Activities potential to groundwater pollution
Residential	Un-sewered sanitation Land & stream discharge of sewage Sewage oxidation ponds Sewer leakage, solid waste disposal, landfill leachate Road & urban run-off, aerial fall out
Industrial & Commercial	Process water, effluent lagoon etc. Land & stream discharge of effluents Tank & pipeline leakage & accidental spills Well disposal of effluents Aerial fall out Poor housekeeping Spillage & leakages during handling of material
Mining	Mine drainage discharge Process water, sludge lagoons Solid mine tailings Oilfield spillage at group gathering stations
Rural	Cultivation with agrochemicals Irrigation with waste water Soil Salinization Livestock rearing
Coastal areas	Salt water intrusion

Source: Central Pollution Control Board, 2007

Technology). Although the quantity of plastic waste reaching disposal sites is fairly low (0.62 per cent on dry weight basis), testifying to a high rate of recycling and reuse, the management of thin plastic bags remains a matter of concern due to low collection efficiency, which therefore needs to be strengthened.

There is an increased trend in the percentage of recyclables, accompanied by a decrease in the percentage of biodegradable matter in the waste stream (Table 3.5.11).

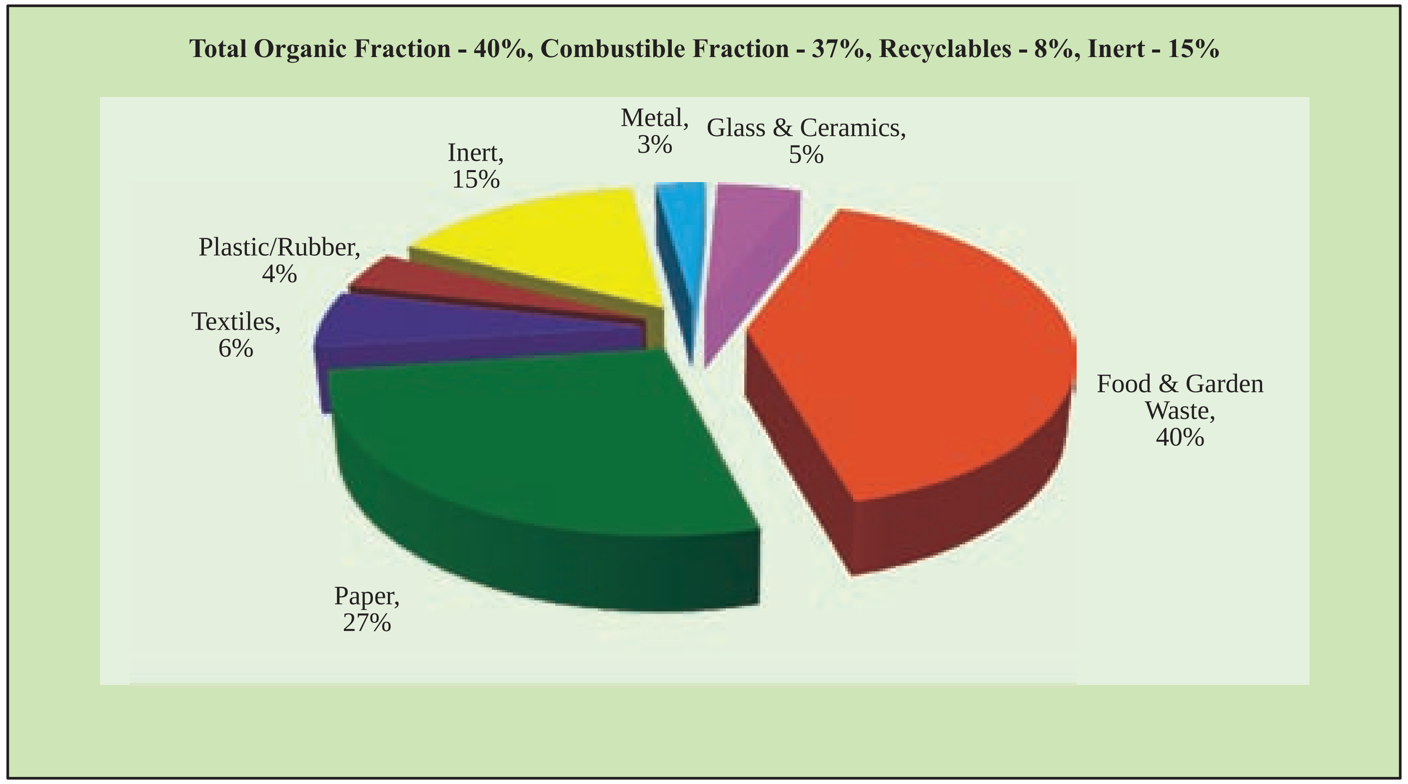
Figure 3.5.6: Solid Waste Generated in India's Top Ten Cities



Source: Central Pollution Control Board, 2006-07

We are all responsible for keeping our cities clean

Figure 3.5.7: Composition of MSW in a Typical Indian City



Source: CPHEEO Manual on MSW, 2005

Table 3.5.11: Change in Waste Composition in Selected Cities

City	Compostables (%)		Recyclables (%)	
	1982-1990	2005	1982-1990	2005
Lucknow	60.31	47.41	6.72	15.53
Kolkata	46.58	50.56	2.58	11.48
Kanpur	53.34	47.52	2.57	11.93
Mumbai	59.37	62.44	3.85	16.66
Delhi	57.71	54.42	8.24	15.52
Chennai	56.24	41.34	6.60	16.34
Bangalore	75.00	51.84	2.70	22.43
Ahemadabad	48.95	40.81	5.57	11.65

Source: 1982-90: Planning Commission; 1995 -2005: CPCB

CPCB, with the assistance of NEERI, has conducted a survey of solid waste management in 59 cities (35 metro cities and 24 state capitals) in 2004-05.

Mumbai and Delhi generated the largest amount of municipal solid waste in 2005, which is 5,922 tonnes/day for Delhi and 5,320 tonnes/day for Mumbai, followed by Chennai (3,036 tonnes/day) and Kolkata (2,653 tonnes/day). But if we consider the per capita generation of solid waste, it is the largest in Chennai, where it is about 0.620 kg/day. The lowest per capita waste generation is in Mumbai, which is about 0.45 kg/day. Again, about 90 per cent of the municipal solid waste generated in Mumbai and Chennai is being collected. However, in Delhi there is no adequate system of collection as only 77 per cent of the municipal solid waste generated is collected (Table 3.5.12).

Table 3.5.12 : Status of Municipal Solid Waste Management In Selected Metro Cities, 2004-05

Particulars	Kolkata	Chennai	Delhi	Mumbai
Area (sq. km)	187.33	174	1484.46	437.71
Population (Census 2001)	45,72,645	43,43,645	1,03,06,452	1,19,78,450
MSW generation (tonnes/day)	2,653	3,036	5,922	5,320
MSW generation rate (kg/c/day)	0.58	0.62	0.57	0.45

Source: Central Pollution Control Board, 2006

Box 3.5.3: Localities Manage Their Own Waste Better in Greater Mumbai

Municipal Corporation of Greater Mumbai has adopted ***Advanced Locality Management (ALM)*** scheme wherein citizens and the Municipal Corporation employees work hand-in-hand for the improvement of solid waste management services. These ALM groups are actively involved in segregation of waste into dry and wet waste and vermi-composting of biodegradable waste. It also handles various other civic problems and developmental works in the given locality. This scheme was started in July 1997 with only one locality participating in it, and by December 2000, the number of ALM Societies registered has grown to 666. ALM concept has also been extended to slums and commercial areas. The concept has been recognized as an effective model for citizen's participation in waste management.

