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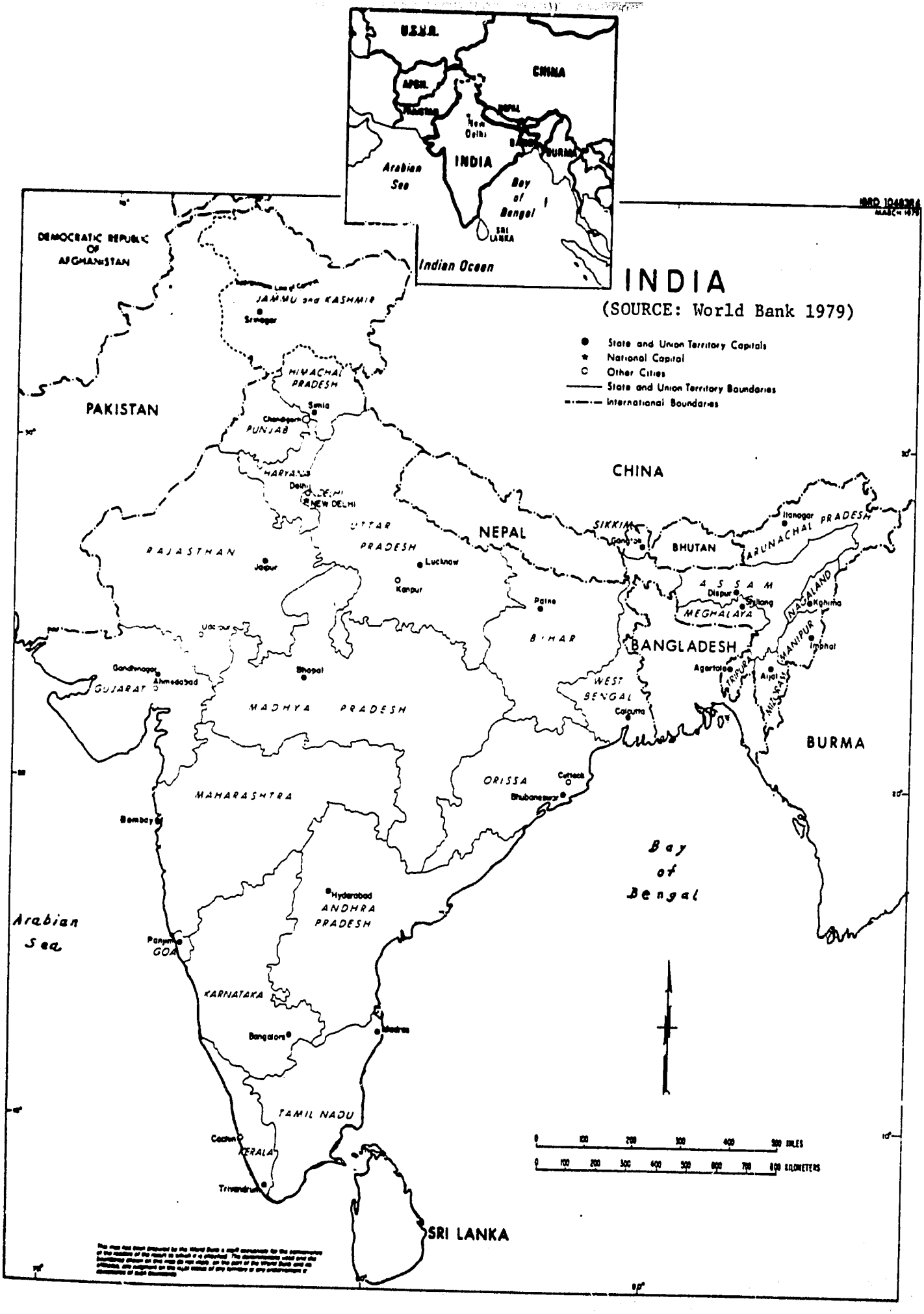
U.S.S.R.
CHINA
AFGH.
PAKISTAN
New Delhi
INDIA
BURMA
Arabian Sea
Bay of Bengal
SRI LANKA
Indian Ocean
INDIA
(SOURCE: World Bank 1979)
State and Union Territory Capitals
National Capital
Other Cities
State and Union Territory Boundaries
International Boundaries
DEMOCRATIC REPUBLIC OF AFGHANISTAN
JAMMU and KASHMIR
Srinagar
HIMACHAL PRADESH
Simla
Chandigarh
PUNJAB
HARYANA
Delhi
NEW DELHI
PAKISTAN
CHINA
NEPAL
SIKKIM
Gangtok
BHUTAN
ARUNACHAL PRADESH
Itanagar
UTTAR PRADESH
RAJASTHAN
Jaipur
Lucknow
Kanpur
Patna
BIHAR
ASSAM
Dispur
Shillong
MEGHALAYA
NAGALAND
Kohima
MANIPUR
Imphal
BANGLADESH
Agartala
TRIPURA
Aizal
MIZORAM
Udaipur
Gandhinagar
Ahmedabad
GUJARAT
Bhopal
MADHYA PRADESH
WEST BENGAL
Calcutta
BURMA
ORISSA
Cuttack
Bhubaneswar
MAHARASHTRA
Bombay
Hyderabad
ANDHRA PRADESH
Panjim
GOA
KARNATAKA
Bangalore
Madras
TAMIL NADU
Cochin
KERALA
Trivandrum
SRI LANKA
Arabian Sea
Bay of Bengal
0 100 200 300 400 500 MILES
0 100 200 300 400 500 600 700 800 KILOMETERS

INDIA: DRAFT ENVIRONMENTAL REPORT

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0.0 ENVIRONMENT AND NATURAL RESOURCES IN INDIA: Introduction and Summary

Located in South Asia with extensive coastlines on both the Arabian Sea and the Bay of Bengal, India, covering a territory of 3.28 million square kilometers (about two-fifths the size of the United States), is the world's seventh largest country in terms of land and, with a population estimated at 660 million in mid-1979, the world second most populous country.

India's population, distributed over 22 states and several union territories, comprises diverse groups of people speaking many different languages and practising several different religions. Despite India's rather extensive industrial development, about 80% of this population still lives in villages and, according to the most recent estimates, over 70% are engaged in agriculture or related pursuits such as fishing or forestry. Large portions of the population are afflicted by severe poverty and accompanying disease and malnutrition. India's birth rate has dropped considerably in recent years so that the natural rate of increase of the Indian population is now down to about 1.9% per year; however, this still represents a population gain of roughly 12.5 million per year.

geography and climate

Geographically India is a diverse country with terrains ranging from the lofty Himalayas in the north to the nearly level stretches of the Indo-Gangetic Plains and the plateau land of the Deccan Peninsula to the south. India's climate, heavily influenced by the presence of the Himalayas, which form a barrier against cold winds from the north and mark out the area of operation of the yearly monsoon rains from the southwest, also varies considerably. Rainfall, for example, is very heavy in both the Western Ghats (the line of mountains fringing the west coast of the peninsula) and Assam in the northeast, both of which get the full strength of the monsoon rains, while those areas benefitting less from these rains, in particular peninsular India to the east of the Western Ghats and the desert areas of Rajasthan to the north, receive low levels of rainfall and are considered arid or semi-arid regions. Most of the country depends on the monsoon rains and experiences dry seasons of varying severity during the remainder of the year; however, Tamil Nadu to the southeast receives most of its rainfall between October and December, during the Indian winter.

Weather and its vagaries constite a major problem for India. Despite advancements in the extension of irrigation, Indian agriculture still depends largely on the moisture brought by the monsoon rains. However, the intensity of the monsoon rains varies considerably from year to year, and drought years are of frequent occurrence, bringing drastic drops in agricultural production and consequent hardships for the people in the stricken areas; some parts of the country such as the low rainfall areas to the east of the Western Ghats are chronically affected by droughts. On the other hand, heavy rainfall also brings chronic flooding to other areas of the country such as the Indo-Gangetic Plain, where swollen rivers descending from the Himalayas overflow their channels and fre-

quently bring disaster to villages on their banks. In West Bengal cyclones associated with the onset or retreat of the monsoon season bring both destruction and death.

environmental problems

As is evident throughout this report many of India's resource and environmental problems arise from attempts to meet even the basic needs of its enormous population. The efforts of the population to meet its food needs have resulted in the clearing and loss of forest land; the need for firewood for cooking and other home uses has resulted in the degradation and loss of forests and the loss of trees in areas near villages; grazing of domestic animals in forests has also had led to deforestation, which in its turn has led to soil erosion and damage to watershed areas.

water

Water resources are plentiful in some areas of India and in short supply in others, particularly in areas such as the Deccan Plateau, where river flows are drastically reduced during the dry months of the year. Furthermore, although India's Himalayan Rivers are perennial and carry enormous quantities of water during wet season, much of this flow is lost to the sea because India lacks favorable sites for water storage. India's surface waters are utilized for navigation, for domestic water supply, for industrial water, and for irrigation, the last of which is by far the major water use in the country. India's groundwater supplies, plentiful particularly in the Indo-Gangetic Plain and less plentiful in the hardrock areas of the Deccan Plateau, are utilized for domestic water and increasingly for irrigation water; by most recent figures, some 40% of irrigated land in India is irrigated by groundwater.

Problems with surface water are of several types. Flooding, of annual occurrence, causes damage and often loss of life. Inefficient use of water in irrigation results both in water losses and in waterlogging of agricultura soils because of over-irrigation. Water pollution, a problem that is increasing in severity as population continues to grow, comes above all from the discharge of domestic wastes, although industrial water pollution is also a problem, not only in urban areas but also in some rural areas, where sugar mill effluents present a problem. Runoff containing pesticides and fertilizers have also added to the pollution load, while the heavy sediment load carried by rivers leads to several problems including adverse effects on fish and wildlife.

Problems with groundwater include: overpumping and consequent reduction of the groundwater table; groundwater salinity, a problem particularly in coastal areas and one often linked to over-pumping of freshwater supplies, allowing incursion of salt water; and pollution of groundwater by seepage from fertilizers and pesticides.

soils

Several different soil groups are represented in India, the most fertile of which are the alluvial soils which are predominant in the Indo-Gangetic Plain. Problems, reported to affect some 20% of India soils, are: erosion,

salinity and alkalinity, acidity, waterlogging, and cracking. The most serious of these problems is erosion, the effects of which are most evident in certain river valleys, where severe gully erosion has taken place. Erosion is caused by wind, water, and, in coastal areas, by the sea. It is aggravated by human-introduced factors such as deforestation and over-grazing of livestock, particularly on slopes. Erosion results in loss of soil fertility and is responsible for desertification, a severe problem in the arid region of Rajasthan; it also leads to large sediment loads in rivers, which in turn cause damage to irrigation works and result in rapid sedimentation of reservoirs intended to supply water for irrigation and hydroelectric power.

forests

Forests cover an area generally estimated at 22% to 23% of Indian's territory; however, recent satellite imagery for some areas of India indicate that this figure may in fact be somewhat lower. India's forests are of several different types, ranging from tropical wet evergreen forests and tropical moist deciduous forests, with their valuable growth of teak and sal, to the subtropical coniferous forests of the Himalayas. India's forests are utilized for the production of timber and other commercial products, but their chief product is firewood, which by some estimates accounts for as much as 95% of total wood production.

Rapid deforestation and loss of tree cover in areas around villages and other human habitations is a major environmental problem in India. This has had several causes: clearing of forest land for cultivation; slash and burn agriculture, particularly in the northeast; poorly controlled exploitation of wood for timber and firewood; forest fires; and grazing of domestic animals and the lopping of trees for fodder. As much as 4.0 million hectares of forest may have been lost during the past two decades, and this loss is expected to continue as demand for wood continues to grow with population. Some observers have predicted a crisis in fuelwood supply in the early 1980's.

Deforestation has several consequence in India. Loss of forest land has laid soils open to erosion from both wind and water, with the consequences considered in the discussion of soil erosion above. Loss of forest in the watershed areas of the Himalayas, has resulted in increased danger from flooding. Furthermore, the loss of forest has reduced the habitat available for wildlife.

wildlife

India has a great diversity of fauna, including an estimated 500 species of mammals and 1,200 species of birds. The most renowned of these animals are the Indian tiger, the Indian elephant, and the Great Indian Rhinoceros, but there are also many other cat species, as well as species of deer, wild goats, wild sheep, and monkeys.

India has experienced great losses in its wildlife numbers. These have come about chiefly through loss of habitat resulting from the clearing of forests, swamps, and other areas for agriculture and human habitation

and from hunting of animals. This loss has accelerated in the years since Independence was achieved in 1947. Today large numbers of India's wildlife species are endangered and many have become extinct. The U.S. Fish and Wildlife Service, for example, lists 25 endangered mammals (including the tiger, the elephant, and the rhinoceros), 9 species of birds, and 13 species of reptiles.

fisheries

India is the world's seventh largest fishing nation, with catches coming both from coastal areas (about 64%) and from various inland waters such as rivers, lakes, reservoirs, and irrigation ponds. Because India's fisheries have not been fully exploited, development plans call for expansion of both inland and marine fisheries. Problems with fisheries have come about as as result of overfishing in certain areas. Sedimentation at river mouths has adversely affected breeding grounds, while water pollution from several sources has led to fish kills. Problems are also anticipated as river flows are reduced by damming of rivers for river valley projects.

coastal zones

India has some 5,700 kilometers of coastline. This extensive coastal zone is exploited chiefly for fishing operations, although mineral development is also increasing and off-shore oil is now being exploited on the western coast near Bombay. Coastal zone problems include sea erosion, which has most seriously affected the coast of Kerala in the southwestern peninsula, siltation of harbors, and marine pollution, resulting above all from domestic pollution from coastal cities.

air pollution

Pollution of air is most pronounced in urban centers, where automobile and industrial operations are prominent sources of pollution. However, rural areas also suffer air pollution problems, chiefly because of the burning of wood and dung.

