

National Circumstances

Chapter 1

India is a vast country covering 3.28 million km², and is situated north of the Equator between 66°E to 98°E and 8°N to 36°N. It is bordered by Nepal, China and Bhutan to the north; Bangladesh and Myanmar to the east; the Bay of Bengal to the south east; the Indian Ocean to the south; the Arabian Sea to the west; and Pakistan to the north west. India consists of diverse physio-geographical features that may be classified into: (a) the Great Mountain Wall (the Himalayan range) in the north; (b) the Northern Plains; (c) the Great Peninsular Plateau; (d) the Coastal Plains; and (e) the Islands. India occupies only 2.4 per cent of the world's land area, but supports about 16.2 per cent of the world's human population. India also has only 0.5 per cent of the world's grazing area, but supports almost a sixth of the world's livestock population. This, as one can imagine, places unbearable stress on both the land and the available natural resources. India is endowed with varied soils, climate, biodiversity and ecological regions. Under such diverse natural conditions, over a billion people speaking different languages, following different religions and inhabiting rural and urban areas, live in harmony under a democratic system.

CLIMATE

India's unique geography produces a spectrum of climates over the subcontinent, affording it a wealth of biological and cultural diversity. The diversity is perhaps greater than any other area of similar size in the world. Land areas in the north of the country have a continental climate with fierce summer heat that

alternates with cold winters when temperatures plunge to freezing point. In contrast are the coastal regions of the country, where the warmth is unvarying and the rains are frequent. There is a large variation in the amounts of rainfall received at different locations. The average annual rainfall is less than 13 cm over the Thar desert, while at Cherrapunji in the north-east it is as much as 1080 cm (Figure 1.1). The rainfall pattern roughly reflects the different climate regimes of the country, which vary from humid in the north-east (about 180 days rainfall in a year), to arid in Rajasthan (20 days rainfall in a year)¹. A semi-arid belt in the peninsular region extends in the area between the humid west coast and the central and eastern parts of the country.

The most important feature of India's climate is the season of concentrated rain called 'the monsoon'. So significant is the monsoon season to the Indian climate, that the rest of the seasons are quite often referred relative to the monsoon.

India is influenced by two seasons of rains, accompanied by seasonal reversal of winds from



Monsoons are the most important feature of India's climate

¹ A rainy day is defined as a day with a rainfall of 2.5 mm and above, as per the operational practice of the India Meteorological Department.

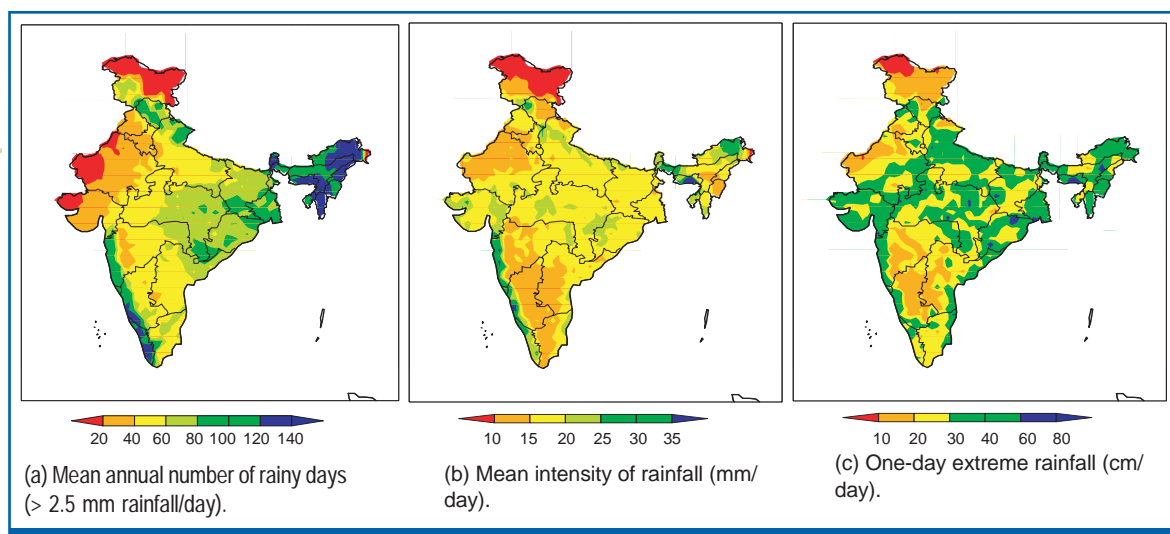


Figure 1.1: Indian rainfall profile.

January to July. During the winters, dry and cold air blowing from the northerly latitudes from a north-easterly direction prevails over the Indian region. Consequent to the intense heat of the summer months, the northern Indian landmass becomes hot and draws moist winds over the oceans causing a reversal of the winds over the region. This is called the summer or the south-west monsoon.

The four principal seasons—identified area:

- Winter—December, January and February.
- Pre-monsoon or summer—March, April and May.
- South-west monsoon—June, July, August and September.



The Himalayas in the north influence the Indian climate considerably.

- Post-monsoon or Northeast monsoon—October and November.

The cold weather season starts in early December. Clear skies, fine weather, light northerly winds, low humidity and temperatures, and large daytime variations of temperature are the normal features of the weather in India from December to February. The cold air mass extending from the Siberian region, influences the Indian subcontinent (at least all of the north and most of central India) during the winter months. The Himalayas obstruct some of the spreading cold air mass. The mean winter temperatures increase from north to south up to 17 °N, the decrease being sharp as one moves northwards in the north-western parts of the country. During January, the mean temperatures vary from 14 °C to 27°C. The mean daily minimum temperatures range from 22 °C in the extreme south, to 10 °C in the northern plains and 6 °C in Punjab. The rains during this season generally occur over the western Himalayas, the extreme north-eastern parts, Tamil Nadu and Kerala.

The mean daily temperatures begin to rise all over the country by the end of winter, and by April, the interior parts of the peninsula record mean daily temperatures of 30-35 °C. The central regions become warm with daytime maximum temperatures reaching about 40 °C at many locations. During this season

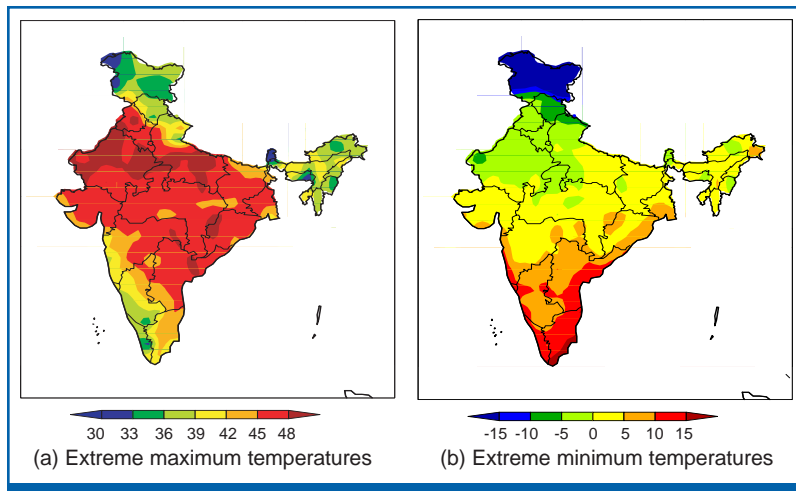


Figure 1.2: Indian temperature profiles (1951-1980).

stations in Gujarat, North Maharashtra, Rajasthan and North Madhya Pradesh are marked by high daytime and low night-time temperatures. At many locations in these regions, the range of the daytime maximum and night-time minimum temperatures exceeds 15 °C. In the north and north-west regions of the country, the maximum temperatures rise sharply, reaching values exceeding 45 °C by the end of May and early June, heralding the harsh summers (Figure 1.2). In the coastal areas of the country, land and sea breezes predominate due to the stronger temperature contrast between the land and the sea during this season.

Tropical cyclones, which are intense circulations of 200-300 km diameter, with winds blowing at velocities close to 150 km/hr form in the Bay of Bengal and the Arabian sea during this season. The storms generally move towards a north-westerly direction at first and later take a northerly or north-easterly path. Storms forming over the Bay of Bengal are more frequent than the ones originating over the Arabian Sea. About 2.3 storms form on an average during a year.

Thunderstorms associated with rain and sometimes hail are the predominant phenomena of this season. Over the dry and hot plains of north-west India dust storms (known locally as *andhis*), accompanied with strong dust-laden winds, occur frequently. Violent thunderstorms with strong winds and rain lasting for short durations also occur over the eastern and north-

eastern regions in the states of Bihar, West Bengal and Assam. They are called norwesters because they generally approach a location from the northwest direction (locally they are known as *Kal Baisakhis* in the context of their season of occurrence).

The SW monsoon over India is the single most important feature of the Indian climate. Although it is spread over four months (June-September), its actual period at a specific place differs

depending on the dates of its onset and withdrawal. The duration of the monsoon varies from less than 75 days as in West Rajasthan, to more than 120 days observed over the south-western regions of peninsular India. The rains during this season alone contribute to about 80 per cent of the annual rainfall of the country.

The SW monsoon normally sets in over the Kerala coast, the southern tip of the country, by 1 June, advances along the Konkan coast in early June and extends over the entire country by the end of July. On islands in the Bay of Bengal, the onset occurs about a week earlier. The onset of the monsoon over the country is one of the most spectacular meteorological events every year and is looked upon with great expectations by the people of India as it heralds a major rainy season and the beginning of sowing operations on a large scale. The SW monsoon rains



Tropical cyclones cause wide-spread devastation.

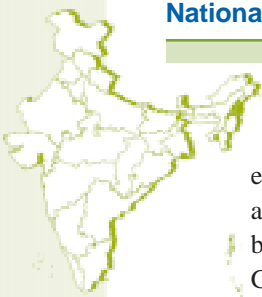


exhibit a striking regularity in their seasonal onset and distribution within the country, but are variable both within the season, and from one year to another. Global features like *El Nino*, northern hemispheric temperatures and snow cover over Eurasia are known to influence the year-to-year variability of monsoon performance. Within a season, the monsoon rainfall oscillates between active spells associated with widespread rains over most parts of the country and breaks with little rainfall activity over the plains and heavy rains across the foothills of the Himalayas. Heavy rainfall in the mountainous catchments under 'break' conditions leads to the occurrence of floods over the plains. Breaks are also associated with very uncomfortable weather due to high humidity and temperatures.

The Bay of Bengal during this season, is a source of cyclonic systems of low pressure called 'monsoon depressions'. They form in the northern part of the bay with an average frequency of about two to three per month and move in a northward or north-westward direction, bringing well-distributed rainfall over the central and northern parts of the country. The path taken by these depressions critically influence the distribution of rainfall over northern and central India.

Towards the latter half of September, the SW monsoon current becomes feeble and begins withdrawing from the north-western parts of India. By the end of September, it withdraws from almost all parts of the country and is slowly replaced by a northerly continental airflow. The retreating monsoon winds cause occasional showers along the east coast of Tamil Nadu, but decrease towards the interior.

The post-monsoon or north-east (NE) monsoon season is a transitional season, when the north-easterly airflow becomes established over the subcontinent. These winds produce the winter or NE monsoon rains over the southern tip of the country during the transitional period. Tropical cyclones that form in the Bay of Bengal and move in during this season cause heavy rainfall along their path. Many parts of Tamil Nadu and some parts of Andhra Pradesh and Karnataka receive rainfall during this season solely due to these storms. They can also cause widespread damage due to high-velocity winds and tidal waves in the coastal regions.