Situation before the initiative

- People were totally dependant upon the Municipal Corporation for cleanliness and did not take interest in keeping their locality clean. There was little interaction between residents and the Corporation employees.
- The waste from the community bins was not always collected on a daily basis.
- Lack of timely street sweeping and littering by people resulted in dirty streets. At some places, the surface water drains choked due to accumulation of solid waste in it.
- Accumulation of waste on streets and around the community bins was a threat to health and hygiene.
- Rag pickers used to pick waste from collection points and landfill areas in a very unhygienic manner.

Benefits

- Involvement and active participation of citizens who took this initiative improved the level of cleanliness in the locality considerably.
- Throwing of garbage on roads has come down considerably. Segregation of waste at household level has increased. Dustbins were removed from the main roads and this provides a cleaner look to streets.
- The system has provided a platform for the Corporation and the residents to work together and in cooperation with each other rather than having confrontation, as earlier.
- Few ALMs, that are functioning for more than three years, have increased their scope to other activities such as tree plantation, prevention of encroachment on pavement, beautification of streets, etc.
- The ALM movement that started with the objective of cleanliness i.e., Zero Garbage, is gradually spreading to other areas of peoples' grievances regarding other civic services like maintenance of roads, improvement in water supply, check on unauthorized construction and monitoring unauthorized hawking.

Source: Ministry of Urban Development

Box 3.5.4: Recycling Waste In Namakkal, India

- Namakkal is a town in Tamil Nadu, situated on the highway from Salem to Dindigul. It is the first municipality in the country to privatize all the components of solid waste management, by the institutionalization of the door-to-door collection with segregation at source, vermi-composting and sale of recyclable waste from inorganic waste. Namakkal has the distinction of being the only zero garbage town in the country. In order to actively achieve this, they follow a ten point charter:
- Extend the scheme of door-to-door garbage collection (with segregation) to the entire town and make the streets and roads garbage-free.
- Introduce night sweeping at the bus stands and important roads, etc., and maintain cleanliness round the clock.
- Extend the scheme of door-to-door garbage collection and sweeping to holidays and sundays.
- Make the plants and burial grounds beautiful and attractive through NGOs and voluntary agencies.
- Remove encroachments on all the roads and streets.
- Prevent road-side hotels, lorry repair shops, etc. on the national highways and plant trees.
- Remove stray animals from the town.
- Levy service charges on hotels, kalyanamandapams (or wedding spots), commercial complexes and garbage generating industries.
- Manufacturing of vermi-compost from organic waste through voluntary organizations/ private agencies on BOT basis, sell the inorganic recyclable garbage and convert the component yard into Nandanvanam.
- Engage two 'mop-up' teams with two auto model carriers to remove the waste then and there, round the clock, and make the town garbage free.

The experiment has been successful due to its holistic approach, with all the agencies cooperating under the leadership of the District Collector. The committee includes the district administration, the municipality, a consortium of NGOs, women self help groups, schools, market associations, industrial associations, RWAs and rag pickers. Although Namakkal is a small town with a population of 60,000 to 70,000, it has two major industries - body building 60 per cent CNG tankers in the country and a very large and well organized poultry industry. Hence, if no effort was made, the town would have virtually turned into a garbage dump. Now, awareness has been created and every citizen accepts the responsibility of keeping the town clean and ensuring that nothing is thrown anywhere except in a bin.

With appropriate efforts, we can turn 'trash' into 'cash'

Source: Development Alternatives

Plastic Waste

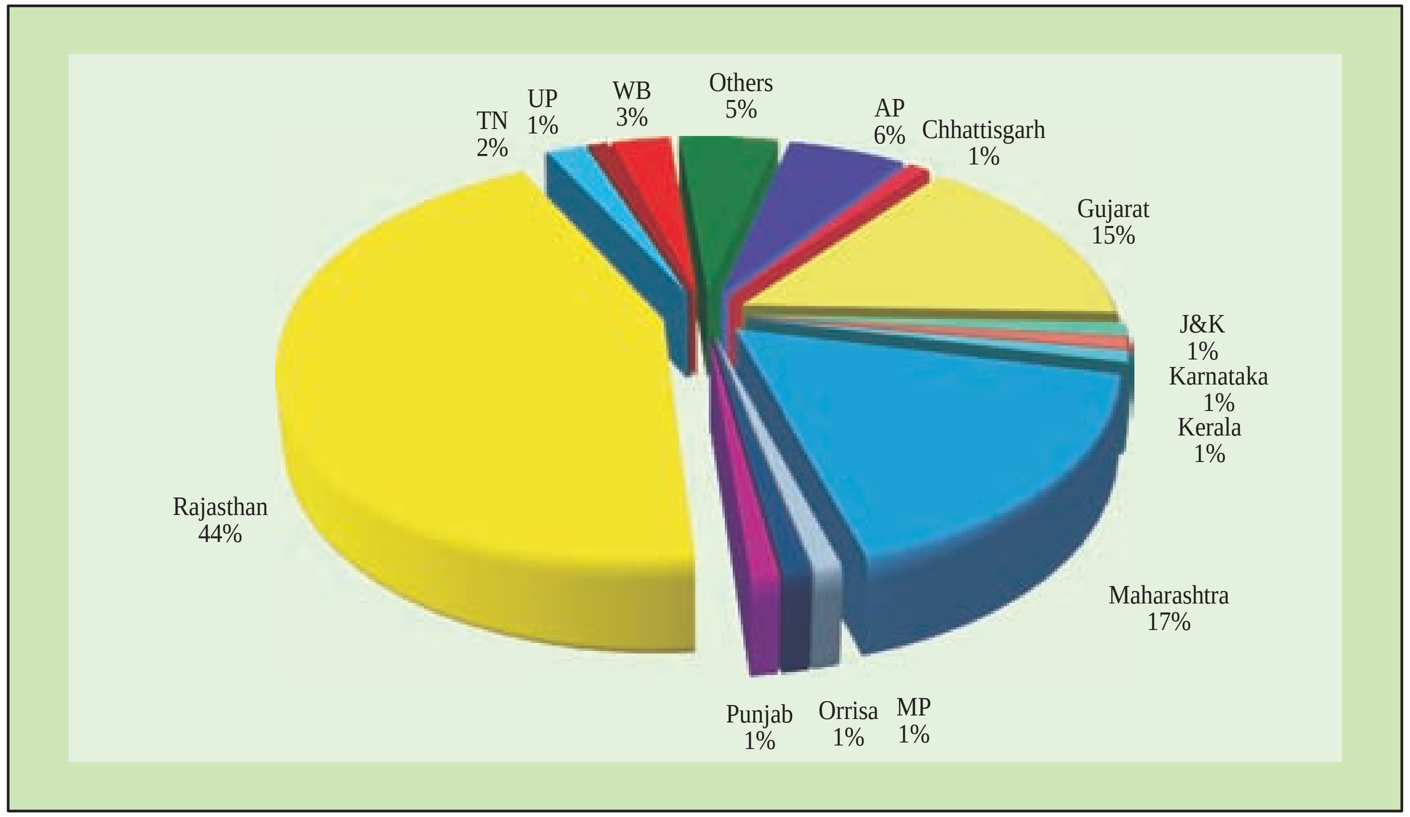
It is noteworthy that the quantum of waste is ever increasing due to the increase in population, developmental activities, changes in life style, and socio-economic conditions. Plastics waste constitutes a significant portion of the total municipal solid waste (MSW). It is estimated that approximately ten thousand tonnes per day (TPD) of plastic waste is generated i.e. 9 per cent of 1.20 lakhs TPD of MSW in India. The plastic waste includes two major categories of plastics; (1) Thermoplastics and (2) Thermoset plastics. Thermoplastics constitute 80 per cent and Thermoset constitutes approximately 20 per cent of total post-consumer plastic waste generated in India. Thermoplastics are recyclable plastics and include Polyethylene Terephthalate (PET), Low Density Poly Ethylene (LDPE), Poly Vinyl Chloride (PVC), High Density Poly Ethylene (HDPE), Polypropylene (PP), Polystyrene (PS), etc. Thermoset plastics contain alkyd, epoxy, ester, melamine formaldehyde, phenolic formaldehyde, silicon, urea formaldehyde, polyurethane, metalized and multilayer plastics etc.