1.0 POPULATION CHARACTERISTICS

1.1 General population statistics (WPDS 1979)

Total population: 660.9 million
(population at last census--1971--548.2 million)

Birth rate: 34 per 1,000 population

Death rate: 15 per 1,000 population

Rate of natural increase: 1.9%

Number of years to double population: 36

Population in the year 2,000: 1,010,500,000

Population under 15: 41%

Population over 64: 3%

Life expectancy: 50

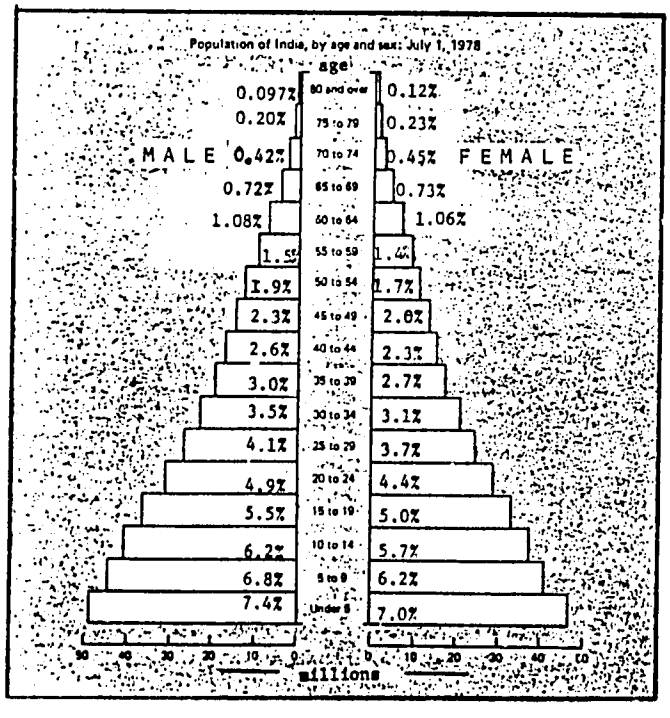
Urban population: 21% (138,789,000 million persons)

Population density: 210 persons per square kilometer

PQLI: 52

POPULATION PROFILE

(based on an estimated total population of 656,382,000)



(Source U.S. Bureau of the Census: 1978)

Although the overall growth rate of India's population is not extremely high, the absolute number of persons added each year is very large. Between 1956-1978, for example, the number of persons added to the population of India was greater than the combined populations of the United States and Canada in 1978 (U.S. Bureau of the Census 1978: 1).

Because both mortality and fertility have been slowly declining for many years in India, the rate of natural increase has remained fairly stable. Both mortality and fertility are expected to continue declining in the future as well.

Crude birth rates for rural areas, as estimated for 1975, were considerably higher than those for urban areas: 28.5 for urban areas as compared with 36.7 for rural. This difference is more pronounced in some states than in others. In Himachal Pradesh, for example, the urban rate is 20.6, while the rural rate is 33.5. In Maharashtra, on the other hand, the difference is slight: 29.4 for urban areas and 29.9 for rural areas. (U.S. Bureau of the Census 1978: 26).

1.2 Distribution of population

1.2.1 Distribution by State and Union Territory (see maps and table, page 2a/)

1.2.2 Rural-urban distribution *

Urban measures 1971

% of total population: 19.9

Cities with 100,000 inhabitants or more

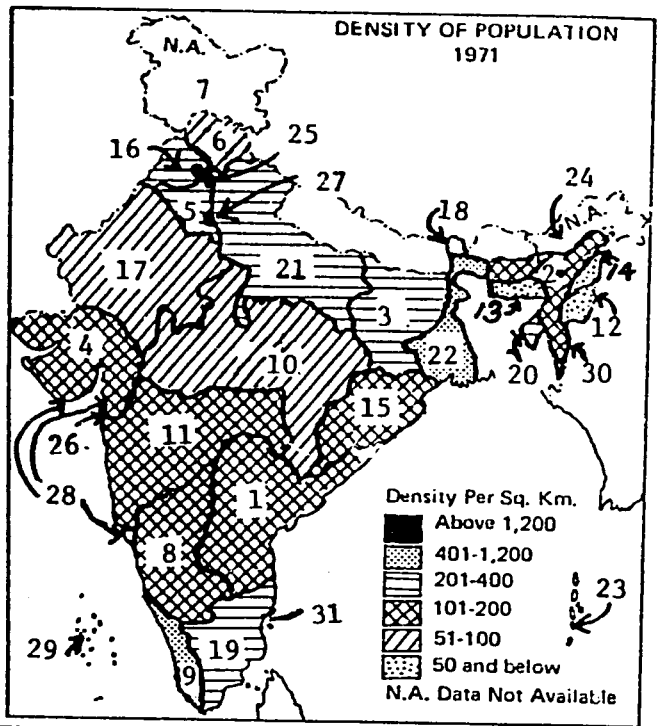
Number of cities: 151
Population: 53,380,841
% of country's total population: 9.7

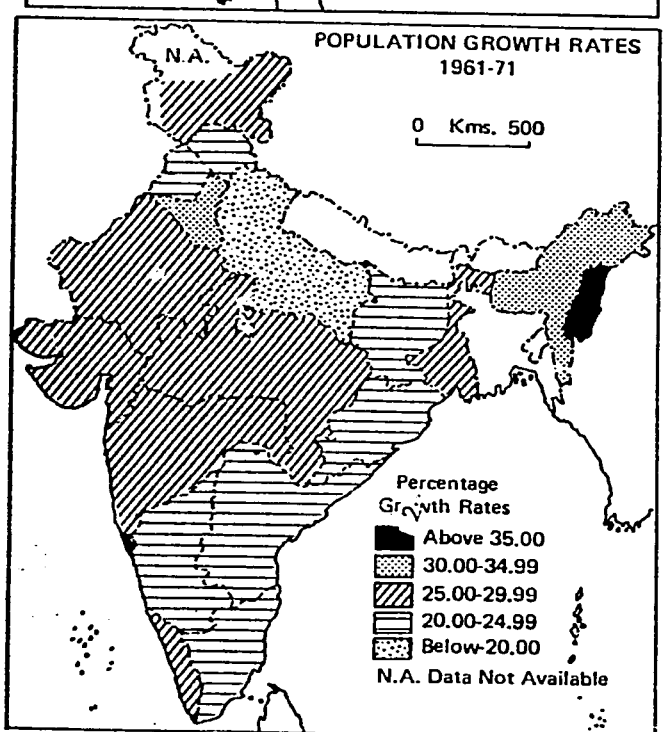
Cities with 20,000 inhabitants or more

Number of towns and cities: 1,022
Population 88,039,834
% of country's total population: 16.1%

According to the Indian national report to the 1976 United Nations Habitat Conference, India's population is distributed among 579,052 settlements. Nearly 80% of the population lives in 575,933 villages, with populations ranging from 100 to 25,000; average village size is 762. The remaining 20% inhabits some 3,119 urban settlements with populations ranging from 5,000 to nearly nine million. About 20% of this urban population is in the eight major metropolitan centers (NCECP 1976:9).

*Definition of urban as employed by the Indian Census:
a) all places with a municipal corporation, town committee, notified area committee or cantonment board;
b) all other places satisfying the following criteria: 1) a population of at least 5,000; 2) population density of at least 400 per square kilometer or 1,000 per square mile; 3) pronounced urban characteristics; 4) at least 3/4 of the male working population is non-agricultural (NCEPC 1976:36).





SOURCE: Datta 1973:106

DEMOGRAPHIC CHARACTERISTICS BY STATE AND UNION TERRITORY*
(Source: World Bank 1979:Table 1.3; Alam and Reddy 1975:67)

	area: 1,000 of km2	% of total Indian area	(millions) pop. 1971	pop. 1979**	% of total pop. 1971	% of total pop 1979	% of urban to total pop. 1971	% of total rural pop. 1971	% of total urban pop. 1971	pop per km2 197.	pop per km2 1979	gwth rate 1961-71***
STATES												
1. Andhra Pradesh	276.8	8.44	43.43	49.74	7.92	7.8	19.3	8.0	7.7	157	180	1.92
2. Assam	78.5	3.04	14.63	18.55	2.67	2.9	8.8	3.1	1.19	186	236	3.07
3. Bihar	173.9	5.30	56.35	64.16	10.28	10.0	10.0	11.55	5.13	324	369	1.95
4. Gujarat	196.0	5.97	26.70	32.00	4.87	4.99	28.1	4.37	6.87	136	163	2.61
5. Haryana	44.2	1.35	10.04	11.74	1.83	1.83	17.7	1.89	1.65	227	266	2.83
6. Himachal Pradesh	55.7	.86	3.46	3.77	0.63	0.59	7.0	0.73	0.18	62	68	2.10
7. Jammu&Kashmir	222.2	6.77	4.62	5.38	0.84	0.84	18.6	0.87	0.82	21	24	2.63
8. Karnataka	191.8	5.85	29.30	33.96	5.34	5.30	24.3	5.06	6.51	153	177	2.19
9. Kerala	38.9	1.19	21.35	25.06	3.89	3.91	16.2	4.08	3.21	549	644	2.36
10.Madhya Pradesh	442.8	13.50	41.65	49.93	7.60	7.79	16.3	7.95	6.23	94	113	2.55
11.Maharashtra	307.8	9.38	50.41	59.17	9.20	9.23	31.2	7.91	14.39	164	192	2.46
12.Manipur	22.4	.68	1.07	1.25	0.20	0.20	13.1	0.21	0.09	48	56	3.24
13.Meghalaya	22.5	.69	1.01	1.18	0.18	0.18	14.5	0.21	0.09	45	52	2.78
14.Nagaland	16.5	.50	0.52	0.58	0.09	0.09	9.9	0.11	0.09	31	35	3.41
15.Orissa	155.8	4.75	21.94	25.68	4.00	4.00	8.4	4.58	1.65	141	164	2.26
16.Punjab	50.3	1.54	13.55	15.68	2.47	2.45	23.7	2.35	2.93	269	312	1.98
17.Rajasthan	342.2	10.43	25.76	30.53	4.70	4.76	17.6	4.83	4.12	75	89	2.49
18.Sikkim	7.3	0.22	0.21	n.a.	n.a	n.a	9.5	n.a	n.a	29	n.a	2.61
19.Tamil Nadu	130.1	3.96	41.20	47.12	7.52	7.35	30.2	6.54	11.46	317	362	2.03
20.Tripura	10.5	0.32	1.56	1.81	0.28	0.28	10.4	0.32	0.18	149	172	3.14
21.Uttar Pradesh	294.4	8.97	88.34	99.32	16.11	15.50	14.0	17.32	11.37	300	337	1.82
22.West Bengal	87.9	2.68	44.31	52.80	8.08	8.23	24.7	7.59	10.08	504	600	2.41
UNION TERRITORIES	[119.4]		[0.46]	[7.60]	[1.38]	[1.34]		[0.43]	[4.06]			
23.Andaman&Nicobar Islands	8.3	0.25	0.12	0.13	0.02	0.02	22.6			14	16	0.12
24.Arunachal Pradesh	83.6	2.5	0.47	0.55	0.08	0.09	3.6			6	6	3.34
25.Chandigarh	0.1	0.003	0.26	0.30	0.05	0.05	90.7			2,257	3,000	7.96
26.Dadra&Nagar Haveli	0.5	0.015	0.07	0.09	0.01	0.01	-			151	180	2.50
27.Delhi	1.5	0.046	4.07	5.60	0.74	0.87	89.7			2,738	3,733	4.34
28.Goa,Daman&Diu	3.8	0.12	0.86	1.00	0.16	0.16	26.5			225	263	3.19
29.Lakshadweep	0.03	0.0009	0.03	0.04	0.005	0.006	-			994	1,333	2.81
30.Mizoram	0.5	0.015	0.33	n.a.	0.06		41.9			983	n.a.	n.a.
31.Pondicherry	21.1	0.65	0.47	0.55	0.09	0.09	11.4			22	26	2.48
TOTAL	3,287.8		548.2	640.8						177	195	2.24

Figures from: World Bank 1979: Table 1.3; and Alam and Reddy 1975: 67.
* It should be noted that Assam and Meghalaya were actually a single state until 1972 and that Sikkim has been part of the Indian Union only since 1975.
** World Bank Estimate for March 1979
***Average compound growth rate: per cent per year

Although India remains principally a country of rural dwellers, urban population increased 17.9% to 19.9% of the total population between 1961 and 1971. Much of this increase can be acccounted for by migration from rural into urban areas. It has been estimated by the Planning Commission (basing its figures on a length of residence of 20 years) that migrants form nearly half of the population of cities with populations of over one million and about 30 to 40% of those with populations of less than 300,000 (NCEPC 1976:35).