The day temperatures all over the country begin falling sharply. The mean temperatures over north-western India fall from about 38 °C in October, to 28 °C in November. This is accompanied by a decrease in humidity levels and clear skies over most parts of north and central India after mid-October.

GEOGRAPHY, LAND USE AND WATER RESOURCES

Water is the most critical component of life support systems. India shares about 16 per cent of the global population but it has only 4 per cent of the total freshwater resources. India is a land of many rivers. The 12 major rivers, spread over a catchment area of 252.8 million hectares (Mha), cover more than 75 per cent of the total area of the country. The rivers in India are classified as: the Himalayan, peninsular, coastal, and inland-drainage basin rivers. The Himalayan rivers are snow fed and maintain a high to medium rate of flow throughout the year. The heavy annual average rainfall levels in the Himalayan catchment areas further add to their rates of flow. During the summer monsoon months of June to September, the catchment areas are prone to flooding. The volume of the rain-fed peninsular rivers also increases during the monsoon. The coastal streams, especially those in the west, are short and episodic. The rivers of the inland system, centred in western Rajasthan, are few and sparse and frequently disappear altogether in years of poor rainfall. Most of the major Indian rivers flow through broad, shallow valleys and eventually drain into the Bay of Bengal.



The Ganges is the most prominent Indian river.

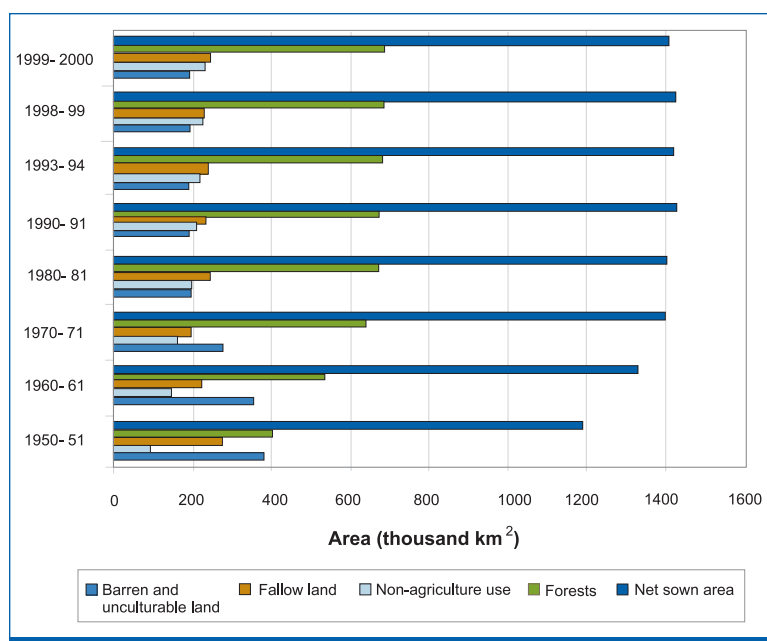


Figure 1.3: Indian land-use changes.

Source: Land Use Classification and Irrigated Area: 1998-1999, Ministry of Agriculture, Government of India.

Ground water is another major component of the total available water resources. In the coming years the ground water utilization is likely to increase manifold for the expansion of irrigated agriculture and to achieve national targets of food production. Although ground water is an annually replenishable resource, its availability is non-uniform in terms of space and time.

The land-use pattern is influenced by a variety of factors, such as population density, expanding urbanization, industrial growth, agriculture, grazing needs, irrigation demands, and natural calamities like floods and droughts. Despite these stresses, the area under forests has increased steadily due to proactive reforestation and afforestation programmes of the Government of India over the years, aimed at sustainable development. Presently, 23 per cent of the total land area is under forest and tree cover, while 44 per cent is net sown area (Figure 1.3). The remaining one-third is almost equally distributed between fallow land, non-agricultural land, and barren land.

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 montane zone and temperate montane forests. The forests of India can be divided into 16 major types, comprising 221 sub-types. The area under forests as per land records was 6,83,100 km² in 1994 and 6,90,200 km² in 2000. However, the entire area recorded as 'forest' did not bear forest cover (as this includes grassland, wasteland and desert under the administrative control of the state forest departments). India's forest cover in 1994 was assessed in

1997 by the Forest Survey of India through satellite imagery interpretation at 6,33,397 km² (Figure 1.4), increasing to 6,75,538 km² for the year 2000 (as per the assessment conducted in 2001). An estimated 2.46 billion trees outside forests contributed an additional area of 81,472 km², making the total tree and forest cover at 23.03 per cent of country's geographic area in 2000.

The forests of India are a source of fuel and fodder for rural people, an industrial input for a growing economy, a habitat for thousands of plant and animal species, a sink for CO₂ emissions, and a protective cover for its soils. An effective Forest (Conservation)



A Sal forest in the central plains of India.

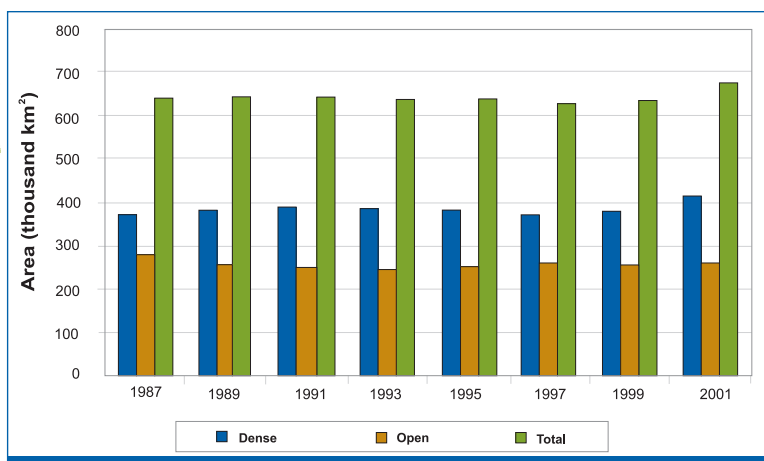
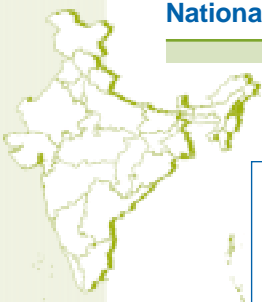


Figure 1.4: Indian forest cover assessments, 1987-2001.

Note: Mangroves are not covered in either dense or open forests during 1987-1997 but are included in total forest area. However they have been sub-classified into dense and open forests since 1999.

Source: State of Forest Reports, 1987 to 2001, Ministry of Environment and Forests, Government of India.

Act, 1980, further strengthened in 1988, stipulating a massive afforestation programme, the establishment of reserves and re-vegetation of degraded lands through joint forest management and people's participation, helped India to conserve its forests and put a check on the diversion of forest land to non-forest uses. In spite of such measures, the average growing stock in India is $74 \text{ m}^3/\text{ha}$, much lower than the global average of $110 \text{ m}^3/\text{ha}$. Despite the various conservation acts, the forests themselves are degrading because of continued illegal felling, extraction of fuel-wood and non-timber products, invasion by weeds, and forest fires.

Planned afforestation programmes began in the late 1950s as a government policy for soil conservation, production of industrial raw material, fuel-wood, fodder, and increasing tree cover in urban areas. After the establishment of Forest Development Corporations in the states and the launching of Social Forestry Projects, large-scale afforestation activity began in 1979. While the Forest Corporations continued planting industrially important species after clear felling of the commercially less-valued forests, most of the plantations under social forestry were established outside forest reserves, along rail, road and canal sides, other government wastelands, and in

private farmlands using short rotation species. The annual planting rates were about $10,000 \text{ km}^2$ (1980-1985), $17,800 \text{ km}^2$ (1985-1990) and about $15,000 \text{ km}^2$ after 1991.

A comparison of the forest cover of India between the years 1994 and 2000 shows a net increase in the forest cover by $42,141 \text{ km}^2$. Dense forest (>40% tree canopy cover) increased by $46,690 \text{ km}^2$ (excluding dense mangroves), mainly due to the enhancement of many open forest

areas to the dense forest category. The area under mangroves declined by 265 km^2 during this period. However, the forest cover of India has been increasing steadily over the years due to various conservation- and climate-friendly policies of the government. This increase is despite the diversion of about $43,200 \text{ km}^2$ of forestland for non-forest purposes such as agriculture ($26,200 \text{ km}^2$), for feeding our increasing population, and developmental activities such as river valley projects, industrialization, mining, and road construction. In 1999, the Food and Agricultural Organization's State of the World's Forests Report had acknowledged that India was the only developing country in the world where the forest cover was actually increasing.

Despite these policy-induced forest cover enhancements, uncontrolled grazing by domestic livestock in forest areas is perhaps one of the most important reasons for the degradation of forests in India, as it destroys the seedlings and young recruits, and in turn the regeneration process. It has been estimated that about 77.6 per cent of India's forests are affected by livestock grazing. The pressure of grazing has increased tremendously owing to the increasing cattle population.

Shifting cultivation, mostly practised in the north-eastern parts of India, is another factor responsible for the degradation of forests; this affected about 1.73 Mha during 1987-1997. About 53 per cent of forests in India are affected by fire; of these 8.9 per cent are frequent incidences of fires while occasional fires affect 44.2 per cent of the forest area in India. These results are not indicative of annual fires, but indicate