Hazardous Waste

The hazardous waste generated in the country is about 4.4 million tonnes, out of which 38.3 per cent is recyclable, 4.3 per cent is incinerable and the remaining 57.4 per cent is disposable in secured landfills. Twelve states of the country (including Maharashtra, Gujarat, Tamil Nadu, West Bengal, Andhra Pradesh and Rajasthan) account for 87 per cent of total waste generation. The top five waste generating states are Maharashtra, Gujarat, Andhra Pradesh, Rajasthan and West Bengal (Figure 3.5.8).

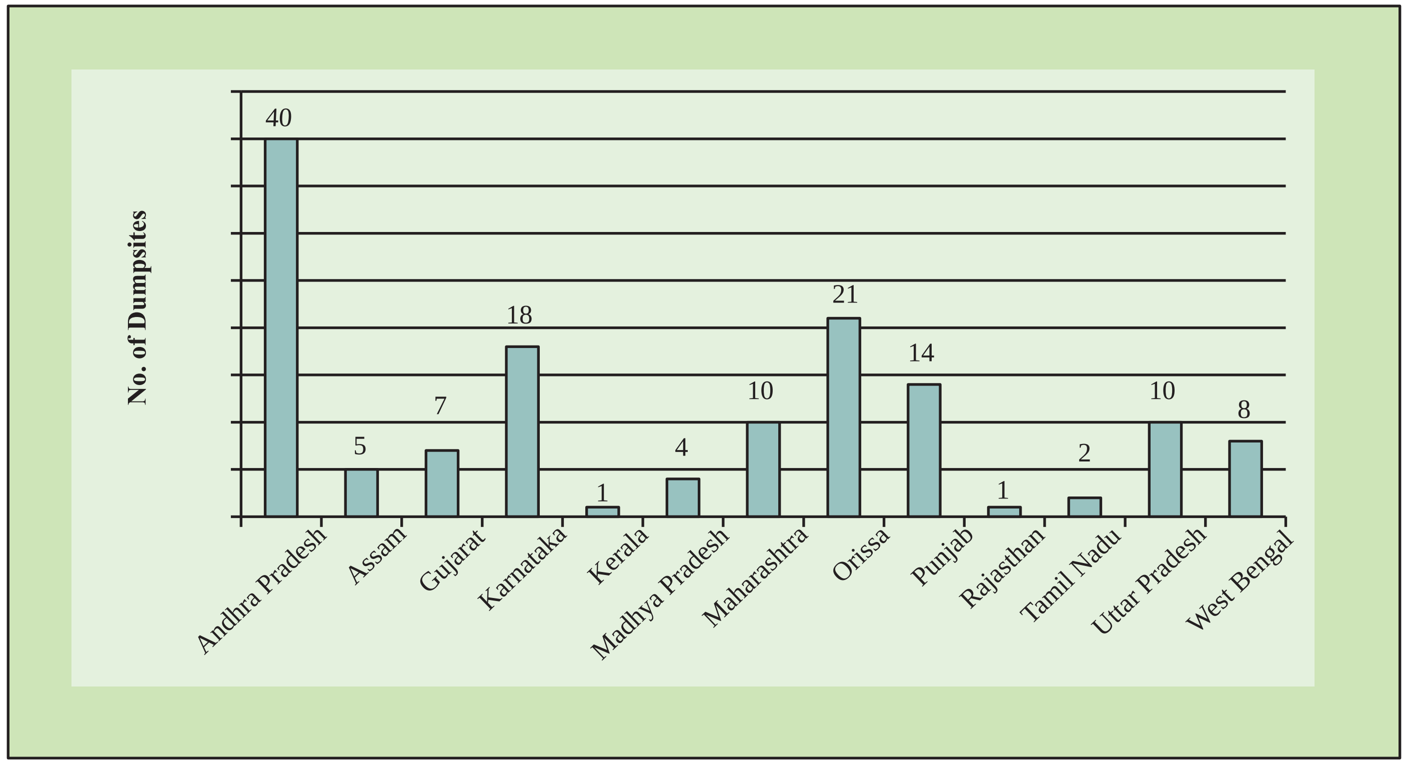
Electronic waste : needs proper recycling

Figure 3.5.7: Distribution of the Total Hazardous Waste Generated Among Different Hazardous Waste Generating States



Source: Inventory Hazardous Waste Generation, CPCB, 2006

Figure 3.5.8: State-wise Identified Hazardous Waste Dumpsites



Source: Inventory of Hazardous Waste Generation, CPCB, 2006

Electronic Waste (e-waste)

The growth of e-waste has significant environmental, economic and social impact. The increase of electrical and electronic products, consumption rates and higher obsolescence rates lead to higher generation of e-waste. The increasing obsolescence rate of electronic products also adds to the huge import of used electronics products. The e-waste inventory based on the obsolescence rate in India for the year 2005 has been estimated to be 1,46,180 tonnes, and is expected to exceed 8,00,000 tonnes by 2012. There is no large scale organized e-waste recycling facility in India, whereas there are two small e-waste dismantling facilities functioning in Chennai and Bangalore, while most of the e-waste recycling units are operating in the un-organized sector.

RESPONSE

For countering urbanization pressures, Ministry of Urban Development has initiated many programmes, some of which are given below.

1. JNNURM *(Jawaharlal Nehru National Urban Renewal Mission)*

It is a programme to ensure that the following objectives are achieved in the urban sector:

(a) Focused attention to integrated development of infrastructure services in cities covered under the Mission;

(b) Establishment of linkages between asset creation and asset management through a slew of reforms for long-term project sustainability;

(c) Ensuring adequate funds to meet the deficiencies in urban infrastructural services;

(d) Planned development of identified cities including peri-urban areas, outgrowths and urban corridors, leading to dispersed urbanization;

(e) Scale-up delivery of civic amenities and provision of utilities with emphasis on universal access to the urban poor;

(f) Special focus on urban renewal programme for the old city areas to reduce congestion; and

(g) Provision of basic services to the urban poor, including security of tenure at affordable prices, improved housing, water supply and sanitation, and ensuring delivery of other existing universal services of the government for education, health and social security.