Rural migration to urban areas has been encouraged by several factors: increase in population, improved communications and education, seasonal unemployment in rural areas, the availability in urban areas of industrial and construction jobs for semi-skilled and unskilled labor, and a decreasing man-land ratio (NCEPC 1976:35).

While migration toward the city often deprives rural areas of young workers and skilled labor, it also confronts urban areas with unsurmountable problems involving housing and services. Migrants often occupy hastily constructed huts and shacks in areas without public water supply or sewerage. Nearly 25 to 30 percent of the urban population are estimated to live in slum or squatter settlements (NCEPC 1976:35-37). Urban growth also has had its effects on villages in the vicinity of metropolitan areas. Some of these which have come under the jursidiction of cities suffer from an influx of people seeking cheaper housing, with the result that agricultural lands are converted into residential areas, orchards are destroyed, and trees and vegetation are removed and not replaced (NCEPC 1976:34-35).

1.2.3 Population density with relation to arable land

Based on an FAO 1976 estimate of 162.5 million hectares of arable land, India has approximately 406 persons per hectare arable land.

1.3 Ethnic, linguistic, religious characteristics of the population

The Indian population is comprised of a great diversity of ethnic groups, resulting from the many waves of conquering peoples that have moved across the subcontinent since prehistoric times.

The population is now dominated by Caucasoid peoples, which fall into two large groups: the Dravidians of South India (25% of the population) and the North Indians (72% of the population).

In isolated hilly regions of the country are the tribes that represent the aboriginal peoples of India. These groups, which form about 3% of the total population are found in three "scheduled areas": in the the North East states of Arunachal Pradesh, Mizoram, Manipur, Nagaland, Meghalaya, and Assam are Mongoloid tribes, while in the hills of Central India (Madhya Pradesh and Orissa) and the southern Peninsula (Tamil Nadu and Kerala) are tribes of Negrito or Proto-Australoid stock (Kurian 1978:631).

The many languages of India fall into three broad groups: Indo-European languages (spoken by roughly 75% of the population) such as Hindi, Sindhi, Punjabi, Bengala, Gujarati, Marathi, and Bengali; the Dravidian languages (spoken by about 25% of the population) such as Kannada, Tamil, Malayalam,

and Telugu; and the Tibeto-Burman languages spoken by the Mongoloid tribes of the north east. Fifteen of the some 1,652 languages and dialects spoken in India, are accorded official status under the Indian Constitution; all of these are of the Dravidian and Indo-European groups. Hindi, the largest single language group is the predominant language of the Indo-Gangetic plain and is taught as the primary or secondary language throughout India. English, which is spoken by an estimated 11 million persons in India, has been assigned the position of an associate official language. It serves an important function as a lingua franca throughout the country and is also the language of the courts, the medium of instruction in secondary schools and universities, and the language of innumerable Indian publications (Kurian 1978:631-632).

Many prominent world religions are substantially represented in India: Hinduism (about 83% of the population), Islam (about 11%), Christianity (about 3%), Sikhism (about 2%), Buddhism (about 1% of the population), and Jainism (about 0.5%) (Kurian 1978:632-633).

1.4 Educational characteristics of the population

Adult literacy rate

% literate ages 15 years and over by sex: 1971
(from U.S. Bureau of the Census 1978: 12).

	both sexes	male	female
total 15 years+	34.1*	47.7	19.4
15 to 24 years	48.2	62.1	33.3
25 to 34 years	34.8	50.1	19.3
35 years +	25.2	38.0	10.7

School enrollment as %age of age group (World Bank 1979)

		1960	1970	1976
Primary School:	Total:	61	72	79
	Female	40	55	63
	Male	80	87	94
Seconday School:	Total	20	29	28
	Female	10	17	18
	Male	30	39	38
Vocational (as % of secondary)	Total	8	6	n.a.
University enrollment as percentage of ages 17-23** (inc.: arts, science commerce)	Total	0.89	2.93	n.a.
% studying Science:**		26.9	43.8	n.a.

*The Indian government reports a 1974 literacy rate of 38.8% for ages 5-59 years (NCEPC 1976:48).
**Source: NCEPC 1976:48.

Education is now free in all the Indian states for the age group 6 through 11 and is free for children from 11 to 14 in all states except Orissa, Uttar Pradesh, and West Bengal, which, however, provide free education for female students and students from backward communities. All states have compulsory Primary Education Acts except Manipur, Meghalaya, Nagaland, Sikkim, and Tripura. In many areas, incentives such as mid-day meals, free books and uniforms are used to attract children to schoools (India. Min. of Information and Broadcasting: 1978: 52-53).

Secondary education is free up to the secondary level in Andhra Pradesh, Gujarat, Karnataka, Kerala, Tamil Nadu, Andaman and Nicobar Islands, Arunachal Pradesh, and Lakshadweep and in government institutions in Jammu and Kashmir, Nagaland, Dadra and Nagar Havell, and Pondicherry. This level is free for girls in Madhya Pradesh, Manipur, Orissa, Rajasthan, Tripur, and Uttar Pradesh, while children belonging to particular castes and tribes get free education in all the states (India. Min. of Information and Broadcasting 1978:53).

1.5 Health characteristics of the population

Life expectancy at birth 51.0 (WB 1979).

Infant mortality: 122 per 1,000 live births (WPDS 1979)

Mortality rate ages 1-4: 10.0 (WB 1979) per thousand

Per capita supply of calories as % of daily requirements: 89 (WB 1979)

Protein (grams per day): 48 (WB 1979)
animal and pulse 12.9 (WB 1979)

1.5.1 Health problems

Comunicable disease are the major health problems in India today, although cancer and heart diseases are also common ailments. Although accurate statistics on disease incidence are said to be unavailable (Evaluation Technologies 1978:11) an estimated 50% of illnesses are attributed to unsanitary water supplies and lack of sanitation. Bacillary and amoebic dysentery, for example, are the major causes of infant mortality, while typhoid fever, also widespread and endemic, has been correlated in its occurrence with unsafe water supplies (Evaluation Technologies 1978:12).

The administration of health programs is primarily the responsibility of state governments, although the central government bears this responsibility in the Union Territories. Some diseases such as smallpox, filaria, and leprosy have become the focus of national eradication or control programs.

malnutrition

Malnutrition is widespread and affects a large portion of the population, particularly in rice-eating areas. Beri-beri (vitamin B1 deficiency) is common in rice-eating areas. Other problems are scury (vitamin C deficiency), osteomalacia and rickets (deficiencies of vitamin D, calcium, and other

minerals), and goiter (iodine deficiency), the last of which is most prevalent in the sub-Himalayan belt. The National Goitre Control Progamme aims to provide iodized salt to persons in the goiter belt areas of Jammu and Kashmir, Punjab, Haryana, Himachal Pradesh, Bihar, West Bengal, Nagaland, Arunachal Pradesh, and Manipur. Also widespread are anemias resulting from malnutrition and/or parastic infestation (Evaluation Technologies, 1978:12).

parasitic worms

An estimated 80% of children in villages are infected by parasitic worms. Hookworm is reported to be particularly severe in South India as well as in West Bengal and Assamese plantations, where incidence may be as high as 80% (Evaluation Technologies 1978:12).

malaria

Malaria is endemic and epidemic in India, which, according to the World Health Organization, is the most seriously affected country in the world. Malaria affects all areas except the Himalayas above 5,000 feet. The number of cases, as high as 75 million per year in 1952, has dropped considerably because of the institution of a National Malaria Eradication Programme, initated in 1958-59, to an estimated 740,000 cases in recent years (Evaluation Technologies 1978:12). By one recent count there were units operating under the National Malaria Eradication Programme, to cover some 535 million people (Lal 1976:105).

filariasis

Present in humid, high rainfall areas, filariasis is carried by mosquitoes. There were some 8 million active cases in 1973. The disease has been the object of a National Filaria Control Program, in operation since 1955-56, which, with headquarters at the National Institute of Communicable Diseases in Delhi, had 136 Filaria Control Units functioning in 15 States and Union territories in 1973 (Lal 1976:104).

leprosy

In 1973 there were an estimated 3,000,000 cases of leprosy, about 20% of which were infectious. The greatest numbers of cases were in Tamil Nadu and Andhra Pradesh, but most of the southern and eastern states are affected. The National Leprosy Control Programme, had 245 Leprosy Control Units and 1,496 Survey, Eradication and Treatment Centers acting to provide care for sufferers as of 1973-74 (Lal 1976:105).

cholera

Cholera is persistent in India and epidemic outbreaks are of frequent occurrence. The most severely affected areas are in the seven states of Andrha Pradesh, Bihar, Maharashtra, Karnataka, Orissa, Tamil Nadu, and West Bengal. New cases, as high as 40.8 thousand in 1973 had dropped to 16.4 thousand by 1976, with 297 deaths reported during the first half of 1976 (Germany...Federal Statistical Office 1977:17). A group of Cholera

Combat Teams were scheduled to be established under the Fifth Five Year Plan (Lal 1978:104).

tuberculosis

The number of activte tuberculosis cases in India has been estimated at nearly 8 million, with mortality rates as high as 500,000 annually (Lal 1976:106; Evaluation Technologies 1978:12). Nearly all towns and villages are afflicted by the disease. To combat TB the National Tuberculosis Institute of India was established by the government in 1959 with responsibility for formulating and continuously evaluating India's Naitonal Tuberculosis Programme. As of the mid-1970's there were about 300 control teams functioning throughout the country, administering vaccinations and tuberculin tests (Lal 1976:106).

smallpox

Smallpox cases dropped to 27,407 in 1972 but had risen to 188,003 in 1974, only to drop to 1,436 in 1975. No new cases were reported in 1976. The most prevalent smallpox areas, accounting for some 94% of cases, had been Madhya Pradesh, Uttar Pradesh, West Bengal, and Bihar (Lal 1976:106; Germany...Federal Statistical Office 1977:17).

venereal diseases

In the mid-1970's it was estimated that about 20% of the reproductive age population was suffering from venereal diseases, with about 5% of the total population suffering from syphillis and another 5% from gonorrhea. V.D. control programs are sponsored by the central government which provides necessary funds to state governments. In the mid-1970's about 39 V.D. clinics were in operation, and some hospitals offered special wards for V.D. patients (Lal 1976:106).

trachoma

Trachoma, endemic in many areas of India, constitutes the most important cause of preventible blindness. The disease is most prevalent in Punjab, Hayana, Rajasthan, Uttar Pradesh, and Gujarat and is moderately prevalent in Madhya Pradesh, Bihar, Assam, and Karnataka. About 329.3 million people were considered at risk in the mid-1970's. A National Trachoma Control Programme, established in 1963, is being implemented on a large scale in Punjab, Haryana, Rajasthan, Uttar Pardesh, and Gujarat and on a limited scale in Madhya Pradesh, Bihar, Karnataka, and Jammu and Kashmir (Lal 1976:106).

other diseases

Recent health statistics also list deaths from diphtheria, whooping cough, meningitis, acute poliomyletis, measles, meningitis, and infectious hepatitis. Both influenza and diabetes, which affects mostly the urban population also give some cause for concern (Lal 1976:106).

1.5.2 health care (see India. Min. of Inf. and Broad:99)

Population per physician: 3,135 (WB 1979)

Population per nursing person: 6,320 (WB 1979)

Number of hospital beds (1976): 300,000 (Min. of Inf. 1978)

Population per hospital bed: 1,231 (WB 1979)

Number of medical colleges: 106 (Min. of Inf.: 1978)

Total outlays on Health Programs under the Sixth Plan for 1978-83: Rs. 20,950 million (3.0% of total) (Economic Intelligence Unit 1978:21).

Under the Indian Constitution, health care is primarily the responsibility of the state governments, but the central government both provides guidance and sponsors and supports major schemes for improving health. Coordinating the work of the state governments is the Ministry of Health and Family Welfare, while the Central Council of Health advises the Ministry on all aspects of programs and policies.

Under the Fifth Plan (1974-1978) the primary objective for the health sector was to provide minimum public health and medical care facilities integrated with family welfare and nutrition for vulnerable groups of the population such as children, pregnant women, nursing women, and the poor. Emphasis was on: (1) increasing the accessibility of health services to rural, hill, and tribal areas; (2) correcting the regional imbalance in health care systems; (3) further development of referral services by removing deficiencies in district and sub-divisional hospitals; (4) intensification of the control and eradication of communicable diseases; (5) qualitative improvement in the education and training of health personnel; and (6) development of referral services by providing specialist services in the rural areas. Particular emphasis has been placed on backward and tribal areas, which are to receive preference in the implementation of health programs (India. Min. of Information and Broadcasting 1978:95).

rural health care delivery

In rural areas, the chief unit for health care delivery is the primary health care center, which forms the base of the integrated structure of medical services for such areas. As of September 1976 about 3,372 centers were in operation, 1,290 of which were scheduled for upgrading to 30-bed rural hospitals under the Fifth Plan. The primary health care centers and subcenters provide basic medical care through multi-purpose health workers. There are plans to have a male and a female health worker for every 10,000 persons (India. Min. of Information and Broadcasting 1978:100).