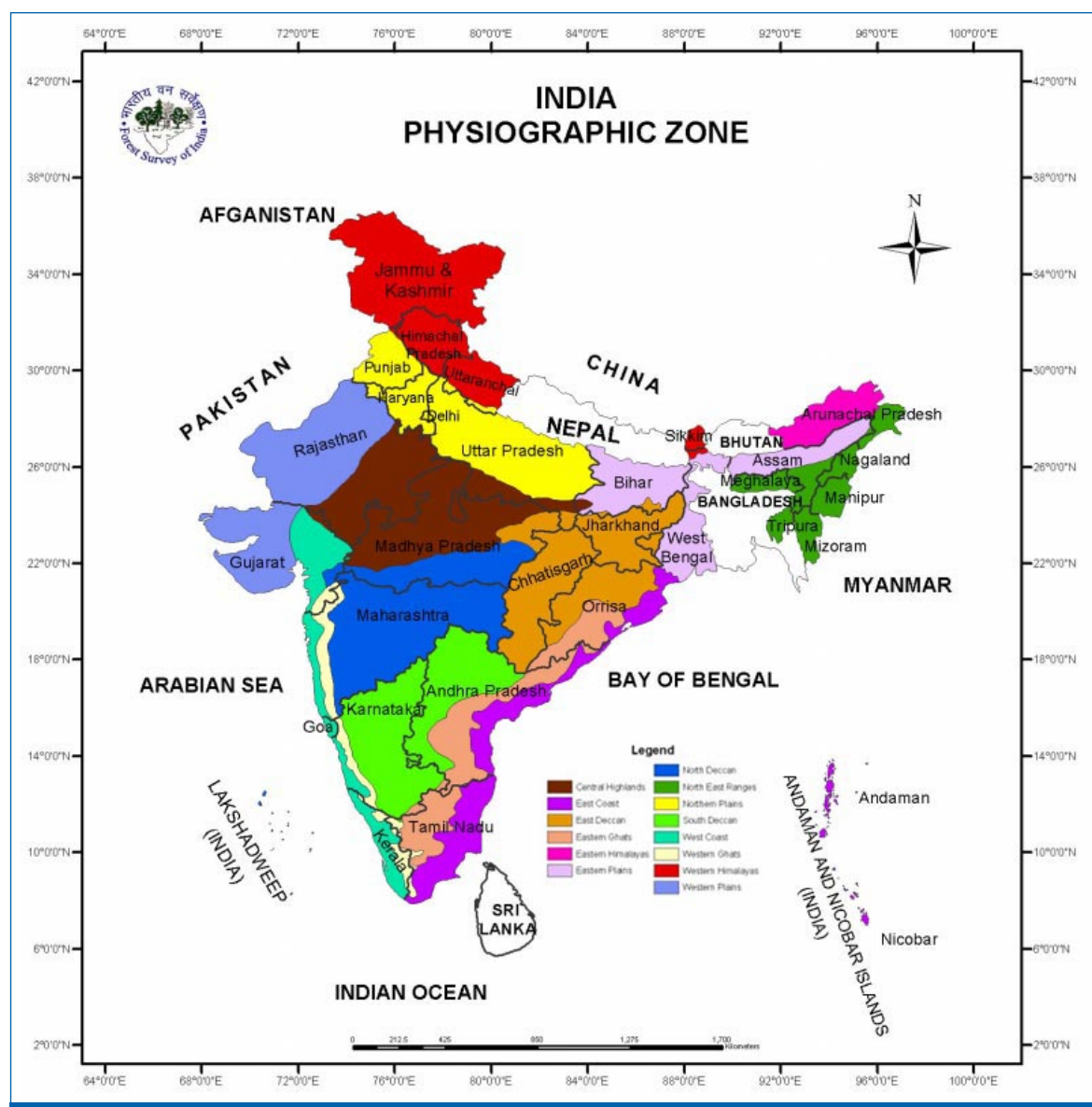


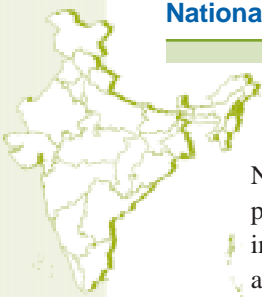
Figure 1.5: Physiographic zones of India.

Source: Status of Forest Report, 2001.

that the areas are definitely prone to heavy or light fires.

Almost 53.4 per cent of India's land area comprises arid and semi-arid regions (Figure 1.5). In these regions, cultivation is restricted to more productive but limited land, while a large animal population depends on native vegetation. The rains are erratic and often come in a few heavy storms of short duration resulting in high run-off, instead of replenishing the ground water. Protective vegetation cover is sparse

and there is very little moisture for the most part of the year. India's arid zone is the most densely populated desert in the world. The growing pressure on the land due to the ever increasing population (both human and cattle) and the absence of any subsidiary occupation, compels people to cultivate the marginal lands and graze the dunes. There is severe wind erosion in areas that have bare soils and unconsolidated geological material, like sand. The area subjected to high wind erosion is about 59.2 Mha, which includes about 7.03 Mha of cold desert in Ladakh and Lahaul valleys. In western Rajasthan, the process of desertification is active in about 13.3 Mha. The Government of India is committed to the United



Nations Convention to Combat Desertification and provides financial support and guidance for the implementation of centrally-sponsored schemes such as the Desert Development Programme, Drought Prone Areas Programme, and the Integrated Watershed Projects in the country.

The wetlands in India are distributed in various ecological regions ranging from the cold and arid zone of Ladakh, through the wet Imphal in Manipur, and the warm and arid zone of Rajasthan-Gujarat to the tropical monsoon-influenced central India, and the wet humid zone of the southern peninsula. Recent remote sensing studies show that the total wetland area of India is 7.58 Mha; of this 5.3 Mha is natural wetland, whereas 2.26 Mha is man-made wetland.

The coastal areas of India accommodate about one-fourth of the country's population that depends to a large extent on marine resources. Nine of the Indian states, namely, Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal are situated along the long coastline. In addition, some of the Union Territories such as Pondicherry and Daman, and groups of islands including Andaman and Nicobar in the Bay of Bengal and Lakshadweep in the Arabian Sea, also constitute coastal ecosystems of great economic and ecological importance.

AGRICULTURE

India is an agrarian society, with nearly 64 per cent of the population dependent on agriculture, though the share of agriculture in the GDP has been continuously declining. Crop production in India takes place in almost all land class types, namely, dry, semi-dry, moist, sub humid, humid, fluvisols and gleysols. Agriculture will continue to be important in India's economy in the years to come as it helps to feed a growing population, employs a large labour force, and provides raw material to agro-based industries.

Given the physical and biogenetic diversity of the Indian subcontinent, a strategy of diversified and regionally differentiated agriculture is desirable for improving the economy and augmenting its resources. India is one of the few developing countries that has the potential to produce crops in almost all land class

types. This is indeed a great policy challenge and opportunity; particularly so in an emerging environment which regards bio-diversity as nature's bounty and not as earlier, a constraint to technological progress.

Crop yield is a function of many factors, including climate, soil type and its nutrient status, management practises and other available inputs. Of these, climate plays an important role, probably more so in India where the majority of agriculture is dependent on the monsoon, and natural disasters such as droughts and floods are very frequent. Therefore, efficient crop planning requires a proper understanding of agro-climatic conditions. This calls for the collection, collation, analysis and interpretation of long-term weather parameters available for each region to identify the length of the possible cropping period, taking into consideration the availability of water.

With 329 Mha of geographical area, India presents a large number of complex agro-climatic situations. The Planning Commission of India has delineated 15 agro-climatic regions, which were proposed to form the basis for agricultural planning in the country. The 15 regions are: Western Himalayan, Eastern Himalayan, Lower Gangetic Plains, Middle Gangetic Plains, Upper Gangetic Plains, Trans-Gangetic Plains, Eastern Plateau and Hills, Central Plateau and Hills, Western Plateau and Hills, Southern Plateau and Hills, East Coast Plains and Hills, West Coast Plains and Ghat, Gujarat Plains and Hills, Western Dry, and the Islands region. The agro-climatic zone planning aims at the scientific management of regional resources to meet the food, fibre, fodder and fuel-wood needs without adversely affecting the status of natural resources and the environment. The Ninth Plan has reiterated that agricultural planning should follow the agro-climatic regions. This should now be done using satellite imagery to provide an up-to-date base for developmental projects. The database has been already created and preparations for satellite-based information systems are at a fairly advanced stage.

India has come a long way since the 1950s, from being a food-starved to a food-sufficient country. Food grain production has increased by over four-fold since the 1950s. Agriculture contributed 22.61 per cent to India's GDP in 2001-2002, while 68 per cent of the

country's workforce is employed in this sector. The improvement in grain yield has been realized through the 'green revolution' in the 1960s, and later with improved agricultural practises and inputs. These include improved mechanized farming since the 1970s, increased net area under irrigation (31 Mha in 1970-1971; 53 Mha in 1994-1995; and 57 Mha in 1998-1999) and net sown area (119 Mha in 1950-1951 that has increased and almost saturated at 143 Mha over the past decade). The growth in total fertilizer consumption (2.6 Mt in 1970-1971; 13.6 Mt in 1994-1995; and 16.6 Mt in 2000-2001) and the availability and use of high-yielding variety seeds (area under these for different crops increased from 15.38 Mha in 1970-1971 to 72.11 Mha in 1995-1996), have contributed substantially to the increased grain yield. Despite the above improvements, agriculture in India is still heavily dependent upon the monsoon, indicating its vulnerability to climate change.

Agriculture has been accorded high priority under the different five-year plans. The conversion of cultivable wastelands into the other categories of land use, especially into cultivated land, took place in the first two decades after Independence. Net sown area has increased by 12 per cent during 1954-1994, while the intensity of farming (area sown more than once) has increased almost three-fold during the same period. India has made fair progress in developing her



The majority of livestock rearing in India is in small holdings for sub-sistence activities, where the animals are small in size and weight.

agriculture in the past five decades and is now almost self-sufficient in food grain production.

India has 13 per cent of the global livestock population, with still increasing growth rates. However, there is a decelerating trend in almost all species except buffalo, poultry, goats and pigs (Figure 1.6). The populations of draught animals have witnessed negative trend. Despite the low productivity and off-take rates, the contribution from animal husbandry and dairying was 5.9 per cent of the GDP in 2000-2001 at current prices. The Indian livestock

sector employs 18 million people and acts as a storehouse of capital and an insurance against crop failure. The GDP from the livestock sub-sector has grown at 7.3 per cent per annum during 1981-1998, much faster than the 3.1 per cent growth of the crop sector. With production concentrated among small landholders, rearing livestock also help improve income distribution.

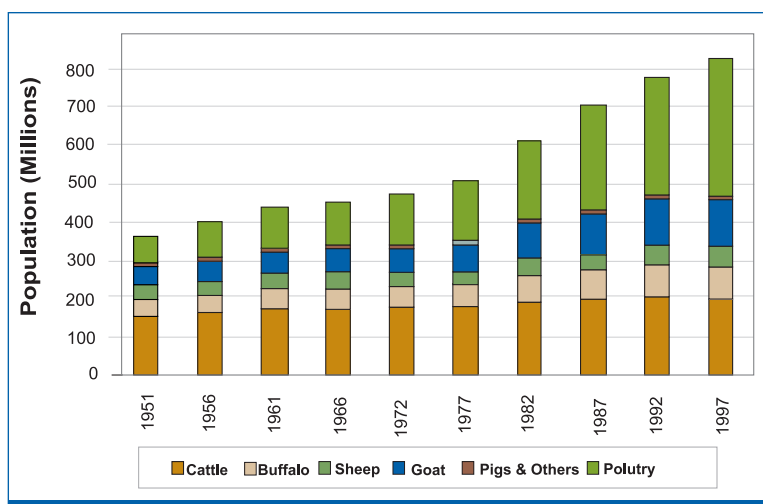


Figure 1.6: Changes in livestock population, 1951-1997

Source: Basic Animal Husbandry Statistics 2002, Ministry of Agriculture, Department of Animal Husbandry and Dairying, Government of India.

DEMOGRAPHIC PROFILE

Population levels and growth rates drive national consumption of energy and other resources, and therefore GHG emissions. India's population has steadily risen over the years, crossing the one billion mark in 2000 and

increasing annually by about 15 million since then. With a population of 846 million in 1991, 914 million in 1994, and 1027 million in 2001, India is the second most populous country in the world. The decadal population growth rate has, however, steadily declined from 24.8 per cent during 1961-1971 to 21.3 per cent during 1991-2001, and is targetted to further decline to 16.2 per cent during 2001-2011, due to various policies of the Government of India towards family welfare, education, health and the empowerment of women. This has resulted in reducing births by almost 40 million over the last 30 years.

India's population density is very high; the density of 264 persons/km² in 1991 increased to 324 persons/km² in 2001. 95 percent of India's districts have more than 50 persons/km², 80 per cent have above 100 persons/km² and 20 per cent have above 500 persons/km², as per the 1991 census (Figure 1.7). Almost all the coastal districts are very densely populated (above 500 persons/km²), with over a 100 million people inhabiting them. This, coupled with low per capita incomes and low adaptive capacity of the majority of

this population, renders them vulnerable to the impacts of climate change on coastal areas and fisheries.

India is steadily improving on many critical demographic indicators. The average life expectancy at birth has gone up from 32 years in 1951 to over 60 years today. The Total Fertility Rate (TFR) has declined during 1982-1992 resulting in the reduction of almost one child per woman. The TFR is projected to decline further from 3.13 during 1996-2001, to 2.52 during 2011-2016. The Infant Mortality Rate (IMR), a sensitive indicator of health status as well as of human development, has also declined considerably for both males and females. The average literacy rate has gone up from less than 20 per cent in 1951, to more than 65 per cent in 2001. The poverty level has gone down to 26 per cent of the total population in 2000 from 51.3 per cent during the 1970s. In spite of these achievements India continues to face the persistent challenge of population and poverty. Around 74 per cent of the population lives in rural areas, in about 5.5 lakh villages, many with poor communications and transport facilities. Reproductive health and basic health infrastructure require considerable strengthening, despite commendable achievements in the last 50 years. Nearly a 100 million people live in urban slums, with better but limited access to clean potable water, sanitation facilities, and health care services. In addition to this, there is the issue of a large-scale migration of people from rural to urban areas.