The sectors that come under JNNURM are as follows:

- Urban renewal, that is, redevelopment of inner (old) city areas including widening of narrow streets, shifting of industrial and commercial establishments from non-conforming (inner city) areas to conforming (outer city) areas to reducing congestion, replacement of old and worn out pipes by new and higher capacity ones, renewal of the sewerage, drainage, and solid waste disposal system, etc.;
- Water supply (including desalination plants) and sanitation;

- Sewerage and solid waste management;
- Construction and improvement of drains and storm water drains;
- Urban transportation including roads, highways, expressways, MRTS, and metro projects;
- Parking lots and spaces on PPP basis;
- Development of heritage areas;
- Prevention and rehabilitation of soil erosion and landslides only in cases of special category states where such problems are common; and
- Preservation of water bodies.

Box 3.4.5: CRISIL Awards For Excellence In Municipal Initiatives, 2006-07

When the Government of India launched the JNNURM programme in December 2005, it recognized that mere funding of infrastructure projects in cities would not transform them. Reforms of the urban local bodies, Parastatal and the State level was essential for the city's sustainable, long-term growth. Urban local bodies need to re-engineer their processes through the adoption of technology. States have to eliminate legal, institutional and financial constraints impeding investment in urban infrastructure and services. JNNURM specifies thirteen mandatory and 9 optional reforms, which States and cities have to execute over the seven-year mission period.

The CRISIL Awards are being launched in partnership with the Ministry of Urban Development, Government of India. A city's 'Commitment to Reform' was the theme of CRISIL Awards for Excellence in Municipal Initiatives, 2006-07. The following cities were awarded for their performance at National Conference on JNNURM held on October 9, 2007:

- Water Supply: Chandigarh and Nanded
- Sewerage: Chandigarh and Bangalore
- SWM: Vijayawada and Nanded
- Financial Management: Mumbai and Pimiprichwad Municipal Corporation
- Progress on e-governance set-up is being made in 8 cities
- 100 per cent cost recovery (water supply) has been achieved in 3 cities

Source: Economic Survey of India, 2007-2008, Ministry of Finance

2. National Urban Housing & Habitat Policy, 2007

The National Urban Housing and Habitat Policy, 2007 seeks to use the perspective of Regional Planning in terms of preparation of District Plans by District Planning Committees (DPCs) and Metropolitan Plans by Metropolitan Planning Committees (MPCs) as a vital determinant of systematic urban planning. The policy seeks to promote symbiotic development of rural and urban areas. In this regard, the policy seeks to ensure refinement of Town and Country Planning Acts (wherever required) and their effective implementation. The focus areas of this Policy are:

- Urban Planning
- Affordable Housing
- Increase Flow of Funds
- Increase Supply of Land
- Special Provision for SC/ST/OBC/Minorities/Disabled
- Special Provision for Women
- Employment Generation
- Public-Private Partnerships
- Management Information System
- Healthy Environment

3. Solid Waste Management Rules

Considering the pathetic situation of Solid Waste Management practices being adopted by the Urban Local Bodies in the country, in September, 2000, Ministry of Environment & Forests notified the 'Municipal Solid Waste (Management and Handling) Rules, 2000', making it mandatory for ULBs to improve the systems of waste management as envisaged in the rules, in a given time frame ending 31st December, 2003. These rules lay out procedures for waste collection, segregation, storage, transportation, processing and disposal.

In India, there are no specific environmental laws or guidelines for e-waste. None of the existing environmental laws have any direct reference to electronic waste or reference to its handling as hazardous in nature. However, several provisions of these laws may apply to various aspects of electronic wastes. Since e-waste or its constituents fall under the category of 'hazardous' and 'non-hazardous waste', they shall be covered under the purview of 'The Hazardous Waste Management Rules, 2003'.

4. Plastic Manufacture and Usage (Amendment) Rules, 2003

Regulation of plastic waste, particularly manufacture and use of recycled plastic carry bags and containers, is being regulated in the country as per 'Recycled Plastics Manufacture and Usage Rules, 1999' and as amended in 2003.

5. National Urban Transport Policy, 2006

A national policy was developed by the Ministry of Urban Development to manage urban transport.

The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. This is sought to be achieved by:

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement;
- Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education, and other social needs, especially for the marginal segments of the urban population is improved;
- Improving access of business to markets and the various factors of production;
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus;
- Encourage greater use of public transport and non-motorized modes by offering Central financial assistance for this purpose;
- Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes;
- Establishing effective regulatory and enforcement mechanisms that allow a level playing field for all operators of transport services and enhanced safety for the transport system users;
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems;
- Introducing Intelligent Transport Systems for traffic management;
- Addressing concerns of road safety and trauma response; and
- Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements, etc.

Delhi and Kolkata have introduced the Metro Rail system. The Government of West Bengal is also planning to set up an East-West Corridor metro rail project for Kolkata on the DMRC model covering a length of 13.7 km (8 km underground and 5.7 km elevated) from Howrah to Salt Lake.

The Bangalore Mass Rapid Transit System (MRTS), called the Bangalore Metro Rail Project, was approved on April 27, 2006 for construction over a total length of 33 km (elevated: 25.65 kms; underground: 6.7 km; at grade: 0.65 km) in two corridors. The first East-West Corridor from Byappanahalli to Mysore Road is 18.1 km long and the second North-South Corridor from Yeshwanthpur to R.V. Road Jayanagar is 14.9 km long. The project is scheduled to be completed in five years, by December 2011. The first section of 7 km will be completed by March 2010.

The Government of Maharashtra also prepared a master plan for the Mumbai Metro which suggested implementation in three phases over nine corridors. The first corridor of Phase-I (Versova- Andheri-Ghatkopar) is fully elevated covering a total length of 11.07 km. This is to be implemented in the PPP mode on BOT basis.

To provide better public transport and ease congestion, proposals for Bus Rapid Transit System (BRTS) have been approved for Ahmedabad, Bhopal, Indore, Jaipur, Pune, Rajkot, Vijayawada and Visakhapatnam under JNNURM, covering a total length of more than 310 km with a total estimated cost of Rs. 2,740 crores, out of which the Central assistance is around Rs. 1,295 crores.

Delhi Metro Rail

Box 3.4.6: Delhi Metro Rail System

The Delhi Metro Rail System, technically known as Delhi Mass Rapid Transit System (MRTS) and popularly called the Delhi Metro, has transformed the way people travel where it has already been commissioned in Phase I in 65.1 km. It has incentivized a model shift from the private to public transport. Delhi Metro has also set standards for completion of projects with quality and without time and cost overrun as well as no inconvenience to the general public. Ever since it was commissioned, it has maintained the same level of quality of service. The unique joint venture institutional structure of 50:50 partnership of the Government of India (GoI) and the Government of the National Capital Territory of Delhi (GNCTD), set up for speedy implementation of this project, has proved to be very successful. Hence, the venture is being repeated in other States as well.

Delhi MRTS project Phase I (65.1 km), already completed, consists of the following corridors:

Line 1: Shahdara-Rithala

Line 2: Vishwavidhyalaya-Central Secretariat

Line 3: Barakhamba Road-Dwarka, and Extension of Line 3 to Dwarka sub-city and Barakhamba Road Indraprastha.