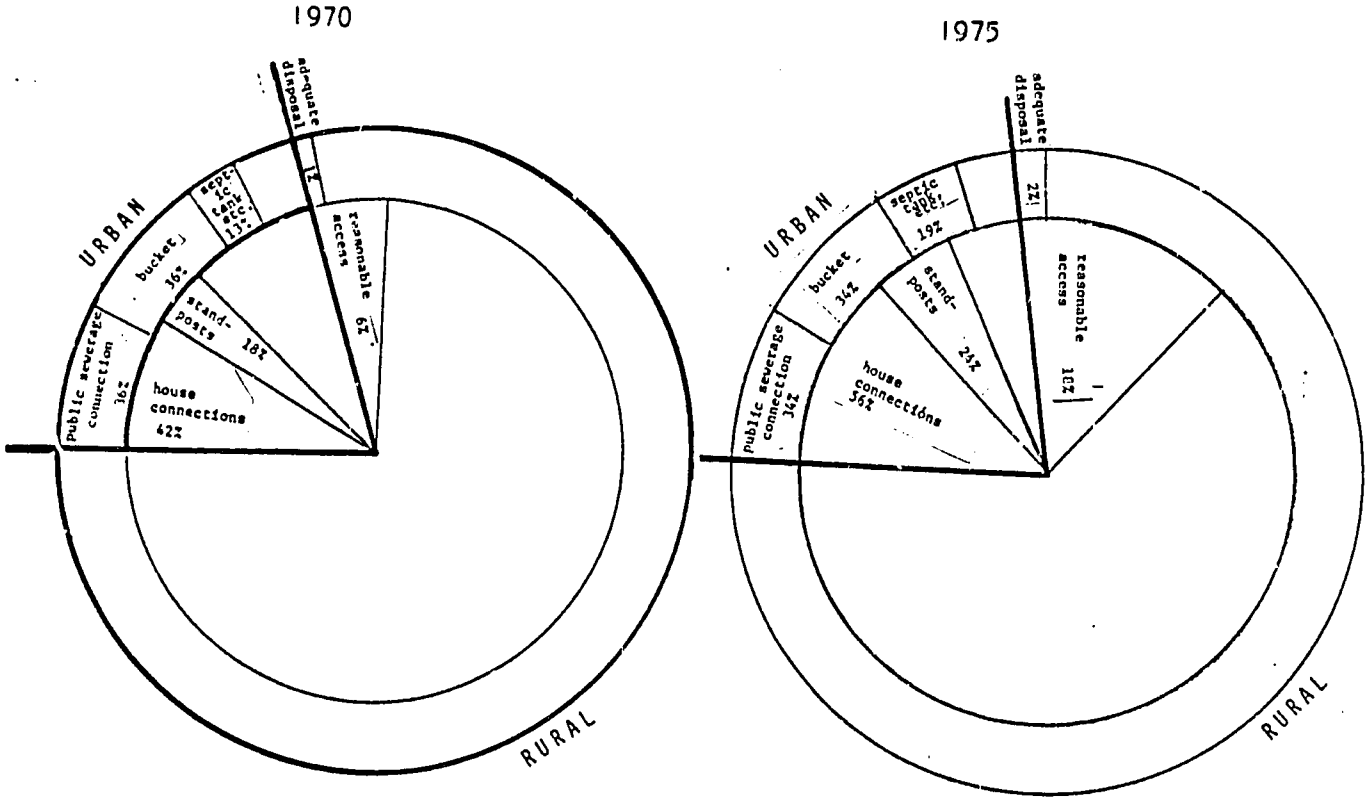
indigenous medical systems

Among the rural population, Indian systems of medicine continue to thrive. An estimated 250,000 registered practioneers (hereditary vaidyas and

hakims) are active in some 13,000 dispensaries and 200 hospitals throughout the country, and money has been allotted under the Fifth Plan for the development of these systems (about Rs. 263.5 million). There are presently over 100 undergraduate colleges and two post-graduate institutions providing education in Indian medicine (Ayurvedic, Unani, and Siddha), and a National Institute of Ayurveda was established at Jaipur in early 1976. The Central Council of Indian Medicine, set up in 1971, has established a curriculum and minimal standards of education in the Indian systems of medicine, while the Central Council for Research in Indian Medicine and Homeopathy, founded in 1969, bears responsibility for initiating, conducting and co-ordinating scientific research in different aspects of the Indian systems of medicine as well as in homeopathy and yoga (India. Min. of Information and Broadcasting 1978:99-101).

1.5.3 Water supply and sanitation

WATER SUPPLY AND SANITATION: 1970 and 1975
[Inner ring indicates water supply; outer ring indicates availability of sewerage disposal services]



(Figures from UNEP/ESCAP 1979:22; and World Health Statistics Report, vol. 29, no. 10 [1976].)

According to one recent set of figures protected water supply was available to about 83% of India's urban population (about 115 million) but to as little as 4.3 per cent of the rural population (22.4 million) (NCEPC 1976: 43). Other sources (see above graph) indicate that as much as 18% of the rural

population (93.9 million) may now have "reasonable access" to safe water supplies.

In rural areas, as of 1968-69, 65% of villages obtained drinking water from wells, 15% from rivers, lakes, and springs, 8% from tubewells, and the remaining 12% from sources such as irrigation tanks and ponds (Chaturvedi 1976:35). Figures for March 1976 indicate that about 64,000 villages (1.1 %) had piped water supply and hand pump tube wells , while an additional 422,000 (73%) relied on water supplies such as conserved wells and springs (India. Min. of Information and Broadcasting 1978: 105).

As many as 152,000 villages in India are defined as "problem villages" with regard to water supply because of several factors: they are more than 1.6 kilometers from their closest water source; they must obtain water by means of a vertical lift of 100 meters or more; or they are situated in areas having only brackish water with excessive salinity (Parikh 1977:192).

The problem of inadequate water supply is reflected in the situation that about 50% of the diseases commonly encountered are water-borne diseases that could be prevented were safe-drinking water supplies available. One of the causes of this problem is inadequate sewage-disposal facilities, which allow refuse to get mixed with open-water resources. An estimated 80% of the children in Indian villages suffer from parasitic helminthic disease caused by the mixing of excrement with open water sources (Parikh 1977:193).

National Water Supply and Sanitation Programme

Aware of the extent of its problem, the Indian government in 1954 launched the National Water Supply and Sanitation Programme, which includes well construction, the boring of hand-operated tube wells, and the renovation of old wells (Lal 1976:106). 1954 also saw the establishment of the Central Public Health and Environmental Organization (CPHEEO), designed to provide technical advice and guidance to state governments in the preparation and executions of their schemes.

Under the Fifth Five Year Plan, the main objective stated for rural water supply is the provision of safe water to problem villages. The plans foresees the extension of safe water to some 57,800 villages during the first three years of the plan and to some additional 53,900 during the remaining two years (India. Planning Commission. 1976:82). Under the draft sixth plan a Minimum Needs Program has been instituted under which about 16% of outlays are marked for rural water supply (World Bank 1979:18).

The Plan also calls for the extension of water supply systems to 520 towns and of sewerage and drainage systems to 84 towns (India. Planning Commission. 1976:82).

sanitation

As indicated above, water-borne sewerage services still cover only some 34% of the urban population (47.1 million), while only about 2% of the

urban population (10.42 million) have the benefit of adequate disposal. The Indian National Report to the 1976 U.N. Habitat Conference lists as "negligible," the number of rural households covered by water-borne sewerage disposal (NCEPC 1976:43).

The Fifth Five Year Plan calls for outlays for supporting programmes such as public health engineering to train about 3,000 personnel and mechanical composting to set up 27 mechanical compost plants along with 60 mechanical sieve plants in different cities. There are also provisions for converting as many as 35,000 dry latrines into sanitary latrines (India. Planning Commission. 1976:82).

surveillance of water supplies

WHO records of surveillance of drinking water quality in developing countries indicate that public health authorities bear the responsibility for this surveillance, that water quality standards other than WHO standards are used, that all urban supplies are regularly examined for bacteriological content, whereas some rural supplies are regularly and others only occasionally monitored (van der Leeden 1975: 494).

.5 Birth control

Active users and users as a percent of married women, ages 14 to 49 years, by method: 1972-1977 (U.S. Bureau of the Census 1978:11) (table does not include Sikkim)

Method	(in thousands) 1972	1977	% of married women 1977
all methods	12,928	25,371	20.8
IUD.s	1,552	1,671	1.4
Steriliz.	8,142	21,925	17.9
Other	2,234	1,775	1.5

The various five-years plans of the Indian Government have called for reducing the birth rate, and population policy as contained in the draft sixth five year plan still aims at reducing the birth rate to 30 per thousand by March 1983. The Indian government reaffirmed its total commitment to population control at a February 1979 meeting of the National Development Council, which all-out efforts were urged to intensify the implementation of the somewhat flagging program (World Bank 18).

The basic policy statement in this area is the National Population Policy, romulgated in 1976 but now altered so that: (1) acceptance of fertility control is to be completely voluntary; (2) the promotion of family planning ("family welfare") is to be integrated with services for basic health, maternal and child health and nutrition and is to be linked with the longer-term aim of economic and social development; (3) health and fertility control services are to be particularly emphasized for the lower income groups, particularly in the rural areas, with the major focus of expenditures shifted from the urban to the rural poor (World Bank 1979:4).

According to one recent assessment, however, the pace at which new acceptors are entering the program has declined since the high point of 12.5 million acceptors during the 1976/77 intensive drive and may be below that required to attain the goal of 30 births per thousand by 1983 (World Bank 1979: 4, 18).

1.6 Housing

Types of houses (March 1971: from NCEPC 1976:43).

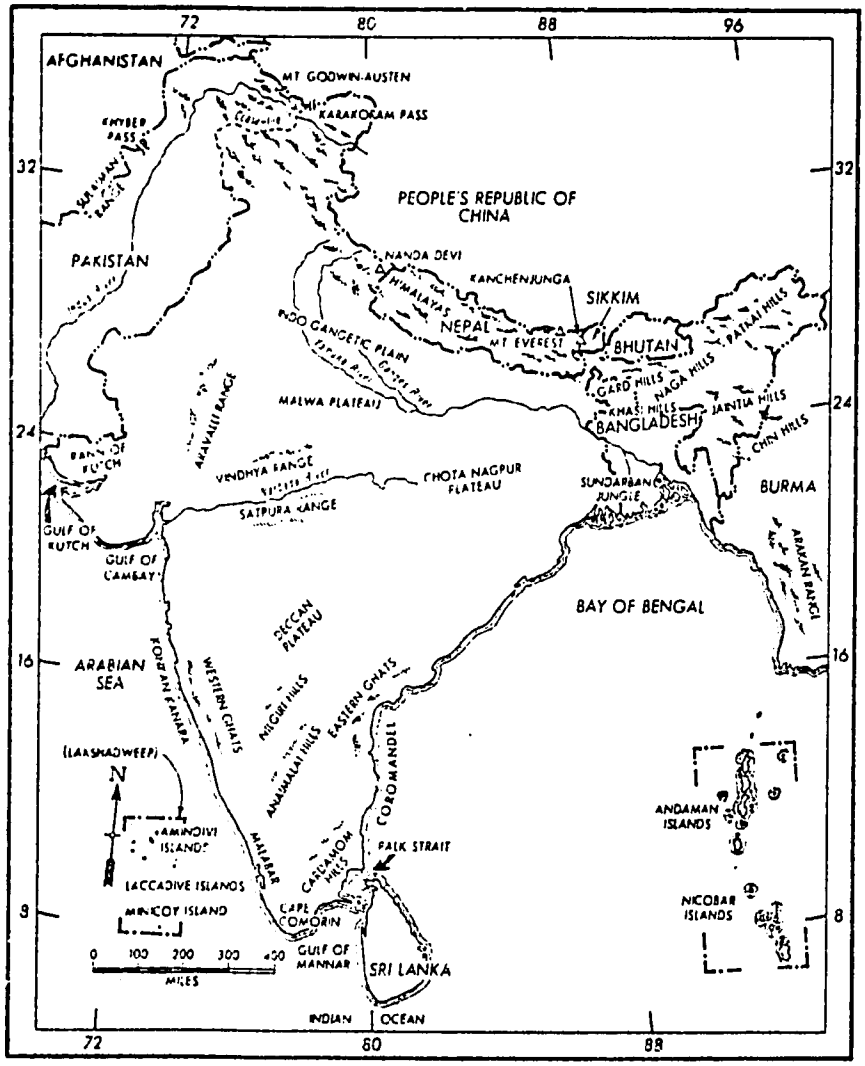
	rural (%age of pop.)	urban (%age of pop.)
Pucca (durable)	18.9%	63.8%
Semi-pucca (semi-durable)	37.6%	23.5%
Kachcha (non-durable)	43.5%	12.7%

2.0 THE RESOURCES OF INDIA

2.1 Topography and geographical regions of India *

Covering 3,287,782 square kilometers of land, India is about two-fifths the size of the continental United States. The Indian subcontinent, a region which India occupies along with Pakistan and Bangladesh, may be divided into three major geographic regions. The Himalayan region, formed by the mountains of the North; the Indo-Gangetic Plain, the generally flat area which forms a east-west band varying from about 160 to 480 kilometers in width south of the Himalayas; and the tableland which forms most of the triangular Indian or Deccan peninsula. Together the Himalayas and the Indo-Gangetic Plain are referred to as Northern India, while the peninsula is often referred to as southern India.

MOUNTAINS AND PLAINS OF INDIA
(source: Nyrop 1975:57)



*The following discussion is derived from Nyrop 1975:57-64; and Datta 1973: 13-24.