India is largely rural and the vast majority of the population continues to live in rural areas². The progress of urbanization has been relatively slow in India as compared to other developing countries. The urban population has increased from 19 per cent of the total population in 1965, to 28 per cent in 2000 (Figure 1.8). Nearly two-thirds of the urban population is concentrated in 317 Class-I cities (population of over 100,000), half of which live in 23 metropolitan areas

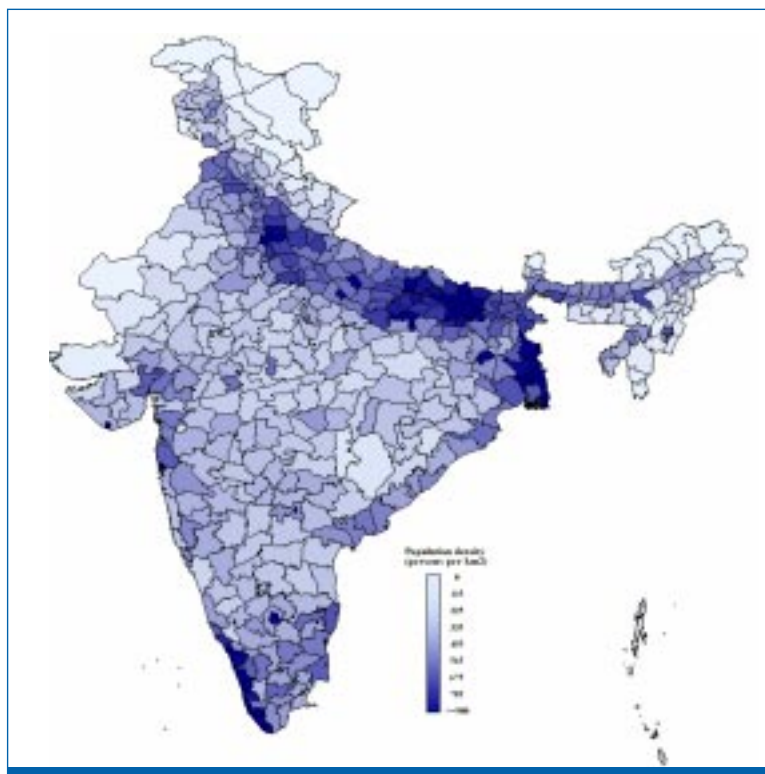


Figure 1.7: Indian population density, 1991.
Source: Census of India, 1991.

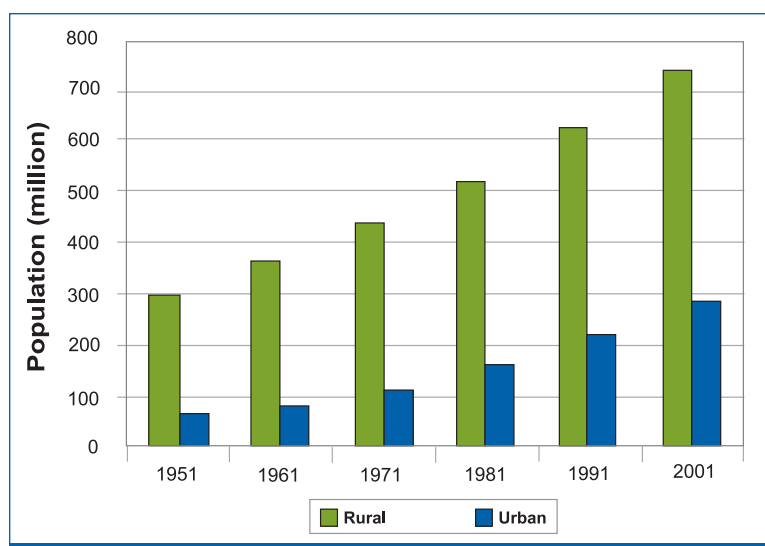


Figure 1.8: Rural-urban population profile of India.
Source: Census of India, 1991 and 2001.

with populations exceeding one million each. The number of urban agglomerations/cities with populations of over a million, has increased from five in 1951, to 23 in 1991, and to 37 in 2001. This rapid increase in urban population has resulted in unplanned urban development, changed consumption patterns



Growing urbanization enhances GHG emissions.

and increased demands for transport, energy, and other infrastructure. This may reflect rapid economic development and industrialization on one hand, but also high levels of energy consumption and emissions on the other.

India's population pyramid shows a broad base indicative of an expanding population. This structure includes a large number of children born each year. Even if the average number of children falls substantially in the future, the young age structure will generate continued growth for decades as a large

number of them enter child-bearing age. Even if all Indians plan for two children per family, the population will continue to grow for the next 60 to 70 years. This will continue to build up a young age composition 'bulge'. This growing 'population bulge' of the younger and older population is pronounced in other Asian countries as well.

Households

India had more than 160 million households in 1994. Nearly three-fourths of these households lived in rural areas accounting for one-third of the total national energy consumption (NSSO 1993-1994; Census of India, 2001). Demographic changes have led to an appreciable rise in the total number of households in India with the urban share increasing faster than the rural one. There is also an increase in energy consuming appliances at all levels (Figure 1.9). However, this is an expected and desirable trend for a developing country where appliance-possession levels per 1000 households are still abysmally low in comparison to the developed and even many developing countries. For example, only 1.2 per cent urban households had a car in 1994, a figure that

² The conceptual unit for urban areas is a 'town', whereas for the rural areas it is a 'village.' The classification of an area as an urban unit in the Census of India (2001) is based on the following definition:

- a All places declared by the state government under a statute as a municipality, corporation, cantonment board or notified town area committee, etc.
- b All other places which simultaneously satisfy or are expected to satisfy the following criteria:
 - A minimum population of 5,000;
 - At least 75 per cent of the male working population engaged in non-agricultural economic pursuits; and
 - A density of population of at least 400 per square kilometer (1,000 per square mile).

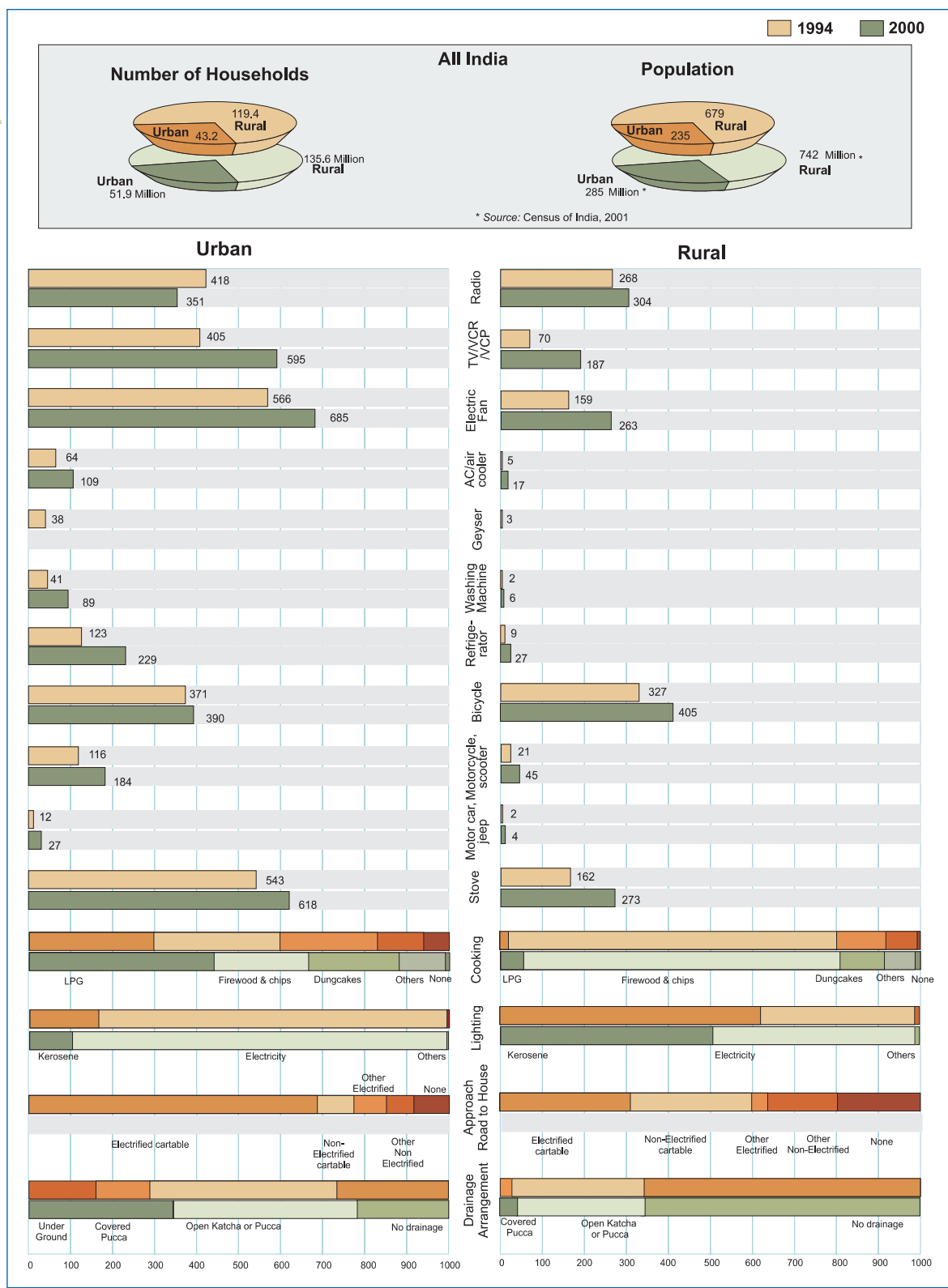
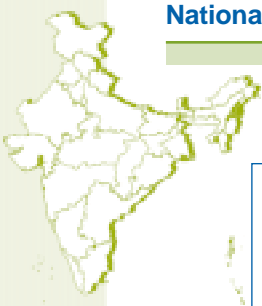


Figure 1.9: Indian household profile (number per 1000 households).

Source: National Sample Survey Organization, Fiftieth and Fifty-fifth round documents, Government of India.

increased to 2.7 per cent in 2000. Only 6.4 per cent urban households had at least one air-conditioner/ air-cooler in 1994 as compared to only 0.5 per cent in rural areas. In 1994 only 3.8 per cent urban households had geysers, 4.1 per cent had washing machines, 12.3 per cent had refrigerators, 29.6 per cent had liquid petroleum gas (LPG) for cooking, and 82.8 per cent had electricity for lighting. The corresponding numbers for the rural households are extremely low with only 1.9 per cent households having LPG for cooking, 2.1 per cent having motorcycles/ scooters, 15.9 per cent having electric fans, and 37.1 per cent having electricity for lighting in 1994. In the wake of rising incomes, the households at all socioeconomic levels are increasingly using energy consuming appliances. The related GHG emissions will therefore continue to rise, even though the energy efficiencies of the appliances are continually improving.