The Government has now sanctioned construction of DMRC Phase II and its extension, totaling to 115.505 km on the following corridors:

1. Vishwavidhalaya-Jahangir Puri
2. Central Secretariat-Qutab Minar
3. Shahdara-Dilshad Garden
4. Indraprastha-New Ashok Nagar
5. Yamuna Bank-Anand Vihar Inter-State Bus Terminal (ISBT)
6. Kirti Nagar-Mundka
7. Qutab Minar- Sushant Lok in Gurgoan
8. New Ashok Nagar-Noida
9. Hi Speed Express Link from New Delhi Railway Station to Indira Gandhi International Airport

Source: Economic Survey of India, 2007-2008, Ministry of Finance

6. Accelerated Urban Water Supply Programme (AUWSP)

Due to the low economic base and lower priority given by the State Governments to provide water supply to smaller towns, these are often neglected during normal times and are worst hit during the periods of drought as was observed in 1987. Therefore, there is a need to extend financial support to the State Governments/Local Bodies for providing water supply facilities in towns having population of less than 20,000 (1991 census). With this in view, a Centrally Sponsored Accelerated Urban Water Supply Scheme was included in the VIIIth Five Year Plan.

Objectives

- To provide safe and adequate water supply facilities to the entire population of the towns having population less than 20,000 (as per1991census) in the country within a fixed time frame.
- To improve the environment and the quality of life.
- For better socio-economic conditions and more productivity to sustain the economy of the country.

7. Public Private Partnerships in Infrastructure Projects

Scheme for support to Public Private Partnerships in Infrastructure projects has been approved by the Cabinet recently. Department of Economic Affairs has issued guidelines for the scheme, which envisages viability gap funding support to eligible projects. In order to make maximum utilization of this assistance window, DEA has suggested that the Ministries which do not have a Model Concession Agreement (MCA) may initiate steps to formulate such an Agreement. The Ministry has requested WSP-SA to prepare MCA for water supply and sanitation sector.

Rotary kiln furnace of the common hazardous waste incinerator

Sectors under this scheme are:

- Roads and bridges, railways, seaports, airports, inland waterways
- Power
- Urban transport, water supply, sewerage, solid waste management and other physical infrastructure in urban areas
- Infrastructure projects in Special Economic Zones

RECOMMENDATIONS

- Redirection of investment is recommended to develop strong economic base for small and medium cities neglected so far.
- Redirection of migration flow is required. Since the mega cities have reached saturation level for employment generation and to avoid over-crowding into the over congested slums of mega cities i.e Mumbai, Kolkata, Delhi, Chennai etc. it is required to build a strong economic sector (Kundu and Basu, 1998) in the urban economy. Growth efforts and investments should be directed towards small cities which have been neglected so far so that the functional base of urban economy is strengthened. Then, the redirection of migration to this desirable destination will be possible.
- Policy should also relate to proper urban planning where city planning will consist of operational, developmental and restorative planning.
- Operational planning should take care of improvement of urban infrastructure, e.g roads, traffic, transport etc. Developmental planning should emphasize on development of newly annexed urban areas. Various urban renewal processes can be used. Restorative planning should aim to restore original status of old buildings and monuments with heritage value.

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Vermicomposting: An effective way of managing waste

CHAPTER - 4

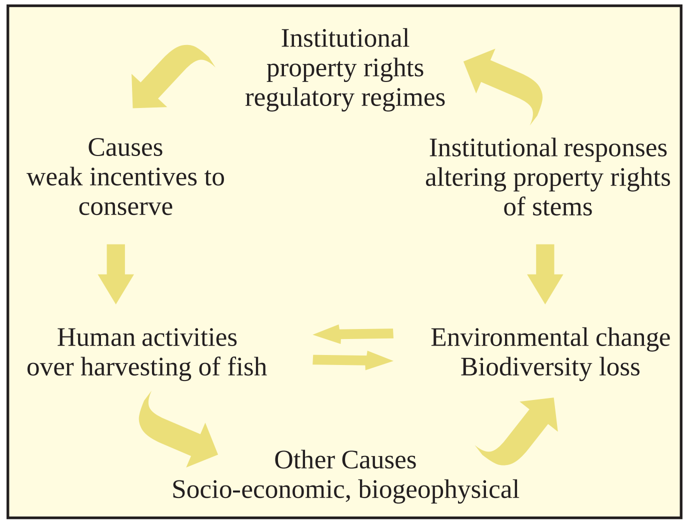
POLICY & INSTITUTIONAL OPTIONS

Managing natural resources requires efficient institutions at all levels i.e. local, national, regional and global. Institutions are defined as humanly devised constraints that structure human interaction (*Berkes and Folke, 2000*). Institutions, as defined by Young (1999), are systems of rules, decision-making procedures, and programmes that give rise to social practices, assign roles to participants in these practices and guide interactions among the occupants of the relevant roles. Institutions often figure prominently in efforts to solve or manage environmental problems (Young, 1999). The role of institutions in natural resource management is being increasingly recognized in the context of global environmental change. Further, challenges involved in integrating research into policy necessitate a thorough understanding of the dynamics between the human actions at different scales.

Awareness campaign in Rural Areas

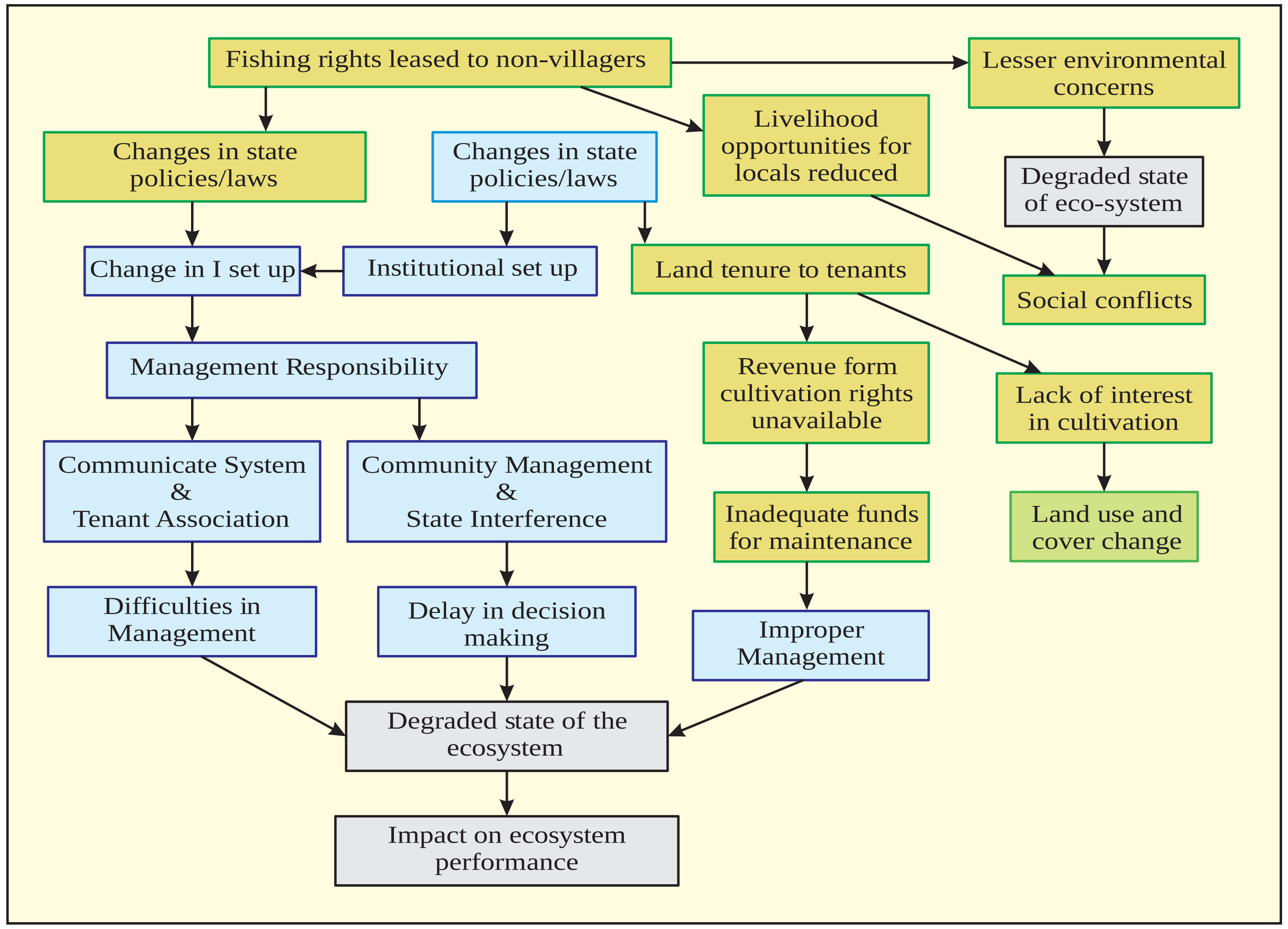
However, policy research and analysis of institutions related to global environmental change, that is ongoing worldwide, normally focuses on international or national mechanisms and programmes in place. While it is accepted that these programmes contribute significantly to causing and confronting global environmental changes, the role of local institutions cannot be ignored. Therefore, it is necessary to study the role of institutions, operating at the local level, in global environmental change and build the capacity of local communities to adapt to these changes (Figure 4.1 & Figure 4.2).