2.1.1 Himalayan Region

The Himalayas, the world's highest mountains, comprise three ranges: most spectacular are the Great or Main Himalayas with heights of up to 6,000 meters; fringing these to the South are the Lesser Himalayas, with peaks of from 1,500 to 3,600 meters; between the Lesser Himalayas and the Indo-Gangetic Plains run the Outer, or southern Himalayas, a system of low foothills with heights of from 300 to 1,000 meters. An important formation of this outer fringe are the Siwaliks, highly erodible hills composed mostly of loosely consolidated materials with some sand and silt.

Much of the Himalayan range falls outside of India, in Nepal, China, and Pakistan. These mountains, however, play an important role for the country. They are the source of the most important rivers of the region: the Ganges or Ganga; the Brahamaputra; and the Indus, most of whose flow is outside of India itself. These rivers not only bring water but also carry loads of silt which enrich the soils of the Indo-Gangetic Plains. Furthermore, the Himalayas exert important influences on the climate of India, forming a barrier to keep out the cold northern winds from Tibet and serving as a screen in which the important monsoons system (see below) operates.

Within the Himalayan ranges the southern slopes are generally too steep to allow either snow accumulation or more than sparse tree growth. The northern slopes, on the other hand, are generally forested below the snow line. Between the ranges are deep gorges, and, in some places, fertile valleys such as the Vales of Kashmir and Kulu.

Economic activity is limited within the Himalayan region, and although there are important agricultural activities such as the tea plantations of Darjeeling, subsistence grazing is by far the most widespread activity. Limited mineral exploitation includes coal in Assam and Kashmir.

2.1.2 Indo-Gangetic Plain

The Indo-Gangetic Plain, covering about 780,000 square kilometers, runs some 2,400 kilometers from the delta of the Brahmaputra in the east through Pakistan to the border of Afghanistan in the west. Once a gulf running between the Himalayas to the north and the Plateau to the south, the plain, varying in width from 160 kilometers in the east to 480 kilometers in the west, is actually a trough that over the centuries has been filled with alluvium--in some places possibly as deep as 3,000 meters--carried from the Himalayas.

The Indo-Gangetic Plain may be considered in various groupings: the Indus Delta, Kathiawar and Kutch--much of which falls in West Pakistan; the Thar Desert of Rajasthan; the Ganges Valley; the Ganges-Brahmaputra Delta; and the Brahmaputra Valley.

The portion of the Indus Delta falling within India, designated as Kutch, is a desolate, wind-blown region consisting of hard salt flats for half of the year and swamps for the other half. The peninsula of Kathiawar, to the south and east of Kutch, sometimes considered as belonging to the peninsula area, though generally low in elevation, has

sections as high as 600 meters.

The Thar or Rajasthan Desert is an arid region, whose only year-round river, the Luni, does not produce flows that are significant enough to compensate for the low level of rainfall. Much of the area is covered by a veneer of loose soil and rock materials of varying thicknesses, below which is a base of crystlline rock of the same type which also underlies the Deccan Peninsula.

The Ganges Valley, a region of wide rivers, level plains, and fertile alluvial soils, has for centuries been the center of economic and political life in the Indian subcontinent. Much of this areas consists of an active floodplain, on which rivers constantly shift their channels. The rich soil of this low-lying area is called "khadar," while the less fertile soils of the higher areas or "doabs" are called "bhangar." The proportion of "khadar" to "bhangar" increases from west to east, until east of Patna (the point of convergence of most of the major tributaries of the Ganges), "bhangar" almost completely disappears. Villages in the Ganges Plain are found mostly on bluffs and levees, where they may still be in danger from rapidly rising floodwaters.

To the north between the Gangetic Plain and the lower foothills of the Himalayas is a swampy, malarial area, extending northwards into Nepal, known as the Teral. Before the middle of this century the Teral (or Taral), contrasted sharply with the plain immediately to the south because of its sparse population, the prevalence of malaria, and its abundant wildlife; drainage and mosquito control are now, however, bringing the area into production.

To the east of the Ganges Valley proper is the Brahmaputra Valley, which like the Ganges Valley is also fringed by a low marshy area known as the "duars." This valley also exhibits the contrast between active floodplain and doab, but here the floodplain dominates, flooding being a problem of such magnitude as to discourage settlements in large portions of the plain.

South of the Brahmaputra Valley in northeastern India is the Shillong Plateau, an upland area geographically isolated from but actually belonging to the crystalline block that forms the southern peninsula. With heights of up to 1500 meters, the plateau is characterized by rolling hills.

3 Southern (Peninsular) India

The Deccan (Southern) Peninsula is a geologically very old and stable area. The Deccan Peninsula proper, that area south of the Satpura Range and the Chota Nagpur Plateau, is a large block that has been upraised and tilted towards the east. It is composed for the most part of crystalline rocks and metamorphized sedimentary rock, which in the northeastern quarter of the peninsula are covered by a thick sheet of basaltic lava. The uplifting of the plateau block and its inclination toward the east was responsible for the formation along its western edge of a line of hills (the Western Ghats), some of which reach heights of from 600 to 900 meters, which run in an almost unbroken chain from the Tapti River in the north

about 1600 kilometers to the tip of the Peninsula in the South. Along the eastern side of the Peninsula run the Eastern Ghats, a disconnected series of hills that mark the eastern edge of the plateau. Because of the eastward tilt of the Peninsula, most of the significant rivers of southern India have course that run from west to east.

The Deccan Plateau itself is a series of plateaus covered by rolling hills and intersected by many rivers. For the most part it consists of thin soils underlain by crystalline rocks, although alluvial soils occur in areas where rivers have deposited silt along their banks. This crystalline shield underlying the peninsula holds India's most significant mineral dseposits: iron ore, bauxite, manganese, gold, chromite, and copper. The balsatic lavas of the northeastern quarter, occurring in thicknesses of up to 3,000 meters in the area of Bombay, provide the basis for the fertile black soils that are characteristic of this area. Towards the tip of the peninsula, where the Western Ghats and the Eastern Ghats converge, are several hill areas, including the Cardamon Hills, which are the home of those tribes which are the least touched by the predominant culture of the subcontinent. These hills, with their powerful waterfalls, are also the site of important hydroelectric projects as well as of many of the country's tea and rubber plantations.

Fringing the peninsula along its entire extent is a generally continuous coastal plain. On the western side the plain is narrower in the north (the Konkan coast), where it is characterized by tidal marshes, drowned valleys and estuaries, than in the south (Malabar coast), which is an area of elongated lagoons, marshes, and intervening beach ridges. The coasts of the eastern peninsula, considerably wider than the western coasts, are dominated by the deltas of large rivers, which have become the focus of settlement and other human activities.

To the north of the Deccan Penisula proper are the Central Highlands of India, dominated by two ranges, the north-south Aravalli range and the east-west Vindhya range. The Aravallis, the dominant mountain chain of southern India, consisting of eroded Pre-cambrian crystalline rocks, gradually lose height toward the north; Delhi is built on the last spur of the range, just before it is lost in the Indo-Gangetic Plain. The Aravallis serve as a barrier to the encroaching Thar Desert in the west, while the Malwa Plateau, running between the Aravallis and the Vindhya Ranges has served for centuries to channel movements of people and political power from Delhi to southern India. The Vindhya Range and the Narbada River directly on its southern flank has provided a major route westward from the Arabian Sea to the Gangetic Plain at Benares. Other ranges are the Satpura in the western sector, Mahadeo, Maikal and Bhanrer Hills in the center, and the Kaimur, Hazaribagh, and jungle hills of the Chota Nagpur occur in the west. The Chota Nagpur Plateau of Southern Bihar in the east, is the site of extensive mining and industrial development, centered in Jamshedpur.

2.1.4 Off-shore Islands

Comprising only about 0.25% of India's total territory are two sets of offshore islands: the Andaman and Nicobar Islands (about 8,300 square kilometers) in the Bay of Bengal, which are actually closer to the Malay Peninsula than to India itself, and the Laccadive, Minicoy, and Amindivi Islands (together as the Union Territory of Lakshadweep covering only about 30 square kilometers) off the Malabar Coast in the Arabian Sea. The heavily forested, lowlying, and thinly population Andaman and Nicobar Islands are a center of timber production, while fishing and coconut farming are the major economic activities of the lowlying, densely-populated islands of Lakshadweep.

2.2 CLIMATE

2.2.1 Climatic conditions

India experiences four seasons: summer, southwest monsoon, retreating monsoon, and winter.

summer (March through early June)

The summer season, following without transition on the Indian winter and generally defined as the period running from March 1 through the early part of June, is a period of rising temperatures. In the mid-Ganges area, for example, temperatures over 38 degrees C are common, while in the Rajasthan Desert average daily temperatures are as high 44 degrees C and may rise as high as 50 degrees C in the shade. High temperatures are common in most other areas as well, the only areas with daily maximum temperatures below 38 degrees C being the coastal plains of the Deccan, where the sea acts to reduce temperature, and two areas in which altitude reduces temperature: the heights of the western Ghats, including the upland areas of the south, and the slopes of the highland regions in the north.

Toward the end of this season humidity increases, bringing life to browning vegetation and creating a sticky uncomfortable weather.

southwest monsoon (mid-June through September)

The monsoon season is the most crucial in India and it plays such an important role in India that it determines the way in which Indians look at the seasons of the year. It is awaited eagerly by rural dwellers, most of whom depend on its rains for their crops, and with some trepidation by the urban population, for whom it may bring leaky roofs and flooded streets.

Explanations for the monsoon phenomenon have been many. Traditionally it was traced almost solely to thermal changes in the Asian land mass. The most recent explanation attributes it to a combination of the topographical barriers of northern India, the northward movement of the sun, and the consequent northward shift of the jet stream. These factors create a dynamic depression above the thermal depression at the surface, triggering the rush of warm moisture-laden air from the southern seas over the Indian subcontinent (Dutt 1973:26).

The onset of the monsoon season varies in different localities in India and the monsoon rains are of varying importance in various areas. In the Plateau, as well as along the western coast from the Gulf of Cambay to Goa, the only significant rains occur during this period, and arable farming is therefore limited to this period.

In Tamil Nadu in the far southeastern portion of the peninsula, an area governed by other climatic forces, the monsoon season is usually only a period of high humidity, light rains, and overcast skies.

retreating monsoon

The season of retreating or the post-monsoon season, usually said to occur from October through November, is the period during which the effects of the monsoon cover progressively smaller areas. By the end of the summer the monsoon rains have all but ceased in the far north west, and have retreated from the mid-Ganges valley by the end of September, while on the Ganges delta they persist through October. The same withdrawal occurs in western and peninsular India.

This period of slackening rains is one of high humidity and high temperatures which causes great discomfort both to men and animals.

The retreating monsoon period is also associated with destructive typhoons or tropical cyclones, about ten or fifteen of which strike South Asia each year, mostly on the eastern side of the sub-continent along the Bay of Bengal. Winds associated with these storms, which generally occur from July through September, may reach 160 kilometers per hour and often are accompanied by tidal waves created by low pressure systems or by the force of the winds, especially on the Ganges-Brahmaputra delta.

winter season

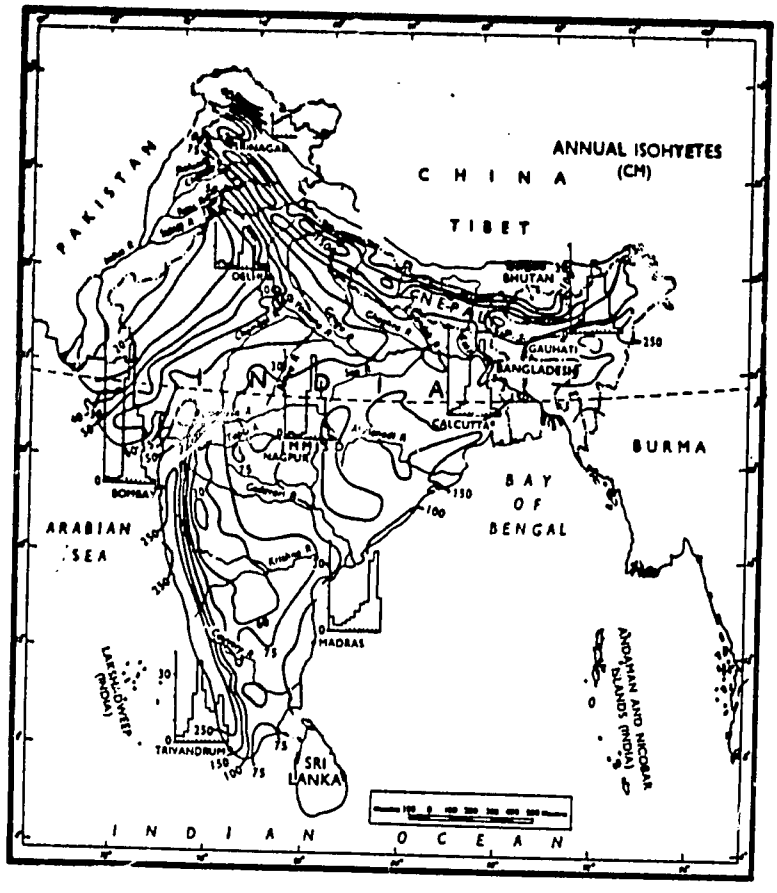
November and December bring cooler temperatures throughout India, except for the extreme southern tip of the peninsula, where changes may be slight. This season brings frosts only to certain areas however: the Punjab, the Vale of Kashmir, and the heights of the Himalayas. Rain is rare during this period of generally clear skies, fair weather clouds, and low humidity.