The share of *katcha* (mud huts), semi-*pucca* and *pucca* (concrete) dwellings in total rural dwellings was 32 per cent, 36 per cent and 32 per cent, respectively in 1993. In the urban sector, about 75 per cent of households resided in *pucca* structures. As incomes rise, the demand for basic amenities such as housing, will increase. The construction sector has major linkages with the building material industry, since material accounts for more than half the construction costs in India. These include cement, steel, bricks, tiles, sand, aggregates, fixtures, fittings, paints, chemicals, construction equipment, petro-products, timber, mineral products, aluminum, glass and plastics. A rise in demand of these materials would influence future GHG emission trajectories for India.

GOVERNANCE PROFILE

India is the world's largest democracy; the legislature, the executive and the judiciary constitute the three building blocks of the Indian Constitution. The legislature enacts laws, the executive implements them, and the judiciary upholds them. The Indian Parliament consists of two houses, the Rajya Sabha (Upper House) and the Lok Sabha (Lower House). India has a unique system of federation with a manifest unitary character. The spheres and activities of the union and the states are clearly demarcated. The exhaustive union list and the state list placed in the seventh schedule of the Constitution distinctly outline

the respective jurisdiction and authority of the union and the states. Some of the sectors belonging to environment and energy are listed in the concurrent list, wherein both the union and the state have concurrent jurisdiction to enact laws. The Constitution also devolves powers to the lower levels—'lower to the people'—through the institutions of *Panchayats* and *Nagar Palikas* (local municipal bodies), with a view to ensure administrative efficiency in concordance with the broader concept of good governance.

The government accords high priority to the environment. The MoEF is concerned with planning, promoting, coordinating and overseeing the implementation of environmental and forestry policies and programmes. It also serves as the nodal agency for international cooperation in the area of environment, including the subject of climate change. Environment ministries/ departments at the state level deal with state-specific environmental issues and concerns. Scientific and technical staff, as well as institutions and experts support environment administrations at union and state levels.

India has a strong and independent judiciary. Environmental issues have received a further boost through the judicial processes, which have recognized the citizen's right to a clean environment as a component of the right to life and liberty. Further, matters of public interest are articulated through vigilant media and the active NGO community.

Environmental governance

Environmental concerns are integral to the governance of India. Prior to the *United Nations Conference on Human Environment*, at Stockholm, the Government of India had established a *National Committee on Environmental Planning and Coordination* (NCEPC) under the aegis of the Department of Science and Technology. This commitment was a major step taken by India which was one of the pioneering nations in the world to amend its constitution to incorporate provisions to protect its environment. The constitutional provisions are backed by a number of laws—acts, rules and notifications. There are more than two dozen laws enacted to protect and safeguard India's environment. They cover all aspects of the environment—from pollution to conservation, from

deforestation to nuclear waste disposal. Some of these laws are precursors to today's environmental movements.

There is a multiplicity of agencies involved in resource management in India and some overlaps in their responsibilities and jurisdiction are common. The allocation of resources to various sectors is directed by the Planning Commission working within the framework of the five-year plans. Environment management is guided at the central level by the MoEF and at state levels by the Departments of Environment. Natural resources (like water, forests and oceans) are managed by separate ministries and departments. Inter-ministerial coordination committees and working groups deal with the cooperation and conflict of interest issues. Indeed, in a large country this is perhaps inevitable. The implementation of government policies on resource use is directed by the multi-tiered administrative structure. The administrative units at the central and state levels coordinate resource allocation and project implementation. However, the implementation of all programmes is done at the field level under the overall supervision of the district collector. Local bodies such as *Panchayats* and city councils also have a stake in implementing various schemes in accordance with the

instructions and directives of the collector, who is a civil servant. Several participatory management schemes dealing with environmental issues have been successfully carried out at the local level.

Most environmental legislation in India is based on active State intervention to preserve, protect and improve the environment. Some important acts related to the protection of environment are the Animal Welfare Act (1960), the Indian Wildlife (Protection) Act (1972), the Water Prevention and Control of Pollution Act (1974), the Forest (Conservation) Act (1980), the Air (Prevention and control of pollution) Act (1981), the Environment (Protection) Act (1986), the Public Liability Insurance Act (1991), and the Biological Diversity Act (2002).

ECONOMIC PROFILE

The GDP (at factor cost and constant prices) grew by 7.2 per cent in the financial year 1994. In the decade following the 1990s, the annual average GDP growth rate was 6.6 per cent making it one of the 10 fastest growing economies of the world. The key socioeconomic indicators for 1994 are presented in Table 1.1. Despite this rapid economic growth, the per capita GDP is one of the lowest, and it is a fact

Table 1.1: National circumstances, 1994.

Criteria	1994
Population (M)	914
Area (Mkm ²)	3.29
GDP at Factor cost 1994-1995 (1993-1994 prices) Rs billion	8380
GDP at Factor cost 1994-1995 (1993-1994 prices) US\$ billion	269
GDP per capita (1994 US\$)	294
Share of industry in GDP (%)	27.1
Share of services in GDP (%)	42.5
Share of agriculture in GDP (%)	30.4
Land area used for agricultural purposes (Mkm ²)	1.423
Urban population as percentage of total population	26
Livestock population excluding poultry (M)	475
Forest area (Mkm ²)	0.64
Population below poverty line (%)	36
Life expectancy at birth (years)	61
Literacy rate (%)	57

Note: The monthly per capita poverty lines for rural and urban areas are defined as Rs 228 and Rs 305 respectively for 1994-1995.

Source: Economic survey 1995-1996 and 2000-2001. Economic Division, Ministry of Finance, Government of India Census of India, 1991 and 2001, Government of India.

that one-fourth of its population of over one billion is still below the poverty line and that 44 per cent of the Indian population has an income below 1 US\$/day. Its human development index is only at 0.571, compared to China (0.718) and to developed countries such as Germany (0.921), Japan (0.928) and the USA (0.934). The technology achievement index of India is at 0.201, which is comparable to China, but far below the developed countries (UNDP, 2001).

Social development depends to a great extent on economic development. For many decades, India followed a mixed economy model, where central planning coexisted with private enterprise. Agricultural activities, however, have rested almost entirely with private farmers. Industrial investment was sought to be controlled through industrial licensing until 1991.

In that year, a major programme of reforms was initiated under which industrial licensing was abolished and trade constraints relaxed, protection reduced and a greater emphasis was laid on the private sector.

GDP and its structure

The Indian economy has made enormous strides since independence in 1947, achieving self-sufficiency in food for a rising population, increasing the per capita GDP by over three-folds, reducing illiteracy and fertility rates, creating a strong and diversified industrial base, building up infrastructure, developing technological capabilities in sophisticated areas and

establishing growing linkages with an integrated world economy.

The primary sector (particularly agriculture) remains the bedrock of the Indian economy, although its share in the total GDP has declined from over 50 per cent in the early 1950s to about 23 per cent in 2002-2003. At the same time the shares of manufacturing, transportation, banking and service sectors have doubled in the last 50 years. The growth of the Indian economy has also been accompanied by a change in its structure (Figure 1.10).

However, much remains to be achieved and the Government of India is committed to developmental targets that are even more ambitious than the United Nations Millennium Development Goals. The high incidence of poverty underlines the need for rapid economic development to create more remunerative employment opportunities, and to invest in social infrastructure such as health and education. Notwithstanding the climate-friendly orientation of the national policies, the developmental pathways to meet the basic needs and aspirations of a vast and growing population can only be expected to lead to increased GHG emissions in the future.

The Indian Budget

The national expenditure can be divided into two broad categories of 'plan' and 'non-plan', as well as 'developmental' and 'non-developmental'. The plan expenditure generally considers the plan outlays of the central government and concerns with the growth and investment in the economy, whereas the non-plan expenditure takes care of the recurring expenditures of the government and the economy. Furthermore, these are split into capital and revenue expenditures.

Non-plan expenditure has shown an increase during the past few years due to a significant rise in the share of defence expenditure and also a rise in interest payments, which is roughly about 15 per cent. Also, the

non-plan expenditure on capital account shows an increase, since there has been an increase in the outlay

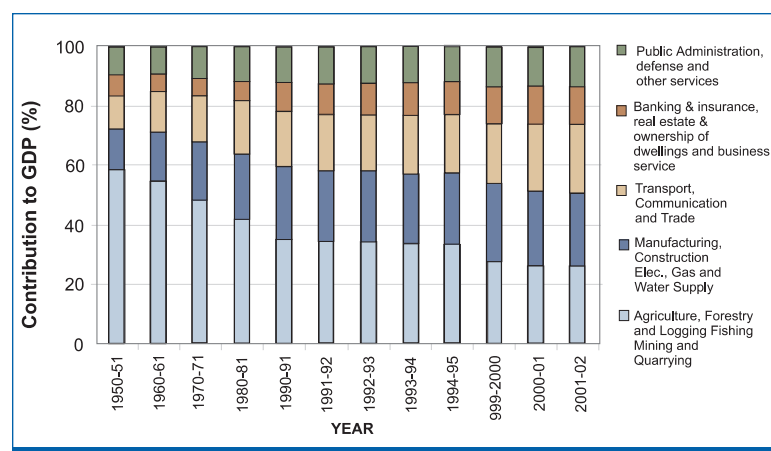
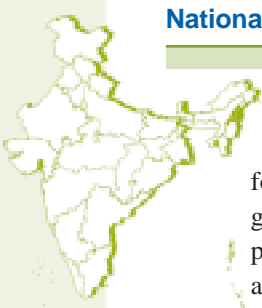


Figure 1.10: Sector-wise contribution to GDP (at factor cost).

Source: Economic Survey, 2003.



for defence capital. The plan expenditure shows a gradual increase attributed to an increase in capital plan expenditure and central assistance to the states and Union Territories (UTs) among others. There has been a 22 per cent increase in the total expenditure, contributed to by about a 30 per cent increase in the plan expenditure and a 19 per cent increase in the non-plan expenditure.

The total expenditure as a percentage of the GDP has shown a gradual decrease since 1980. This may be due to the active participation of stakeholder organizations and the initiatives of NGOs. There has not been a marked decrease in the period 1991-2000, that may be attributed to the liberalization of the economy, wherein the government incurred a considerable amount of developmental expenditure.

Revenue receipts have two parts, namely Part A-revenue receipts and Part B-capital receipts. Part A explains the estimates of revenue receipts, which are grouped under two categories, namely: (a) tax revenue; and (b) non-tax revenue. Part B deals with capital receipts, which includes market loans, external assistance, small savings, government provident funds, special deposits and others. The Gross Tax Revenue (GTR) for the year 2002-2003 has shown an increase of 2,358 billion rupees from 1,983 billion rupees for the year 2000-2001. The rise in GTR for the year 2002-2003 can be attributed to the growth of the GDP, larger revenue generated from union excise duties, corporation tax and income tax. Similarly, the capital receipts have also shown increased trend of 1,652 billion rupees from 1,294 billion rupees for the year 2000-2001. The maximum gain is from short-, medium- and long-term loans. The total receipts account for 4,103 billion rupees for the year 2002-2003, as compared to 3,355 billion rupees for the year 2000-2001.

There has been an increase in total revenue receipts, which is around 19 per cent, contributed by the corresponding increase in the tax and non-tax revenues. The capital receipts have shown an increase of 28 per cent during the past three years. The total Receipts collected show an increase of 22 per cent over the past three years.

The tax revenue has increased by a considerable

amount during the period 1991-2000. There has been a phenomenal increase in the capital as well as revenue receipts during the same period. However, the value of total receipts as a percentage of the GDP has increased only marginally, a reflection of the stability of the economy on the whole. The proportion of the tax revenue to the total revenue has been increasing quite noticeably. Also, there is a greater in the contribution of revenue receipts to total receipts, than to capital receipts from the period 1970-2001.