Figure 4.1: Framework for Analyzing Role of Institutions in Global Environmental Change



Source: Institutional Dimensions of Global Environmental Change (IDGEC) Framework

Figure 4.2: A Simple Framework Connecting Set-up to Ecosystem Performance



BUILDING AWARENESS

Spreading awareness and empowering people to take decisions, at the local level, is an effective way of dealing with the environmental problems of India. Their decisions will enable initiatives that benefit themselves, as well as the local environment. It has been seen that solutions always emerge whenever governments involve people, using a participatory approach to solve problems. Centuries of careful tending of land on which people depend, is an example of their ability to coexist harmoniously with nature, and each generation has passed on its traditional understanding of managing natural resources to those who have followed.

Rapid population growth is a major challenge which India is facing. Education and awareness, better health facilities, accessibility to birth control methods, and promoting a woman's right to exercise her decisions are the obvious solutions. The quickening pace of development, industrialization, urbanization and population growth is challenging traditional practices. The use of medicinal plants, organic farming and traditional arts and crafts are being lost in the globalization process. Farmers need to be educated about better and more sustainable agricultural practices.

Wasting resources is a practice common to affluent sections of society and remains one of the principal causes of environmental problems in India. The per capita consumption of water, energy and food in urban centres is many times more than in rural areas. In India, awareness needs to be spread so that individuals understand the value of conserving resources (water, energy) and products (food), especially among the affluent sections of the population.

Another major challenge is conserving the rich biodiversity and using it sustainably for economic benefit. Local people should be educated about the natural wealth they possess, so that the developed world does not take undue advantage of their traditional knowledge, by patenting it. For example, the Government is working in cooperation with local communities to document this knowledge for posterity and as a step towards protection against unfair patents.

Protecting Traditional Knowledge

India has a rich diversity of plants, which have been used by people for generations. The majority of people still rely directly on the diversity of plants, or plant genetic resources, for food and medicine. There is an abundance of local expertise in plant genetic resources that has been in use over a considerable period of time and is also constantly evolving. In agriculture, for instance, this knowledge is shown in the development and adaptation of plants and crops to different ecological conditions (soils, rainfall, temperature, altitude etc.). Traditional knowledge is people's awareness and understanding of this and other information, which is passed on from one generation to the next, usually by word of mouth, for example, within a specified group of people.

Intellectual Property Rights

Most of the debate about traditional knowledge at the international level is taking place in the context of Intellectual Property Rights (IPR). It is through IPR, and particularly patents, that control and ownership over traditional knowledge is being usurped by commercial interests.

It is clear that industries, with the increased support from governments, are quickly establishing control over plant genetic resources and associated knowledge through the use of IPRs. Yet, resistance to this incursion on community rights has been disparate and experimental. Overall, communities are increasingly losing control over their own plants and are being increasingly exploited for their knowledge. As the awareness amongst groups, communities and even governments has increased, and as those affected have become more organized, the tide has begun to turn.

There is, however, a lot of strategic work to be done among NGOs and people's movements in order to build a stronger social force against the growing influences of trade and IPR over genetic resources and traditional knowledge. Now, concerns are being raised that the very biological resource base of traditional knowledge is on the verge of depletion. Plants are vanishing so quickly that the Earth is losing one major drug to extinction every two years. Disrupting the inter-relation between the traditional knowledge generators and their resource, may well lead to the disintegration of the very processes by which the knowledge is evolved and kept alive.

Training women in paper bag making

Empowering Local Communities

With India facing and even succumbing to such threats of bio-piracy and breach of IPRs, a collective stand may provide an effective sharing of traditional knowledge. Steps which could be taken to address these threats include:

Networking: Increased networking amongst NGOs and communities to present a united body of opinion.

Community rights: Development and establishment of strong community rights' systems that recognize the collective nature of local innovation, promote its development and application, encourage individual innovation within this community framework and shield biodiversity and indigenous knowledge from privatization.

Legal rights: Conferring clear and unambiguous legal rights to genetic resources, as this is closely linked with the recognition of the rights of indigenous people and local communities to such resources. This means that basic issues of self-determination, sovereignty and communities' own definitions of their rights need to be dealt with and built into statutory law and policy at the national level.

Documentation: Recognizing and protecting, through legal means, the various initiatives at documenting the traditional knowledge. The uncertainty about whether and how to document the materials and knowledge, for fear that the information is used against the people's interests, needs to be resolved.

Alternative approaches: Examining and highlighting alternatives to IPRs which protect traditional knowledge.

Trade related aspects of Intellectual Property Rights: Strengthening a unified demand to review and amend the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights.

Environment Education

The dissemination of awareness and education about the environment can be done through formal education and informal means.

Formal Education

The formal education system provides a good framework for reaching out to a large segment of the population and can help make future generations conscious of the importance of environment conservation. India has made efforts to introduce environment education into their primary, secondary and tertiary syllabi with varying degrees of success. Academic approaches have included separating environmental studies from other courses or incorporating them into existing curricula at the primary and secondary levels. Many schools have organized and established eco-clubs, whose members participate in environmental awareness-and-action activities. There is a definite increase in awareness among school going children about the threats to the environment and many of them, in their own small ways, are contributing through activities to preserve the environment (such as boycotting polythene bags, planting trees, etc.). Formal education is often supplemented with activities such as field visits to study centres, museums and parks, use of audio-visual material and children's magazines. NGOs and universities in some countries play a major role in training teachers and providing the material for formal education.