Only two areas receive rain during this period: the Tamil Nadu region of the south, centered on Madras, for which the period of October through December is the rainy season, and an area running running from Baluchistan in Pakistan in an arc through the Punjab to Assam, where modest rainfall allows the extension of agriculture beyond the monsoon season. In the Kashmir snowfall occurs during this period.

2.2.2 Precipitation

As indicated in the discussion of climate above and as illustrated by the rainfall table on page 20a most of the rainfall in India--about 80-90%--occurs during the monsoon season, which generally covers the period from June to September. The normal average rainfall for the entire country is 1,040 millimeters. As indicated by the rainfall map on page 20 and by the table on page 20a, however, rainfall levels vary considerably throughout the country, with the highest levels being reached along the Western Coast and in Assam in the northeast, where Cherrapunji on the Shillong Plateau is said to receive the highest levels of rainfall of any location in the world. The level of rainfall is lowest in the desertic areas of Rajasthan, Gujarat, and Haryana and in section of Jammu & Kashmir. Furthermore, rainfall in India tends to be very erratic, varying considerably in quantity in the same location from year to year (Chaturvedi 1976:10-11).

Rainfall in India in Centimeters
(Source: Chaturvedi 1976:20)



utilization of rainfall

Despite the increase in irrigation works, India remains primarily a country in which agriculture is dependent on rainfall. Rainfall is also the major source for replenishment and maintenance of the flows of most of India's rivers, with the exception of those rivers coming from the Himalayas. An estimated 90% of the total flows in any given year depend on the monsoon rains between June and December (Lahiri and Nagarajan 1977:162).

Because of the difficulties in storing water in large areas of the country, most of the rainfall of the monsoon period is lost to the sea.

drought

Drought is of frequent occurrence in India, some areas being particularly drought-prone. These areas, as shown on the map on page 21 are those characterized by an adverse water balance (that is, in which potential evapotranspiration substantially exceeds precipitation) and in which there is a 20% chance of a rainfall departure of more than 25% from the norm. Those areas designated as hard-core drought areas--encompassing about 16%

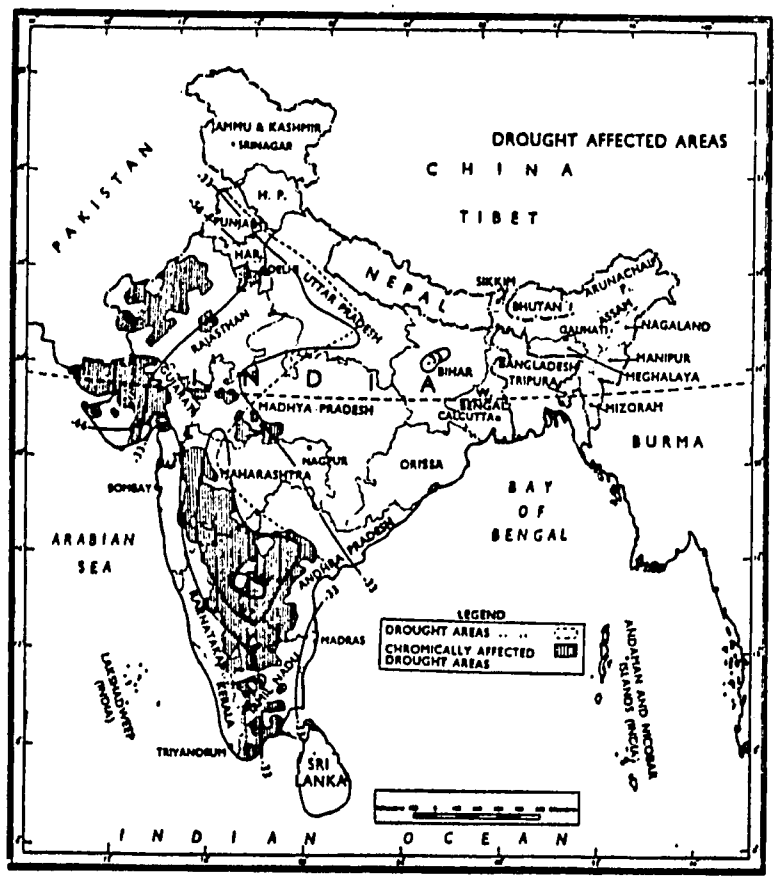
RAINFALL AND TEMPERATURE FOR SELECTED STATIONS
temperature in centigrade; rainfall in millimeters
(Source: Lal 1976:15-16)

Location & altitude in meters	January temp/rain	February temp/rain	March temp/rain	April temp/rain	May temp/rain	June temp/rain	July temp/rain	August temp/rain	September temp/rain	October temp/rain	November temp/rain	December temp/rain
HIMALAYAN REGION												
Srinigar (1,586)	1.1/72.8	3.5/72.3	3.5/104.1	13.3/78.1	17.9/63.4	21.7/35.6	24.6/61.0	23.9/62.8	20.5/31.8	14.1/28.7	7.7/17.5	3.5/35.9
INDO-GANGETIC PLAIN												
New Delhi (216)	14.3/24.9	16.9/21.8	22.7/16.5	28.6/6.8	33.5/7.9	34.3/65.0	31.3/211.1	29.9/172.9	29.3/149.7	25.9/31.2	20.3/1.2	15.7/5.2
Allahabad (98)	16.4/20.2	19.1/22.2	25.1/14.3	30.7/4.8	34.7/8.2	34.3/101.7	30.1/274.8	29.1/333.1	29.0/195.1	26.5/39.7	21.1/6.9	17.1/6.3
Patna (53)	17.3/21.1	19.9/20.2	25.7/6.7	30.5/8.2	32.5/28.3	31.9/139.0	29.8/265.8	29.3/307.1	39.3/242.5	27.5/62.8	22.5/5.7	18.3/2.4
Calcutta (6)	20.2/13.8	23.0/24.2	27.9/26.5	30.7/42.7	31.1/120.6	30.4/259.1	29.1/300.6	29.1/306.3	29.2/289.7	27.9/160.2	23.9/34.9	20.6/3.2
Hyderabad (545)	21.6/1.7	23.9/11.4	27.4/13.4	30.3/24.1	32.5/30.0	29.1/107.4	26.1/165.0	25.8/146.9	25.7/163.3	25.1/70.8	22.3/24.9	20.6/5.5
Assam (Shillong Plateau) Cherrapunji (1,313)	11.7/19.8	13.7/37.3	16.7/178.9	18.5/605.2	19.2/1,705.1	20.1/2,921.5	20.3/2,456.7	20.5/1,827.5	20.5/1,167.7	19.1/447.4	15.8/46.7	12.9/5.0
SOUTHERN PENINSULA												
Mysore (767)	22.3/2.8	24.7/5.5	26.9/12.0	27.7/67.6	26.9/165.9	24.5/60.5	23.5/71.9	23.7/80.1	24.0/116.3	24.0/179.9	22.9/66.6	21.7/14.7
Western coast												
Ahmedabad (169)	20.3/3.9	22.7/0.3	27.1/0.9	31.3/1.9	33.5/4.5	32.7/100.0	29.5/316.3	28.2/213.3	28.7/162.8	28.4/13.1	24.5/5.4	21.1/0.7
Bombay (11)	24.3/2.0	24.9/1.1	26.9/0.4	29.7/2.8	30.1/16.0	29.1/520.3	27.5/709.5	27.1/439.3	27.4/297.0	28.3/88.0	27.5/20.6	25.9/2.2
Trivandrum (64)	26.8/20.1	27.3/20.3	29.3/43.5	28.7/122.1	28.3/248.6	26.5/331.2	26.1/215.4	26.3/164.0	26.6/122.9	26.7/271.2	26.6/206.9	26.7/73.1
Tamil Nadu												
Madras (16)	24.5/23.8	25.9/6.8	27.9/15.1	30.5/24.7	32.7/51.7	32.5/52.6	30.7/83.5	30.1/124.3	29.7/118.0	28.1/267.0	25.9/308.7	24.6/139.1

of the country and about 11% of the population are those in which the difference between precipitation received and potential evapotranspiration falls between -33 and -66 centimeters and in which there is a 40% chance of a 25% or more deviation from normal precipitation (Chaturvedi 1976:13).

Severe droughts affecting broader areas of the country have often brought suffering and starvation to India. Such a severe drought was experienced in 1918, and by some reports the worst drought of the century, the result of a failure of the summer monsoons, is presently (December 1979) affecting a broad area from the deserts of Rajasthan in the northwest through the states of Madhya Pradesh, Uttar Pradesh, and Bihar to West Bengal on the Bay of Bengal ("Famine Stalks Parts of India..."). The drought is estimated to have caused a shortfall of from 11 to 12 million tons in the recently harvested summer plantings, and losses calculculated over the course of the entire year may be even greater. In Madhya Pradesh, Bihar, and Rajasthan state governments are demanding central government assistance to alleviate what have been called "unprecedented famine conditions" ("Famine Stalks Parts of India...").

DROUGHT PRONE AREAS OF INDIA
(Source: Chaturvedi 1976:26).



RIVER BASINS OF INDIA

(from Chaturvedi 1976; see also map above, number assigned to river basins on this list correspond to those on map)

	catch. area/ million hectares	precipitation mean (mm)	% coef. of var.	% mons. prec.	pan evap. (mm)	annual runoff m.h.m.*	annual ground-water recharge m.h.m*	% of total runoff	water potential (utilizable water) surface (m.h.m.)	ground (m.h.m)	% of total annual runoff used	% of total gross sown area	cropping intensity	% of pop in basin area	cultur-able land per capita ha.	utiliz-able water per ha. cultur-able land cms.	%Ir-rigated
1. Ganga	86.15	1160	26.4	86.2%	2120	55.01	15.62	26.6%	18.50	10.639	31.50	36.0	125	41.20	0.27	116.00	23.0
2. Brahmaputra	18.71	1220	15.0	65.3	1250	42.20	3.97	9.42%	0.88	1.802	1.50	2.1	118	3.28	6.69	375.00	21.3
3. Barak and others	7.82	2860	15.0	65.3	1500	17.50	1.60	9.15	0.37	0.660	0.57	0.6	124	0.99	0.21	171.50	13.0
4. West flowing rivers below Tapi	11.21	2790	18.0	84.3	2000	21.79	2.01	9.36	2.88	1.036	6.20	3.2	119	7.55	0.16	379.00	17.0
5. Tapi including Kim	6.69	780	30.0	86.9	3050	1.97	0.61	61.00	1.46	0.406	35.6	2.5	104	1.76	0.49	58.40	6.1
6. Narmada	9.88	1210	23.0	90.5	2450	4.01	1.24	31.00	2.96	0.710	10.5	3.0	106	1.97	0.56	89.00	4.5
7. Mahi include Dhadar	3.76	830	35.0	93.2	3000	1.13	0.35	29.70	0.87	0.253	43.2	1.2	112	1.09	0.43	68.20	8.2
8. Sabarmati	2.17	760	40.0	94.7	3400	0.37	0.27	73.00	0.27	0.065	89.2	0.9	111	0.87	0.33	41.40	16.0
9. Luni and other rivers of Saurashtra	32.19	380	50.0	93.1	3050	1.23	0.86	65.00	0.91	2.010	99.4	9.2	105	4.25	1.08	8.64	8.2
10. Indus	32.10	560	30.0	57.3	2000	7.69	2.90	37.70	4.93	1.118	70.8	5.7	113	4.58	0.39	110.00	51.0
11. East flowing rivers between Ganga and Mahanadi	8.10	1470	20.0	78.4	1750	4.35	1.63	37.50	4.09	0.651	14.7	2.4	114	2.55	0.37	117.20	16.8
12. Mahanadi	14.16	1460	21.0	82.2	2000	7.07	2.13	30.01	6.64	1.060	30.5	4.4	125	3.39	0.45	115.10	18.2
13. East flownig rivers between Mahanadi and Godavari	4.97	1110	22.0	66.7	2000	1.72	0.73	42.50	1.61	0.405	52.4	1.4	124	1.76	0.29	90.60	35.0
14. Godavari	31.28	1100	25.0	82.1	2350	11.54	3.31	28.60	8.53	1.916	33.0	9.7	107	6.62	0.54	78.40	13.0
15. Krishna	25.90	810	27.0	71.9	2900	5.78	2.65	45.80	5.78	1.760	100	10.0	105	7.14	0.53	41.60	12.9
16. Pennar and other rivers flowing east between Krishna and Cauver;	14.49	820	27.5	51.8	2300	2.53	1.82	71.70	2.79	0.998	100	4.0	116	5.18	0.31	46.30	37.6
17. Cauvery	8.79	990	24.5	50.3	2250	1.86	1.23	65.50	2.06	0.498	100	2.6	115	4.02	0.27	53.30	36.5
18. Rivers flowing east below Cauvery	3.51	910	27.0	33.0	2700	0.9	0.54	56.80	1.17	0.116	100	1.1	111	1.77	0.28	56.60	42.1
Total/Average	321.91	1180			2280	188.75	42.41	22.55	66.60	26.105		100.0	116	100.00	0.37	115.00	38.04

*m.h.m= millions of hectare meters; 1 h.m.=10,000 cubic meters; total runoff in millions

2.3 WATER RESOURCES

The water resources of India, taken as a whole, appear to be plentiful; average annual rainfall is slightly about the global mean of 99.1 cm. However, these resources are subject to extreme geographical and seasonal variations as well as to year to year variations. This holds not only for rainfall, as already considered above, but also for river flows and consequently for availability of water for irrigation and agricultural development, all of which ultimately depend on rainfall. Most of the rivers, with the exception of a few in the north, derive their flow primarily from rainfall.