Poverty

Despite the growth of the population from 350 million in 1947, to more than a billion today, and despite the low level of economic development at the time of Independence, India has made significant progress in poverty reduction. The percentage of people below the poverty line has decreased significantly. Yet, large numbers of people continue to remain below the poverty line (Table 1.2).

The poverty line was originally defined in 1961, based on the income needed to provide adequate calorie intake, two pairs of clothing and a minimal amount of other essentials. This poverty line has been updated over the years to account for changes in prices. The estimates are based on large-scale sample surveys of household consumption carried out periodically by National Sample Survey Organization (NSSO).

Prior to Independence, India suffered from frequent, devastating famines and stagnation in growth. Therefore, the reduction of poverty and agricultural development have been the central themes of India's development strategy. Uplifting the poor and integrating them into the mainstream is a recurrent theme of India's five-year plans. Universal access to

Table 1.2: Percentage of people below the poverty line (All India).

Year	Rural	Urban	Total
1973-1974	56.44	49.01	54.88
1977-1978	53.07	45.24	51.32
1983	45.65	40.79	44.48
1987-1988	39.09	38.20	38.86
1993-1994	37.27	32.36	35.97
1999-2000	27.0	23.62	26.10

Source: Planning Commission, 2000.

education is enshrined in the Constitution. India has established a wide array of anti-poverty programme and much of India's thinking on poverty has been mainstreamed internationally. India has also successfully eliminated famines and severe epidemics. It has made progress in reducing poverty and in its social indicators, which at the time of Independence in 1947, was among the world's poorest. Its vibrant democracy and free press have been major factors in these achievements.

The incidence of poverty began to decline steadily since the mid-1970s that roughly coincided with a rise in the growth of the GDP and agriculture. Since 1980, India's trend of 5.8 per cent growth rate is the highest among large countries outside East Asia. Empirical analyses suggest that agricultural growth and human development were key factors in the decline in poverty across the country. However, the development strategy of the 1970s and 1980s, based on an extensive system of protection, regulation, expansion of public sector in the economy, and on worsening fiscal deficits in the 1980s, proved unsustainable. In 1991, a crisis in the balance of payments and the fiscal situation were met by stabilization and reforms that opened-up the economy, reduced the role of the public sector, and liberalized and strengthened the financial sector over the next few years. These policies generated a surprisingly quick recovery, and an unprecedented 7.7 per cent per annum average growth followed for three consecutive years. This led to an increase in productivity at the macroeconomic level and a booming private sector. During the 1990s, an agricultural growth of 3.3 per cent per annum was maintained that was about the same as in the 1980s, but much higher than the declining rate of population growth, estimated at about 1.6 per cent per annum.

Poverty is a global concern, and its eradication is considered integral to humanity's quest for sustainable development. The reduction of poverty in India is, therefore, vital for the attainment of national as well as international goals. Poverty eradication has been one of the major objectives of the development planning process.

The high incidence of poverty underlines the need for rapid economic development to create more

remunerative employment opportunities and to invest in social infrastructure of health and education. These developmental priorities would enhance our energy consumption and therefore related GHG.

ENERGY PROFILE

The fact that energy, as an input to any activity, is one of the important pillars of the modern economy, makes the energy policy inseparable from the entire national development strategy. The entire fabric of the developmental policy contains the elements of energy strategy that are rarely out of line with similar policies in other economic sectors. Thus, the path traversed by the Indian energy policy can be viewed in the light of the overall developmental strategy adopted by India after Independence.

Rapid economic development is dependant upon expansion of critical infrastructure and growth in industrial base. Expansion of energy sector is a necessary condition for sustaining growth of the vibrant economy. Since important economic sectors such as petroleum, steel, cement, aluminium etc are energy intensive, the consumption of energy is bound to increase with the development process. India is at present aiming at 8 per cent growth rate, its energy requirements are bound to increase manifold in the near future. Thus, increase in green house gas emissions is inevitable in near future. The growth of energy, electricity and Indian economy with respect to GDP has been shown in the Figure 1.11.

The energy use during the past five decades has expanded, with a shift from non-commercial to commercial energy. Among the commercial energy sources, the dominant source is coal, with a share of 47 per cent. The dominance of coal is because India is endowed with a significant coal reserve of about 221 Bt that is expected to last much longer than its oil and natural gas reserves. The share of petroleum and natural gas in the total commercial energy used in the country are 20 per cent and 11 per cent respectively. The total renewable energy consumption including biomass, amounts to about 30 per cent of the total energy consumption in India.

The consumption of commercial fuels (coal, oil, natural gas) for production of power and other uses

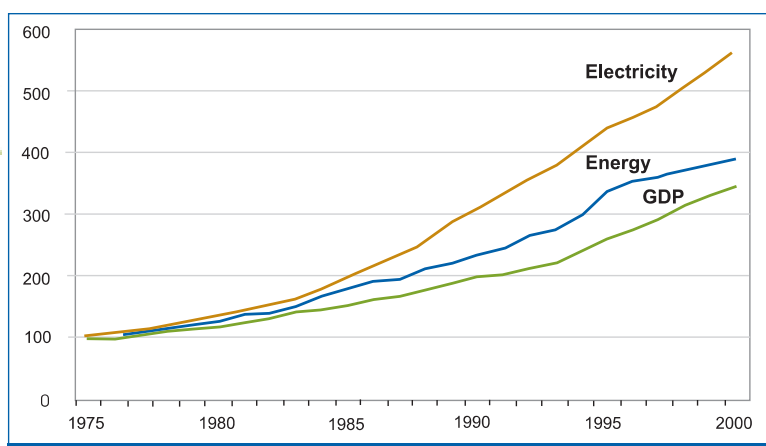


Figure 1.11: Growth of energy, electricity and the Indian economy.

Source: Economic Survey (1990-2003). Ministry of Finance, Government of India.

has been steadily rising over the years with domestically abundant coal continuing to be the dominant source. Coal meets 63 per cent of India's total energy requirements; followed by petroleum products (30%) and natural gas. Nearly 70 per cent of the power requirement in India is presently supplied by thermal power plants. The total coal reserves in India are 211 billion tons (MoC, 2000) and by current estimates these are enough to meet India's power needs for at least another 100 years. The commercial energy/power consumption in India is distributed among agriculture, industry, transport, domestic and other sectors. Out of these sectors, agriculture sector consumes both electricity as well as petroleum products mainly diesel; and the transport sector mainly uses petrol /diesel. For rail transport, both electricity and diesel are being used. CNG use has started for public road transport in some selected cities recently.

In order to meet the growing demand for oil, India imports around 70 per cent of total crude oil requirements. As regards natural gas, the Hydrocarbon Vision 2025 indicates that the gas reserves in India will decline by 16 billion m³ by 2011-12, with reference to its consumption of 22.5 billion m³ in 1998-99. Other than consumption of fossil fuel energy, about 90 per cent of the rural and 30 per cent of urban households in India consume a large quantity of traditional fuels or non-commercial

energy such as fire wood, dung cake, chips etc. The total renewable energy consumption in India including biomass amounts to about 30 per cent of the total energy consumption in India. To meet the energy need of rural / remote areas, various initiatives have been taken up by GoI to provide electricity through locally available renewable energy sources such as solar, wind, biomass and small hydro schemes. These renewable resources are GHG free energy resources. However, as mentioned earlier, coal being abundant, cheap and locally available will be the mainstay of energy in India in near future to ensure energy security.

Primary energy supply

India has seen an expansion in the total energy use during the past five decades, with a shift from non-commercial to commercial sources of energy. Accordingly, the production of commercial sources of energy has increased significantly. Table 1.3 indicates the trends in production of various primary commercial energy resources.

Table 1.3: Trends in commercial energy production.

	Units	1960-1961	1970-1971	1980-1981	1990-1991	2001-2002
Coal	Mt	55.67	72.95	114.01	211.73	325.65
Lignite	Mt	0.05	3.39	4.80	14.07	24.30
Crude Oil	Mt	0.45	6.82	10.51	33.02	32.03
Natural Gas	BCM	-	1.44	2.35	17.90	29.69
Hydro Power	BkWh	7.84	25.25	46.54	71.66	82.8
Nuclear Power	BkWh	-	2.42	3.00	6.14	16.92
Wind Power	BkWh	-	-	-	0.03	1.70

Source: Tenth Five-Year Plan, Planning Commission, Government of India, 2002, pp 764.

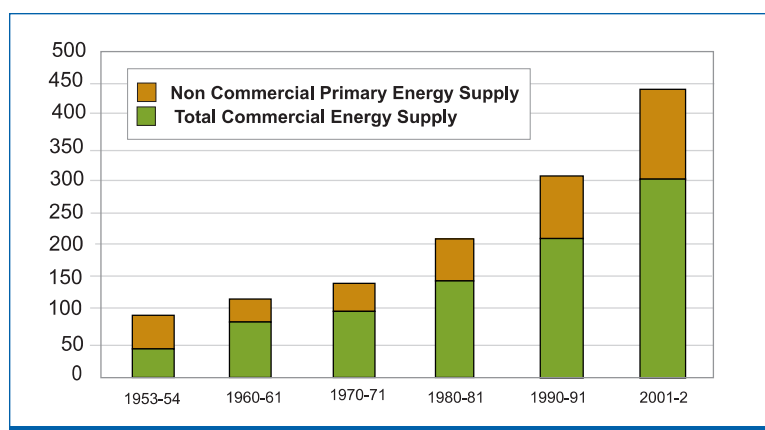


Figure 1.12: Decadal trend in TPES (Mtoe).

Source: Tenth Five-Year Plan, Planning Commission, Government of India, 2002, pp. 765.

The Total Primary Energy Supply (TPES) in India has grown at an annual rate of 3.4 per cent during 1953-2001, reaching a level of 437.7 Million Tonnes of Oil Equivalent (Mtoe) in the year 2001. Much of this growth has been contributed by commercial energy supply, which grew at 5.3 per cent per annum, in contrast to 1.6 per cent per annum growth experienced by non-commercial energy. As a result of this high growth, the share of commercial energy has increased from 28 per cent in 1953-1954 to 68 per cent in 2001-2002, with an associated decline in the share of non-commercial energy (Figure 1.12).

The period between 1953-1960 was one of high growth, with commercial energy supply growing at 6.5 per cent, but the growth slackened slightly during the next two decades only to pick up during 1980-

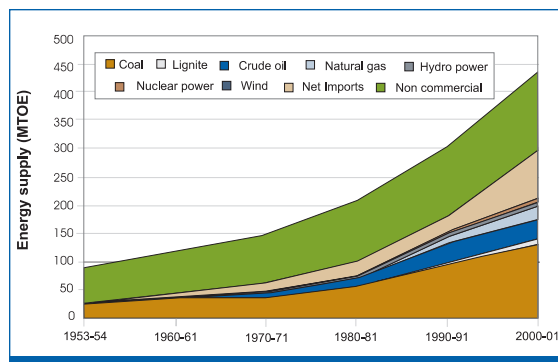


Figure 1.13 Trends in supply of primary energy (Mtoe)

Source: Tenth Five-Year Plan, Planning Commission, Government of India, 2002, pp. 765.

1990. The growth in the past decade has also been impressive in view of several adverse international developments, such as the Asian financial crisis of 1997. The decade-wise growth rates in TPES, primary commercial energy supply and primary non-commercial energy supply, indicate a progressive increase in the commercialization of the Indian energy sector. However, despite reaching such high growth

rates in TPES, the per capita energy consumption at 426 Kilograms per Oil Equivalent (Kgoe) in 2001 was one of the lowest in the world, though it has increased by a factor of 1.71 since 1953.