Programmes and Campaigns

Environmental conservation is a task of such magnitude that no government or group, however influential or knowledgeable, can undertake it successfully without the participation of people. Efforts, therefore, have been made through campaigns to generate in the citizenry a concern for, and awareness of the environment.

The recommendations for making environmental awareness more effective at a formal level are:

- Improve the quality of school curricula to make learning and teaching about the environment more effective.
- Review, select and make available adequate supplementary educational material that has already been developed, for use in primary and secondary schools.
- Produce educational material on environmental issues (that have not been adequately covered) in the form of case studies, and on emerging conditions relating to the environment.
- Organize training courses for teachers and introduce field-oriented methods of teaching about the environment.
- Initiate schemes to motivate teachers and schools to enhance the level of environmental education.
- Encourage and support NGOs to undertake environmental awareness programmes.

Informal Education

Religious Institutions

Naming a piece of land after a god (as in the case of sacred groves), or giving away tree saplings as blessings, are long established practices in the region, which are still being used to preserve our environment.

Industrial Sector

While large industries are generally aware of their responsibility towards the environment (more so because the law keeps a close watch on them), smaller factories and workshops actively flout environmental regulations, both knowingly and unknowingly. Generating awareness and providing cleaner and greener alternatives and technologies should be a major concern for all the countries in the region. In this context, the sharing of information and technologies by research institutions, regionally and globally, is crucial.

The Critical Role of Women

Women have a special stake in helping the cause of sustainable development; they play a critical role in determining a number of factors that affect sustainable development. Moreover, women can play a crucial role in the planting of trees as an alternative to traversing long distances to collect firewood.

In India, local forests established by women have a much higher chance of survival than those planted by the government. The ratio (in terms of the probability of survival) stands at 80 per cent for the women compared to 20-30 per cent for the government. The role of women in household sanitation and health is no less significant. More than any hydrologist or urban planner, it is the women of the developing world - the drawers, carriers and household managers of water - who understand what water scarcity is and its implications for communities. Despite this, access to informal environmental education for women is low in India. Most environmental training programmes on soil regeneration, forestation, energy saving and water management do not provide learning opportunities for women. Therefore, women require better opportunities to translate their knowledge and initiatives into concrete action and control over natural resources such as water, as well as over their own lives. By offering them opportunities in education, economic and political life and in the decision-making process, governments could vastly improve in terms of environment management.

Environmental Communication

The essence of environmental communication is to convince people that there is problem that requires urgent attention. With a host of messages competing every moment for the public's attention, the task of delivering any particular one is by no means easy. Numerous channels of communication, ranging from print and electronic media to folk art and community communicators such as NGOs and action groups, have been used to promote environmental awareness among the people. These have achieved substantial success in raising environmental consciousness over the years.

Role of Media

Until a few years ago, environment reportage was largely limited to covering speeches or tree-planting campaigns on Environment Day. Today, journalists work closely with environmental activists, and are much more pro-active and focused on the larger issues. Media coverage of environmental issues has not only increased in recent years but has also become more diverse. Besides the local issues, global ones such as the greenhouse effect, ozone depletion and loss of biodiversity are increasingly coming in the limelight.

Women empowerment through skill-training

The role and the reach of various media in terms of dissemination of environmental information vary. The print media, radio and television dominate the urban areas, whereas traditional and interpersonal forms of communication appear to be far more effective in rural areas. Radio may be used as a powerful medium for information dissemination in local languages as it reaches most rural areas.

Folk - Art

Communication through folk media is an effective age-old technique. Experiments have demonstrated that people residing in rural areas respond most readily when communicators relate to their local circumstances and cultures, and when they interact with the audience. As for electronic media, it has generally proved persuasive when it has adopted the traditional methods of dissemination: humour, discussion, illustration through dramatization, and song-and-dance sequences.

The recommendations for making environmental awareness more effective are:

- Integrating community concerns in decision-making.
- Involvement of community in natural resource management.
- Market development as a driving force for changes in human-environment relationship.
- Institutions need good support from concerned organizations to perform better.
- Capacity building of concerned organizations.
- Periodical review of performance to enhance responsiveness of institutions.
- Education and communication needs more financial allocation by governments.
- Enhanced awareness and greater public understanding of environmental and development issues is vital for the success of all other development programmes. In other words, a strong educational and communication sector is akin to an insurance policy to secure the future. Increased financial allocation is, therefore, a primary requirement.
- Initiate regional and global cooperation in sharing educational material.
- Encouragement and support to NGOs for carrying out environmental awareness programmes.
- Formulate a comprehensive country-wide awareness programme through the print and audio-visual media, and seek private support for the programme.

Participatory Management in Rural Area

- There is a tendency to focus on formal school education target groups by both governments and NGOs, rather than addressing groups that can make a difference in a policy issue. In reality, our environment is managed by a wide variety of individuals in society. It includes managers of resources (such as town planners and forest officials), teachers (who disseminate environmental information and thus influence the management), and rural women, farmers and urban housewives (who exercise a direct impact on our environment). Governments and NGOs should make these groups the prime catalysts for their awareness generation campaigns.

PARTICIPATORY MANAGEMENT

Community-based natural resource management initiatives, coupled with policy reforms, can prove to be an effective mechanism for improving access to, and improving productivity of natural resources. The success of, joint forest management and irrigation user groups in India, provides enough evidence that social capital and participatory processes are as crucial to environmental protection as financial resources and development programmes. The value of human, land, water and other assets depend on technologies that improve the productivity of those assets, thereby generating adequate return and income. Globalization can bring significant benefits of technological advancement, and market access through improved connectivity and information. However, it must be emphasized here that unless local communities themselves are involved in the selection and use of these technologies, they are unlikely to benefit from their implementation and these technological interventions will be unsustainable in the long term.

Research and Development

In order to rapidly advance the scientific understanding of environmental issues, it is necessary to promote focused research by competent institutions. A continuous engagement with the scientific community, in governments, academics, and private institutions, will provide important insights for policy making and regulation, including multilateral negotiations, and help utilize deeper and broader skills available with the scientific community. Key areas of research are:

- Taxonomies of living natural resources.
- Research leading to better understanding of ecological processes and pathways.
- Research which provides direct inputs to policy making.
- R&D in technologies for environmental management and cleaner production.

The order of priority of these research areas is very likely to change over time. Actions are necessary to periodically identify and prioritize the areas for research, establish a research programme in priority areas within governments, with expected outputs clearly specified, and encourage research in priority areas outside governments with necessary financial and institutional support.

International Cooperation

India has contributed to, and ratified several key multilateral agreements on environmental issues in recognition of the trans-boundary nature of several environmental problems, and has complied with their commitments. To enhance capacities to comply with commitments, and ensure sustained flows of resources for environmental management, the following steps should be taken:

a) Use multilateral and bilateral cooperation programmes for capacity building in terms of environmental management, particularly in relation to commitments under multilateral instruments;

b) Participate in mechanisms and arrangements under multilateral agreements for enhancing the flow of resources for sustainable development; and

c) Encourage cooperation among states in the country, in particular for scientific and technical capacity building in environment management.