2.3.1 Surface Waters

Data on surface water potential in India vary quite widely. The total annual surface water runoff, as estimated by the Central Water and Power Commission and as shown in the table below for the major river basins of India, is 1,881,200 MCM (million cubic meters), whereas earlier estimates placed it as low as ',443,200 MCM or somewhat higher at 1,672,300 MCM. As emphasized in one recent source, these varying figures indicate a poor data base and underline the necessity for a systematic collection of flow data from India's various river basins (Lahiri and Nagarajan 1977: 16!; see also Chaturvedi 1976: 11: "Assessing the surface run-off correctly is not possible...as long-term and reliable discharge measurement at the appropriate locations have not been carried out.").

2.3.1.1 Rivers (see map and chart: page 21a)

Basic data covering India's major river basins is presented in the table on page 22a.

India's rivers fall into four groups: the Himalayan Rivers, the Deccan Rivers, the coastal rivers, and the rivers of the inland drainage basin of Rajasthan. The Himalayan Rivers and the rivers of the Deccan or southern peninsula are India's major rivers.

Himalayan Rivers

The Himalayan rivers (1,2,3, and 10), because they are snow-fed, have continuous flows throughout the year; their flows may, however, fluctuate widely. These rivers frequently flood during the monsoon season, when discharge is particularly high.

The largest of the river basins arising in the Himalayas is the Ganges, which receives waters from a catchment area comprising about 25% of the country. The boundaries of the Ganges basin is defined by the Himalayas in the north and the Vindhya Range of mountains in the south. Its two main headwaters in the Himalayas are the Bhagirathi and the Alaknanda, both arising from glaciers in the Himalayas. Rivers joining the Ganga include the Ghaghra, the Gandak, the Kosi, and the Yamuna, the westernmost of the Gangean tributaries, which joins the Ganges at Allahabad. The Ganges system is also fed by rivers originating in the central

RIVER BASINS OF INDIA
(from Chaturvedi 1976:17; numbers of map correspond to those on table on page 22a)

highlands of the country. The largest of these is the Chambal, which arises in the Vindhya Range and joins the Yamuna south west of Kanpur in Uttar Pradesh.

On the Indo-Gangetic Plain, where the Ganges River system is subject to frequent flooding, the individual rivers have meandering courses and scars of old channels are plentiful. The main outlet of the Ganges into the Bay of Bengal, which as late as the 17th century was the Bhagirathi-Hoogly system that flows through Calcutta, has shifted eastward, and today is the Padma River system in what has since become Bangladesh.

The Brahmaputra, a westward flowing Himalayan river of northeastern India, originates in China and joins the Ganges system in Bangladesh. Although longer than the Ganges, the Brahmaputra is of less importance to India because most of its flow is outside of the country and because it flows through a narrow valley that is well-watered by heavy monsoon rainfall.

The Indus River and its five major tributaries (the Sutlej, Beas, Ravi, Chenab, and Jhelum) follow an westward and then sharply southern

course before emptying into the Arabian sea in Pakistan. Of the major tributaries only the Beas is wholly in India, although all other tributaries either originate in or flow across sections of India. This system has been the focus of disputes between India and Pakistan on the use of its waters for irrigation in the arid regions through which it flows.

Deccan rivers

The Deccan rivers (5,6,7,8, and 11 through 18) are generally rain-fed and fluctuate in volume. A large number of these rivers are not perennial.

The Godavari, the second largest river basin, covers an area of the Deccan peninsula equivalent to 10% of the country. The Krishna basin is the second largest on the peninsula, and the Mahanadi is the third largest. Other large basins are the Narmada in the uplands of the Deccan and the Cauvery in the far south. Agriculturally important, although smaller in size are the Tapi in the north and the Penner in the south.

coastal rivers

The coastal streams (4) , especially on the western coast are short and have only limited catchment areas. Most are non-perennial.

inland drainage

Those streams which belong to the inland drainage system of western Rajasthan (9) are infrequent and most are of an ephemeral character. They either drain towards the individual basins or into salt lakes like the Sambhar. Only the Luni drains into the Rann of Kutch.

2.3.1.1.1 flooding

All rivers basins in India are prone to flooding, including the ephermeral rivers of the desert area of the country, but the lower Ganges River Basin and the Brahamputra are the rivers in which flooding most frequently occurs. Floods are estimated to affect an average 6.7 million hectares of land annually (about 20% of the country), including about 2.6 million hectares under crops. Average annual damage from flooding has been estimated at about Rs. 1,260,000,000 over the period 1958-72; about 70% of this damage was to crops (Chaturvedi 1976:12-14).

Floods not only threaten the population living in flood-prone areas but also endanger both irrigation works and irrigated areas. The sudden floods in the Ganges in 1970, for example, led to silting up and subsequent closing of the Upper Ganga Canal during nine weeks of the important Kharif season in that year (Times of India 1976:65).

2.3.1.1.2 international rivers and arrangements

Two of the major river systems of the Indian subcontinent are shared by India and other nations: the Indus, whose headwaters are in India but whose major flow is in Pakistan, and the Ganges-Brahmaputra,

which meet in Bangladesh, where the major part of their delta is also found. Disputes between India and Pakistan on the use of the waters of the Indus River System were resolved in 1960 by a treaty which gave the western three rivers to Pakistan and the eastern three to India.

Another dispute has involved the the use of the Ganges River on the border of what has since become Bangladesh. Despite protest from its neighbor, India had constructed a dam at Farakka on the Ganges to divert water into the Bhagirathi-Hooghly river system, which cuts off from the main Ganges to flow south through Calcutta to the Bay of Bengal. There were several reasons for this action: the Bhagirathi-Hooghly, which serves the port of Calcutta, had been silting up, thus making navigation poor for most of the year; encroachment of sea water had been increasing the salinity of the river, thus endangering Calcutta's only source of water supply; and the dam would be important in flood control. Bangladesh argued, on the other hand, that reduced flows in the Padma River (the major eastward branch of the Ganges in Bangladesh) would severely hamper Bangladesh irrigation projects which rely on strong flows from the Ganges system (Dutt 1973:9). When the Farakka Barrage was finally commissioned in 1974, there was a one-year agreement between Bangladesh and India as to withdrawals from the Ganges, but when this agreement expired in 1975 India began withdrawing water unilaterally. Reduced water flows in Bangladesh led to increased intrusion of saline waters--up to 432 kilometers from the coast--into intensely cultivated areas of that country. It was not until late 1977 that an agreement between Bangladesh and India on withdrawals from the Ganges was finally reached. The 15-article agreement regulates withdrawals and makes special provisions for water-sharing during periods of unusually high or low flows. The agreement also limits the amount of water which India may withdraw between the dam at Farakka and the point where both banks of the river converge in Bangladesh (WER Dec. 5,1977: 5).

2.3.1.2 Lakes and reservoirs

India has very few natural lakes. The most famous of these are the lakes of Kashmir, where the Dal Lake, with its houseboats, and several alpine lakes continue to be tourist attractions; Wular Lake, to the northwest of Srinigar is the largest lake in Kashmir. Freshwater ponds occupy an estimated 1.6 million hectares of Indian territory (Sigurdson 1976:75). In several areas of the country, but particularly in Rajasthan are salt lakes and ponds, while in the flat alluvial areas of Assam, West Bengal and northern Bihar are numerous ponds, both large and small, called chaurs or hoars, which tend to shrink and dry up during the summer months. While it has been sugested that these could be drained and their areas brought under cultivation, it has also been suggested that they might be used for fish culture, with water being introduced from irrigation canals to keep up water level during the dry season (India. NCA. 1977: 195).

Major manmade reservoirs, created by the damming of rivers, are the Rihand Reservoir, the Govind Sagar, and the Tungabhadra Reservoir. It has been estimated by the National Commission on Agriculture that various reservoirs, designed primarily for irrigation and electricity generation, cover a surface area of nearly 3.0 million hectares. The Commission

view these areas as "new and extensive areas for inland fisheries development" (NCA 1976:vol.8:11).

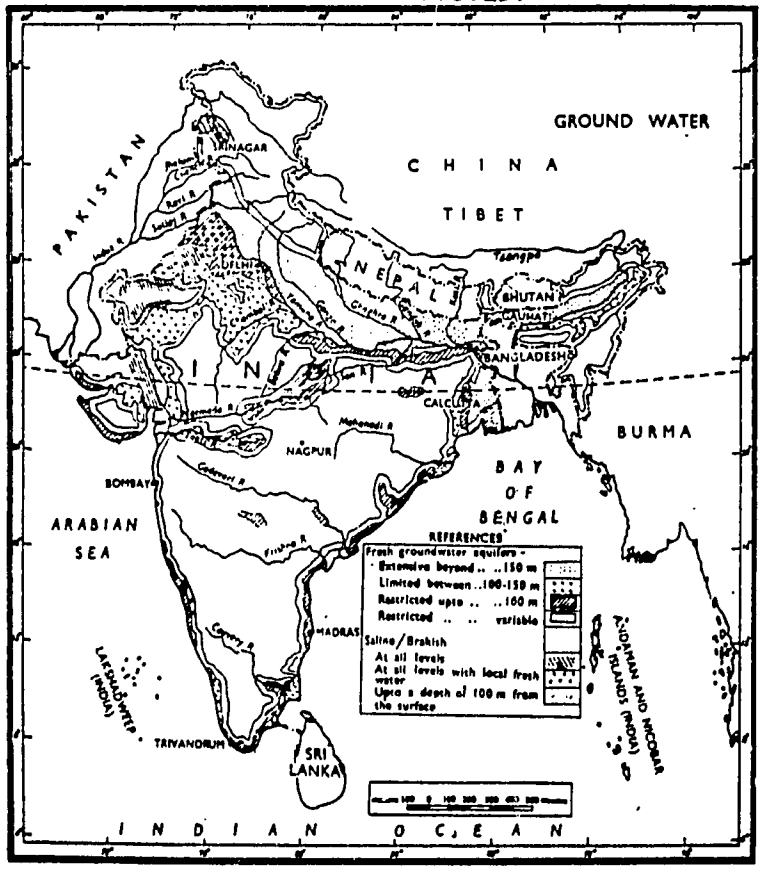
Pollution has become a problem in Dal Lake of Kashmir since the houseboats which have attracted tourists to this area since the era of British rule have begun installing flush toilets to replace the former dry pail systems (Zadoo 1978:29). Nitrites in the lake, the result of fertilizer used in nearby paddy fields have also lowered the quality of its waters (WER Nov. 21, 1977:7).

2.3.2 Groundwater

Estimates of groundwater supplies and potential are available but because little is done in the way of measurement of water balance, annual recharge, and groundwater levels, these assessments are judged to be incomplete (Chaturvedi 1976:12). Systematic evalution of groundwater resources has begun only recently, and detailed exploration for groundwater and systematic mapping are restricted to only a few areas, and although broad regional characteristics can be found they are reportedly also "not known with sufficient reliability" (Lahiri and Nagarajan 1977:169). The Central Ground Water Board, which, along with other agencies such as the Geological Survey of India and various state departments, is reponsible for groundwater exploration, has concentrated its efforts chiefly on the alluvial and semi-consolidated sediments that cover some 30% of the country and has not worked in the extensive hard rock areas (Lahiri and Nagarajan 1977:169).

Groundwater occurrence is indicated by the map below, and calclulations as to groundwater recharge per river basin are indicated on the table on page 22a.

GROUNDWATER RESOURCES
(from Chaturvedi 1976:25)



Figures presented for groundwater recharge in the table on page 21a are from the Irrigation Commission report of 1973; these are not in complete agreement with other assessments of the situation. According to assessments made in 1969, rainfall contributes 36.9 m.h.m* and canal seepage another 5.4 m.h.m. recharge to groundwater each year, about 15.6 of which is lost to evapo-transpiration and sub-surface runoff (Lahiri and Nagarajan 1977:169); if these calculations are correct, the net annual groundwater recharge is 26.7 m.h.m., of which only 20.4 m.h.m. per year would be available for long term development. A more recent study (1975), on the other hand, is more promising in its calculation that the quantity of utilizable groundwater may be about 35 m.h.m. (Lahiri and Nagarajan 1977:170.

Problems with groundwater supplies arise from uncontrolled use of the resource, resulting in several areas in overpumping and permanent lowering of the groundwater table. Frequently overly deep or large wells are bored or tubewells or open wells are spaced too closely together as farmers compete for groundwater supplies. Salinity of groundwaters, a natural problem in many areas, has because particularly severe in some coastal areas, where overextraction of freshwater has led to irreversible intrusion of saline water. Areas listed as affected by overpumping in the National Commission on Agriculture's 1976 report were: the coastal districts of Andrha Pradesh; Bihar Sharif areas in Bihar; the Anjar-Khedoi and Viri areas of eastern Kutch and Mehsama district in Gujarat; Ludhiana district in Punjab; Jhunjhunu district and Kharkar basin in Rajasthan; Coimbatore, Salem, Madurai, and North Arcot districts in Tamil Nadu; and possibly Karnal district in Haryana (India. NCA 1976: vol. v:22-23).