As stated earlier, coal remains the dominant fuel in our energy mix, with a share of 31 per cent, up from 26 per cent in 1953-1954 (Figures 1.13 and 1.14). Another fuel that has gained prominence is petroleum. From a share of just 2 per cent in 1953-1954 (as all petroleum was imported into India at that time), it has risen to about 27 per cent in 2001-2002. The share of natural gas has also increased from virtually nil to six per cent in 2001-02. The geological coal reserves, estimated at 221 Bt are expected to last the longest, given the current consumption and production trends. India is not expected to be self-sufficient in hydrocarbons. India has only 0.4 per cent of the world's proven reserves of crude oil, while the domestic crude oil consumption is estimated at 2.8 per cent of the world's consumption.

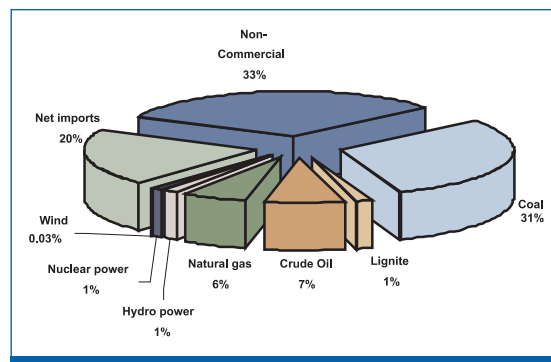


Figure 1.14 Share in primary energy supply, 2001-2002.

Source: Tenth Five-Year Plan, Planning Commission, Government of India, 2002.

Primary energy demand

The demand for petroleum products was estimated at 104.80 Mt during 2001-2002, excluding the liquid fuel requirement for power generation. During the first four years of the Ninth five-year plan (1997-2002), the consumption of petroleum products grew at 5.8 per cent. The consumption of petroleum products during 2001-2002 was 100.43 Mt thereby registering a growth of about 4.9 per cent during the Ninth Plan period, as against the target of 5.77 per cent (Planning Commission, 2002). The lower growth is mainly due to the slowdown in the economy, improvement of roads (including construction of bridges and bypasses) and the introduction of fuel-efficient vehicles. The demand for coal for domestic use has fallen drastically. At present Power Sector consumes nearly 70 per cent of the coal produced in the country. Demand for Coal from power sector is expected to rise further with the execution of on going capacity addition programme.

India is a developing country and three-quarters of the population lives in rural areas. Vast informal and traditional sectors with weak markets coexist with the growing formal and modern sectors. The traditional to modern transitional dynamics is expected to continue in the foreseeable future, further adding to the growth in energy demands. The future dynamics of energy consumption and technology selection in various sectors in India will thus determine their long-term implications for the energy and environmental concerns.

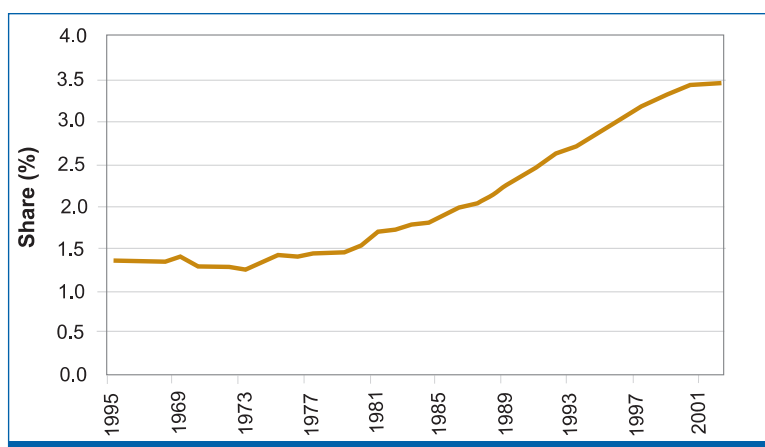


Figure 1.15: India's share in total world commercial energy consumption.
Source: CMIE, 2003.

Comparison with the world energy consumption

India ranks sixth in the world in terms of energy demand, accounting for 3.5 per cent of the world's commercial energy demand in 2001 (Figure 1.15). The world's total primary commercial energy supply (TPCES) grew at a compounded annual growth rate of 2.4 per cent over the period 1965-2002, with the Middle East and the Asia-Pacific regions displaying the highest growth rates. Within the Asia-Pacific region, India has exhibited one of the fastest growth rates in commercial energy supply. On the whole, the share of India in the total world commercial energy supply increased from 1.4 per cent in 1965 to 3.5 per cent in 2001.

However, despite achieving such high growth rates in energy consumption, the per capita energy consumption in India is still low according to global standards, and the energy efficiency of the GDP (PPP basis) is among the best. This holds true even if it is compared with other countries at a similar stage of development (Table 1.4).

POWER SECTOR

The Indian Constitution has included electricity in the concurrent list, which means that both the Centre and the States share the responsibility for this sector. The very first attempts at introducing legislation in this sector were made as early as 1887. However, these attempts were restricted to ensuring safety for

personnel and property. The first legislation, i.e., the Indian Electricity Act, was passed only in 1910, followed by other acts. Until recently, the Indian Electricity Act (1910), the Electricity Supply Act (1948), and the Electricity Regulatory Commissions Act (1998), were the main regulations for the sector. The recent introduction of the Electricity Act (2003), has replaced the previous acts and consolidated them. Apart from the national level acts, each

state is governed by its individual legislations. In 1991, the Policy on Private Participation in the Power Sector was drafted, which encouraged private

Table 1.4: Economy and energy.

	GDP per capita (PPP, US\$), 2001	CO ₂ emissions per capita (Metric tonnes), 1999	Electricity consumption per capita (kWh), 2000	GDP per unit of energy use (PPP, US\$ per kg of oil equivalent), 2000	Traditional fuel consumption (as % of total energy use), 1997
India	2840	1.1	355	5.5	20.7
Developing countries	3850	1.9	810	4.6	16.7
OECD	23363	10.8	7336	4.9	3.3
High income	26989	12.4	8651	4.9	3.4
Middle income	5519	3.2	1391	4.0	7.3
Low income	2230	1.0	352	2.5	29.8
World	7376	3.8	2156	4.5	8.2

Source: United Nations Human development Report, 2003.

participation in generation. At the same time, the Electricity Laws Amendment Act was passed, which gave more authority to the regional load dispatch centres. The Electricity Regulation Act of 1998 initiated the setting up of the Central Electricity Regulatory Commission and also has provisions for setting up State Electricity Regulatory Commissions.

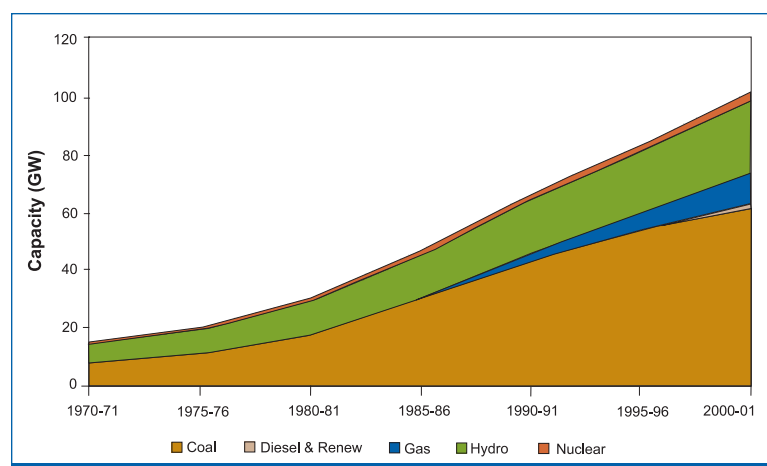
The growth in power generation capacity (Figure 1.16), which increased by almost seven-fold between 1970 and 2000, was accompanied by a greater diversity of technology mix. The capacity mix in 2000 included a substantial share of coal (61%) and 24 per cent share of hydro-based power. Gas-based power

generation capacity gained momentum during 1990s and by the year 2000 its share in total installed capacity became eight per cent. Nuclear power has two per cent share and renewables around 1.5 per cent. In the past decade, generation capacity grew at 4.4 per cent annually, whereas electricity generation has grown at seven per cent due to improved plant utilization. As on March 2004, share of coal based thermal capacity is 58 per cent, gas/liquid based capacity is 11.5 per cent, hydro share is 26.3 per cent, nuclear share is 2.4 per cent and wind power is 1.8 per cent.

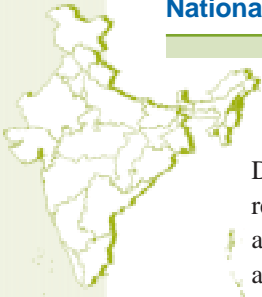
There has been significant growth in gas-fired power generation capacity in the past decade. With increase in private participation in the power sector, plants are

being built in coastal areas near ports with terminals capable of handling liquefied natural gas (LNG). However, inland use of imported LNG remains expensive compared to coal, so natural gas is competitive in these regions only if transported by pipeline directly from the production field. Nuclear power from India's ten nuclear reactors contributes less than three per cent to total generation. There has been a considerable improvement in plant load factor of these plants during the past five years and they

now operate around 80 per cent as compared to 60 per cent earlier.

**Figure 1.16:** Power generation capacity.

Source: Sixteenth Power Survey, Ministry of Power, Government of India.



Despite enhanced competition from other fuels, coal remains the mainstay of power generation. Domestic availability helps coal to retain a competitive advantage over imported fuels that have associated risks from fuel security and exchange rate uncertainties in the long run.

Many energy-intensive industries, such as aluminum, steel, and fertilizer have invested in on-site power generation, which is growing at an annual rate of eight per cent (CMIE Energy, 2001). Captive power generation has grown from about 1.6 GW in 1970 to almost 18 GW in 2002-2003, with almost half being coal based.

Renewables other than large hydro projects have a small share in the power generation capacity presently. However, India has a significant program to support renewable power. A number of facilitating measures have been enunciated in the Electricity Act 2003 to encourage the growth of renewable energy sector. Section 4 of the Act explicitly states that the Central Government shall, after consultation with the State Governments, prepare and notify a National Policy permitting stand alone systems (including those based on renewable sources of energy and non-conventional sources of energy) for rural areas.

TRANSPORT

Sustainable urban transport systems should be economically and socially equitable as well as efficient. When low-income groups do not have access to an affordable transportation system, this imposes hardships on them. Their time and energy is wasted in commuting, making them inefficient and thus trapping them in a vicious circle of poverty and inefficiency.

Managing the transport sector while minimizing externalities such as local pollution, congestion and GHG emissions is a major challenge. Rapid urbanization is now taking place in India. It is expected that more than 50 per cent of the population may reside in urban areas by 2025, a substantial increase from 28.9 per cent in 1999. An efficient transport system is a critical infrastructure requirement in cities for greater economic productivity and better quality of life.



Growing power, transport and construction sectors are main sources of CO₂ emissions.

Transport is a critical infrastructure for development. The sector accounts for a major share of consumption of petroleum products in India. Transport is responsible for an appreciable share of pollution, both local and global. Local pollutants are concentrated in the urban areas due to transport activities. The emission of global pollutants, especially of carbon dioxide (CO₂) from transport, is also a problem of increasing concern in the global environmental scenario.