Regional Mechanisms

The trans-boundary nature of global environmental problems suggests that cooperation between states represents the best strategy for addressing concerns, effectively. Therefore, responding to environmental problems through prompt collective action could be an important means to generate trust and goodwill. Even though there are several regional mechanisms for environmental protection, there exists a need for more policies that address the nature of trans-boundary environmental problems and their impacts. A network of regional institutions could be effective in complementing the existing institutional mechanisms, by contributing to the creation of a better understanding of key issues, exchange of information among key institutions, and training and capacity building of appropriate stakeholders. A proper perception on common environmental problems will result in common and politically compatible solutions, ensuring better cooperation within the country.

Technology Transfer

India is facing one of the fastest growths of population, economic activity, as well as pollution. Transferring state-of-the-art eco-friendly technologies and training people to use them, is essential to meet the three-fold challenge. The focus should be on the propagation and use of 'green technologies' which include an evolving group of methods and materials for producing non-toxic clean products. The scope of environmental technology has been extended to include clean technology for pollution prevention (such as the development and use of less polluting materials), procedural improvements and enhanced energy efficiency. Environmentally sound technology not only refers to each separate technique, but to the entire comprehensive system which includes knowledge, processes, goods and services, facilities, and organization and management processes.

The objectives of technology transfer are to:

- Ensure sustainability by meeting the needs of society in sustainable ways, without damaging or depleting natural resources;
- Manufacture products that are non-toxic or biodegradable and can be partially or fully reclaimed or reused;
- Reduce waste and pollution by changing patterns of production and consumption;
- Develop alternatives to technologies, whether fossil fuel or chemical intensive agriculture, that have been demonstrated to damage health and environment, and create a centre of economic activity around technologies and products that benefit the environment, hasten their implementation and increase employment opportunities in this area.

There is increasing pressure on society to carve out sustainable paths of development and this will lead to public and private sector research and development institutions to develop technological solutions. This will also encourage business sector - Corporations and Small and Medium Enterprises (SMEs) to adopt new green technologies, either voluntarily or in compliance with the growing number of environmental regulations. Biotechnology offers powerful new tools for improving agricultural productivity, environmental sustainability and nutritional quality of staple foods. These new technologies are helping to guide more precise crop and livestock breeding efforts, to diagnose crop and livestock diseases, and to develop more effective livestock vaccines.

Barriers to Successful Technology Transfer

The parameters that act as barriers to successful technology transfer are:

- Lack of information on the benefits of green technologies
- Lack of communication between national and international information systems and industry associations
- Lack of funds to facilitate technology transfer since mandates and financing of these information systems are not specifically oriented to developing countries
- Greater cost of new technologies compared to those of the existing polluting technologies
- Intellectual property rights and royalties
- Lack of skills in terms of managing green technology in the region

Ecosystem Services

Ecosystem services are the systems and processes through which natural ecosystems and species sustain human life. These include oxygen production, carbon sequestration, provision of clean water, assimilation of wastes, and flood regulation. The rising demand for ecosystem services, coupled with their reduced supply, will lead to growing vulnerability and conflicts over who gets the benefits and who pays the costs of disrupted ecosystem, in an already highly inequitable world.

India will also have to confront the larger problems arising from ecosystem degradation. Overlaid will be the effects of growing pressures such as the build-up of nitrogen in rivers and coastal waters, species extinction, and increased incidence of droughts and floods from climate change.

Ecosystem Services Valuation (ESV) can be developed as a vehicle to integrate ecological understanding and economic considerations. It is a holistic approach for making inventories and quantifying the monetary value of ecosystem services so that various stakeholders, including land owners, planners and policy makers can better understand the trade-offs when altering natural ecosystem.

The distribution of benefits from ecosystem goods and services among different beneficiary groups at different time periods is a crucial factor when considering their value. Beneficiaries of ecosystem services include individuals (the basic unit in estimating the total economic value), commercial entities and the public sector.

Another scale at which the conflicts between users, or trade-offs between users, become evident is that of temporal variation of ecosystem goods and services. Benefits and beneficiaries vary in the short and long term. Such variations are obvious when exploitation of ecosystem goods in the short term, leads to a decline in ecosystem services over the long term.

A variety of policy choices are available to reduce the degradation of ecosystem services in order to retain their benefits. These include regulatory approaches (such as establishing 'no take' zones in fisheries), technological approaches (such as promoting drip irrigation systems to reduce water consumption) and economic approaches (such as assigning private property rights to the resource and enabling the owners to charge for the use of the service).

ECONOMIC INSTRUMENTS

In recent years, there has been an increase in the use of economic instruments to promote the conservation of ecosystem services. In some cases, the producers of services that were formerly being provided free, have been paid by the government to provide those services. In other cases, markets are being established for ecosystem services that were formerly being provided free, such as carbon markets that enable a landowner to be paid for management activities that increase carbon sequestration. Many policy alternatives to market based approaches exist, and different societies, and even members within societies, are likely to opt for different mechanisms since value systems differ over time and with the changing circumstances. This makes the process of valuation difficult, except for those services that are widely traded in the marketplace. Maintaining functional ecosystems, which provide essential services for human well being, is the basis of sustainable development.

Strengthen the rights of local people to use and manage ecosystem services

Ecosystem services are a lifeline for the poor in rural communities, who often do not have clear rights to the land, fisheries, forests or other resources they use and are unlikely to have the ability to influence decisions on resource management.

In most countries, decisions on management and use of ecosystem services are made and influenced by the national governments, international donors and multinational companies. Conservation groups have also played a prominent role through their efforts to protect nature by establishing parks and protected areas. However, it is increasingly being recognized that more bottom-up approaches are required to involve local communities in decision-making processes. Similarly, groups working to reduce poverty and promote biodiversity conservation pursue a common cause in development policies and need to synergize efforts.

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Common Myna : Acridotheres Tristis

ABBREVIATIONS

BAU	Business as Usual
BCM	Billion Cubic Metre
BTU	British Thermal Unit
CDM	Clean Development Mechanism
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CSO	Central Statistical Organization
dB(A)	A-Weighted Decibels
DPCs	District Planning Committees
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
GDP	Gross Domestic Productivity
GEDA	Gujarat Energy Development Agency
GJ/t	Gigajoule per tonne
GW	Gigawatt
ICIMOD	International Centre for Integrated Mountain Development
IFPRI	International Food Policy Research Institute
IIPS	International Institute of Population Science
INP	Indian Nutrition Profile
IPCC	Intergovernmental Panel on Climate Change
IIT	Indian Institute of Technology
Kgoe	Kilogram of Oil Equivalent
IUCN	International Union for Conservation of Nature
LULUCF	Land-Use, Land-Use Change and Forestry
Mha	Million Hectares
MNRE	Ministry of New and Renewable Energy
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forests
MoPNG	Ministry of Petroleum and Natural Gas
MPCs	Metropolitan Planning Committees
MPN	Most Probable Number
MT	Million Tonnes
MTPA	Million Tonnes per Annum
MTOE	Millions Tonnes of Oil Equivalent
NAPCC	National Action Plan on Climate Change
NGO	Non-Governmental Organization
NFHS	National Family Health Survey
NSSO	National Sample Survey Organization
NO_x	Oxides of Nitrogen
OED	Occupational and Environmental Health
PM	Particulate Matter
RSPM	Respirable Suspended Particulate Matter
SMEs	Small and Medium Enterprises
SO_2	Sulphur Dioxide
SPM	Suspended Particulate Matter
TERI	The Energy and Resource Institute
ULB	Urban Local Bodies
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VOC	Volatile Organic Compound
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WWF	World Wide Fund for Nature

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

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