The growth of registered motor vehicles in various cities of India is shown in Table 1.5. Metropolitan cities account for about one-third of the total vehicles in India. These trends indicate that the growth rate of vehicles could be high as the cities grow. As a number of towns in India are growing very rapidly, a very high level of vehicle growth can be expected in the future. Thus, while the growth of transport in metropolises slows down, it is growing faster in smaller cities. Some cities like Mumbai and Kolkata are very congested; Chandigarh is spread-out; Pune is also less congested. Delhi has a large fleet of buses and a good ratio of road length per person.

REFORMS AND GHG EMISSIONS

The momentous economy-wide reforms initiated in India in 1991 embraced a variety of sectors and activities that emit GHG as well as other pollutants. A significant area in this context is energy, including electricity, hydrocarbons and coal.

The Energy Conservation Act, 2001

The Energy Conservation Act, 2001 was enacted in September 2001 covering all the matters related to the efficient use of energy and its conservation. A Bureau of Energy Efficiency was set up to discharge the activities entrusted under the Act. The Bureau is expected to investigate the energy consumption norms for each energy-intensive industry and encourage the proper labelling of energy consumption indicators on every electrical appliance. The Bureau will also provide guidelines for energy conservation building codes and take measures to create awareness and disseminate information for the efficient use of energy and its conservation. It also aims to strengthen consultancy services in the field of energy conservation and develop testing and certification procedures and promote testing facilities for certification and for energy consumption of equipment and appliances. Various studies estimate that a potential of 23 per cent energy conservation exists in India. Enactment of Energy Conservation Act, 2001 would help in tapping this potential and thus, partially, offsetting the environmental impacts of new capacity addition.

Reforms in the electricity sector

The Ministry of power has initiated reforms in all aspects of power sector to make the sector viable. To encourage private sector participation with the objective of mobilizing additional resources for the power sector, the 'Private Power Policy' was announced in 1991.

The Electricity Regulatory Commission Act was promulgated in 1998 for setting up independent regulatory bodies, both at the central and the state level with an important function of looking into all aspects of tariff fixation and matters incidental thereto to make the sector viable.

Renovation and modernization (R&M), distribution reforms and GHG emissions

To augment T&D networks, system improvements, R&M of old stations for improving efficiency to make investment in energy conservation and environment performance schemes, concerted efforts are on for quite some time at various levels within the system. Reforms in R&M of old thermal power stations will result in improvement in efficiency, that is availability

Table 1.5: Total number of registered motor vehicles in India in 1951-2002.

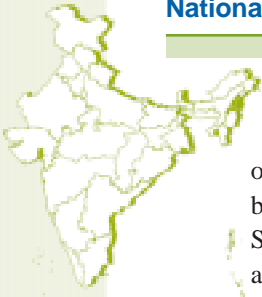
(in thousands)

Year as on 31st March	All vehicles	Two wheelers	Cars, jeeps and taxis	Buses	Goods Vehicles	Others*
1951	306	27	159	34	82	4
1956	426	41	203	47	119	16
1961	665	88	310	57	168	42
1966	1099	226	456	73	259	85
1971	1865	576	682	94	343	170
1976	2700	1057	779	115	351	398
1981	5391	2618	1160	162	554	897
1986	10577	6245	1780	227	863	1462
1991	21374	14200	2954	331	1356	2533
1996	33786	23252	4204	449	2031	3850
1997	37332	25729	4672	484	2343	4104
1998	41368	28642	5138	538 @	2536	4514
1999	44875	31328	5556	540 @	2554	4897
2000 (R)	48857	34118	6143	562 @	2715	5319
2001 (P)	54991	38556	7058	634 @	2948	5795
2002 (P)	58863	41478	7571	669 @	3045	6100

*Others include tractors, trailers, three wheelers (passenger vehicles) and other miscellaneous vehicles which are not separately classified.

@ : Includes omni buses; (P) : Provisional; (R) : Revised.

Source: Motor Transport Statistics 2001-2002, Ministry of Road Transport and Highways.



of additional power with the same amount of coal burnt and, hence, lower greenhouse gas emissions. Similarly, reduction in technical losses will result in availability of extra power in the grid thereby partially offsetting the new power capacity to be added.

The Electricity Act, 2003

The Government of India has recently enacted the Electricity Act, 2003. The Act seeks to promote competition in the electricity sector in India by decoupling the generation, transmission, distribution and supply of electricity. The Act also envisages the preparation of a National Electricity Policy (including tariff) for the development of the power system based on the optimal utilization of natural resources. In consonance with this policy, the central electricity authority will prepare the National Electricity Plan once every five years.

The Act has de-licensed the generation of electricity in India. Clause (7) of the Act states that ‘any generating company may establish, operate, and maintain a station without obtaining a license under this Act if it complies with the technical standards relating to the connectivity with the Grid’.

The Act has also heralded a move away from the Single Buyer model that was followed during the 1990s. Under this model, private power producers were allowed to sell power to SEBs only. However, the financial difficulties faced by the SEBs proved to be a major constraint for private participation. Under the new Act, the generator and the consumer can

individually negotiate the power purchase and use the common access transmission and distribution system to meet the contractual obligations.

Thus, the Electricity Act, 2003 maintains the trend in electricity reforms witnessed the world over by exposing the generation and the supply side of the market to competition, but placing transmission and distribution sections under incentive regulation.

The Act has made the tariff policy one of the cornerstones of the regulatory process. Under the Act, either the state or the central regulatory commission is required to play an important role in tariff setting by the natural monopoly segments of the electricity supply chain, and ensure that such tariff is set through a transparent process of bidding in accordance with the guidelines issued by the central government. The Ministry of Power has recently come out with a discussion paper on the tariff policy. According to the paper, the tariff has to take into account the objectives of: (a) promotion of efficiency; (b) introduction of competition and creating enabling environment for the same; (c) rationalization of electricity tariff; (d) protection of consumer interests; and (e) transparency in subsidy administration (MoP, 2003).

Reforms in the hydrocarbons sector

India imported 77 per cent of her total petroleum consumption in 2001-2002 which required substantial funds. The domestic production failed to keep pace with the domestic requirement, forcing India to import more crude oil and petroleum products. The net imports of both crude oil and petroleum products declined to 32 per cent of total consumption in 1984-1985 from the high of 76 per cent in 1980-1981 but has risen steadily thereafter to reach 77 per cent in 2001-2002 (figure 1.17).

Few attempts at reforms were taken in the 1980s, when the upstream sector was opened for private participation in order to attract private capital and technology to boost indigenous oil production. Economy-wide reforms initiated in 1991 opened up the middle stream refining also for the private sector. The New Exploration and Licensing Policy (NELP) was launched in 1997 and the new format of competitive bidding and relinquishment of blocks by national oil companies made this policy an immediate



T&D reforms are important components of APDRP.

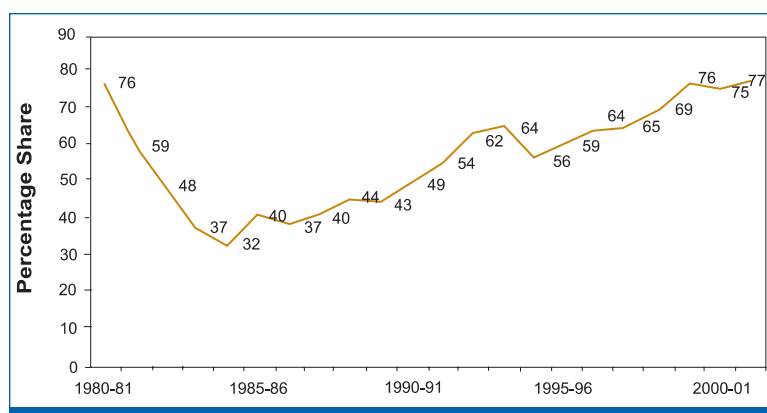


Figure 1.17: Share of petroleum imports in total consumption.

Source: Indian Petroleum and Natural Gas Statistics, 2003, MoPNG, Government of India.

success. Presently, NELP is due for its fourth round and, until now, a 100 blocks have been awarded to both public and private sector companies.

The government remained in control of the hydrocarbons sector in the form of the Administered Pricing Mechanism (APM). Various pool accounts ensured that the oil companies got a fixed return on their investments and the consumers got stable prices. However, mounting concerns about the inefficiency in the sector, the ever-increasing burden of subsidies and crude oil import bills, and sufficient refinery capacity in India propelled the government in 1997 to prepare a road map for dismantling the APM with a step-wise approach, reaching a completely free oil market by 2002. The prices of industrial fuels such as naphtha, fuel oil, bitumen and lubricants, were freed and the national oil companies were allowed to compete in this segment. The last step in dismantling the APM was taken in April 2002, when the Annual Budget 2002-2003 formally announced the move to market-based pricing and, since then, the oil companies, in consultation with the government, have been revising the prices fortnightly in line with the international trend.

Petroleum product pipeline policy

The government also announced a new petroleum product pipeline policy on a common carrier principle. The policy promotes the product pipelines originating from refineries, pipelines dedicated for supplying products to particular consumers, and pipelines

originating from ports. The policy would reduce road and rail transport and enhance the supply of cleaner fuels and, hence, would reduce emissions of GHG and local pollutants.

Auto Fuel Policy

The government announced the Auto Fuel Policy in 2003 to address the issues of vehicular emissions, vehicular technologies and the provision of cleaner auto fuels in a cost-efficient manner, while ensuring the security of fuel supply. These measures would result in the efficient combustion of fossil fuels in the road transport sector resulting in reduced GHG emissions. Transport sector emissions from Delhi are an interesting case in point, where the fuel switch to Compressed Natural Gas (CNG) from diesel in public vehicles has reduced CO₂ emissions. Apart from Delhi, CNG in respect of public passenger transport, has also been introduced in Mumbai.

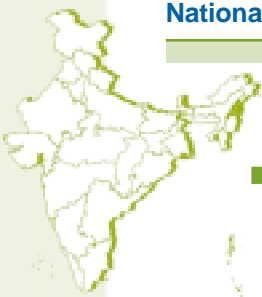
Reforms in the coal sector

Towards reforming the coal sector, the government has recently constituted the Expenditure Reforms Commission (ERC). The major recommendations of the commission are:

- Remove all restrictions on the entry of the private sector in exploration and production of coal by amending the Coal Mines Nationalization Act, 1973.



Delhi has world's largest CNG-based public transport fleet.



- Amend the Coal Bearing Areas (Acquisition and Development) Act, 1957 and set up an independent regulatory body to allow for a level playing field to the private sector.
- Restructure the industry by doing away with the holding company (CIL) and Coal Controller, among other things.
- Amend the Coal Mines (Conservation and Development) Act, 1974, to place responsibility on both public and private sectors for scientific mining, conservation, safety and health, protection of environment, etc.
- Permit states to develop lignite resources outside the command areas of the Neyveli Lignite Corporation.
- Reorient the overall strategy to take into consideration the role of coal in energy security.

Prior to 1 January 2000, the central government was empowered under the Colliery Control Order, 1945, to fix the grade-wise and colliery-wise prices of coal. However, following the Colliery Control Order, 2000, the prices for all grades of coking and non-coking coal have been deregulated. The current basic price of coal varies from Rs 1,450 per tonne to Rs 250 per tonne for different grades.

INDIA'S COMMITMENT TO CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

India accords great importance to climate change and her commitment to UNFCCC is reflected in the various national initiatives for sustainable development and climate change. As a commitment to the UNFCCC, India recently hosted the COP-8 at New Delhi. India has reasons to be concerned about the adverse impacts of climate change, since the vast population depend on climate sensitive sectors. The Government of India makes investments for the promotion of research and development on a continuous basis in diverse areas of the environment, including climate change. Environmental protection and sustainable development have emerged as key national priorities and are manifested in India's approach to socioeconomic development and poverty eradication.