2.3.3 Water utilization (surface and groundwater)

Utilizable water resources vary throughout the country, as indicated by the table on page 22a, which indicates utilizable water resources for India's major water basins. Estimates of the total utilizable surface resources for the country are about 90 m.h.m per year: about 66 m.h.m. from surface and from 20.4 to 26.1 m.h.m. for groundwater (Chaturvedi 1976: Table 2.1; and Lahiri and Nagarajan 1977:178).

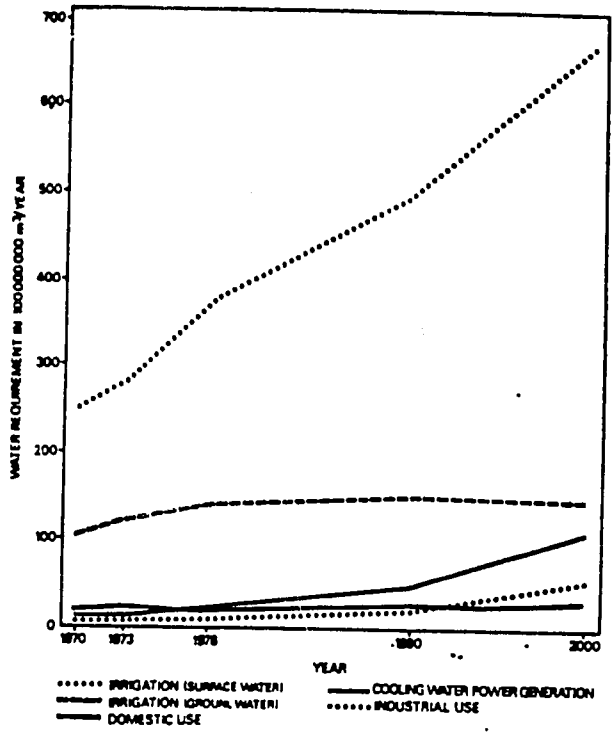
Storage is, however, a major problem and an important factor limiting full utilization of river flows, which peak during rainy seasons and are severely reduced or even completely cut off during the dry season. Large storage reservoirs can be built only in the hills, but there is a shortage of suitable sites for the necessary dams and extensive areas such as the Gangetic Plain are completely unsuitable for storage reservoirs. As a consequence there is, on some major rivers, insufficient storage capacity for completely harnessing the river flows. Of the major rivers, the Ganges Basin with an average annual flow of over 55,000 million cubic meters (MCM) has the maximum potential (variously estimated at from 18,500 to 25,000 MCM), followed by the Godavari and the Krishna. The Bramaputra, on the other hand, with an annual flow estimated at 42,000 MCM has a potential which is only a small percentage of this flow; this is because the valley through which it flows does not have enough land to use its huge flow. Likewise, the westward flowing rivers south of the Tapi (west coast) because of the closeness to the sea and the small land

*m.h.m.= million hectare meters; one hectare meter=10,000 cubic meters

areas through which they flow do not offer much possibility for utilizing their waters (India. NCA 1976:8-9).

With regard to utilization of available water, irrigation is, has been, and will continue to be the chief water use in India, followed by domestic water, cooling water used in power generation, and industrial water uses. Each of these uses, as well as others, is considered below.

WATER REQUIREMENTS 1970-2000 (Sigurdson 1977:72).



2.3.3.1 Navigation

India has 14,300 kilometers of inland waterways, of which 2,575 kilometers are navigable by river steamers, 5,700 by large boats, and the remainder by shallow-bottomed boats. Some emphais has been placed recently on the use of interior shipping, which had dropped in importance because of heavy use of railroads and air transport, for the transport of goods as well as for regional transportation (Germany, Fed. Rep. of 1977:11).

It is expected that long-range water plans, which involve massive diversion of water for irrigation and water supply will seriously disrupt such inland navigation as presently exists (Chaturvedi 1976:47).

2.3.3.2 Irrigation

As indicated by the above figure, irrigation is now and is expected to be the chief water use in India in the future. It has been estimated that the total surface water irrigation potential in India is 72 million hectares: 57 million hectares from major and medium schemes, including

the total surface water irrigation potential in India is 72 million hectares: 57 million hectares from major and medium schemes, including

20 million hectares from presently disputed rivers, and 15 million hectares from minor schemes. If all these surface waters were utilized, canal irrigation could be extended to 41% of the net cultivable area and 22% of the total geographical areas of the country. Groundwater irrigation now accounts for some 40% of total irrigated area in the country, up from about 28% in 1950/51.

The map on page 29a indicates location of irrigation schemes of all types in India. The table below indicates irrigation potential and utilization since 1950/51.

IRRIGATION: ACTUAL AND POTENTIAL (from World Bank 1979:182)
(in millions of hectares)

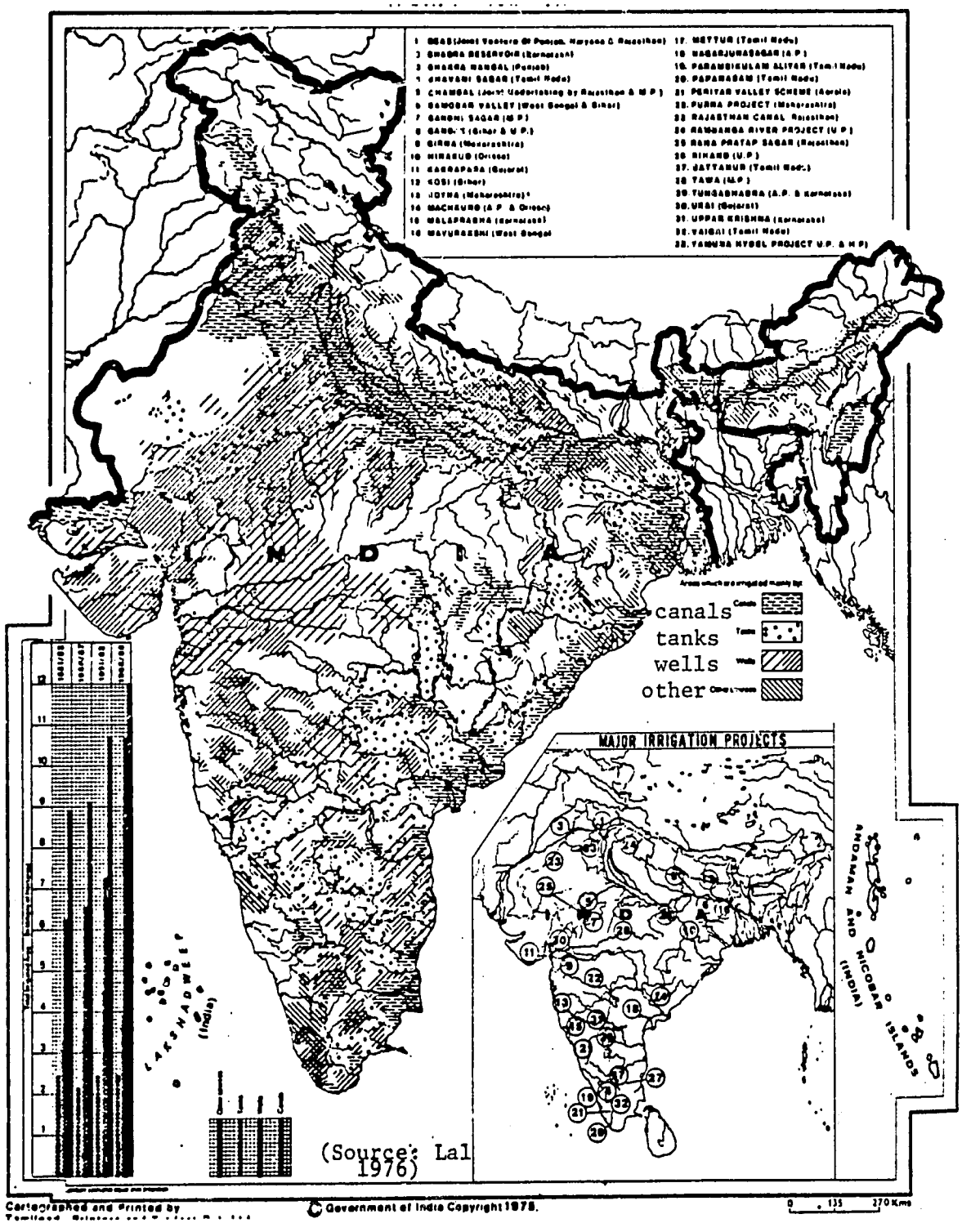
	Surface Irrigation					
	Major and Medium		Minor	Total	Ground	Total Irrigated
	Potential	Utilization	Surface	Utilized	Water	Area(Utilized)
Ultimate Potential	57	57	15	72	40*	112
Position at the end of:						
1950/51	9.7	9.7	6.4	16.1	6.5	22.6
1st Plan	12.2	11.0	6.4	17.4	7.6	25.0
2nd Plan	14.3	13.1	6.5	19.6	8.3	27.9
3rd Plan	15.6	15.2	6.5	21.7	10.1	31.8
1968/69	18.1	16.8	6.5	23.3	12.6	35.9
4th Plan	20.7	18.7	7.0	25.7	16.5	42.2
1974/75	21.5	19.4	7.1	26.5	17.2	43.7
1975/76	22.5	20.1	7.2	27.3	18.0	45.3
1976/77	23.5	20.7	7.3	28.0	18.9	46.9
1977/78	25.0	22.2	7.5	29.7	19.8	49.5
1978/79(target)	26.4	23.3	7.7	31.0	21.1	52.1
1982/83(target)	33.0	28.2	9.5	37.7	26.8	64.5

*Some estimates place the ultimate groundwater potential as high as 42.5 million hectares (Lahiri and Narayan 1977:174)

2.3.3.2.1 surface water irrigation

Surface water irrigation schemes are classified as major, medium, and minor. Major irrigation schemes are those which have involved the irrigation of large areas of water from reservoirs produced by the damming of streams. Water is conveyed to field via canals. As of 1976-77 there had been 445 major and medium schemes completed since the beginning of the first five-year plan period in 1951. During the Fifth Plan period (1974-79), another 46 major and 246 medium schemes were initiated. Major schemes frequently involve the impoundment of water not only for irrigation but also for hydropower production. Such multipurpose projects include the Bhakra-Nangel in eastern Punjab on the Sutlej River providing irrigation for 1.41 million hectares in Punjab, Rajasthan, and Haryana, the Hirakud Dam on the Mahanadi River in Orissa (242,820 hectares), the Damodar Valley Project in West Bengal and Bihar (600,000 hectares), and the the Nagarjunasagar Dam on the Krishna River in Andhra Pradesh, (809,400 hectares) (World Bank 1979:43; Kurian 1978:644).

TYPES OF IRRIGATION IN INDIA



for for irrigation but also for domestic use and serving for fish culture as well. The relative importance of minor irrigation sources has declined considerably since the expansion of irrigation capabilities in the early 1950's; in 1950/51 minor surface irrigation supplied water for 28% of the irrigated hectarage; by 1977/78 this share had dropped to just over 15%.

2.3.3.2.2 Groundwater irrigation

Large scale pumping of groundwater in India did not begin until 1936, at which time a program involving 1,500 tubewells was implemented in the alluvium of the Ganga in Uttar Pradesh. Rapid growth of groundwater irrigation had to wait until the 1960's, spurred on primarily by serious droughts in different parts of the country between 1965 and 1967. The advantages of groundwater for a wide range of purposes, the reliability of supplies, and the low capital investment involved in tubewell and dug well exploitation of groundwater also helped to encourage the increase use of this resource. The gross area irrigated by wells increased from 6,468,000 hectares in 1950 to 14,580,000 hectares in 1970 (Lahiri and Nagarajan 1977:170-171).

By 1973-74 a total area of about 16 million hectares was irrigated by groundwater, and the Fifth Five Year Plan has called for adding another 4.5 million hectares. Ultimate potential is estimated at from 40 to 42.5 million hectares, a potential which, by some projections, may be realized before the end of this century (Lahiri and Nagarajan 1977:1973). In some states, such as Gujarat, Haryana, Punjab, and Rajasthan--the states of the arid regions of the country, where groundwater is of greatest importance and is most heavily employed--full groundwater development is expected to be attained much sooner, perhaps by 1980 (Lahiri and Nagarajan 1977:174).

Different types of wells are used for groundwater exploitation. Open dug wells exploited manually or through animal power are the traditional method of groundwater exploitation; in many instances, funds have been made available for adding pump sets to these wells. Recent years have seen an increase in the number of shallow tubewells owned by private individuals, while an increase in the number of public deep tubewells has also been experienced. As of the mid-1970's the breakdown of groundwater irrigated area by type of well was: dug well--70%; private shallow tubewell--25%; public deep tubewell--5%; the picture in the future expected to be as follows: dug well--50%; private shallow tube-well--35%; public deep tubewell--15% (Lahiri and Nagarajan 1977:165-176). Lahiri and Nagarajan emphasize, however, that the success of groundwater development is dependent on the level of financial assistance advanced to farmers, who, because of the small size of their holdings and the meager level of their earnings , can invest in wells only if such assistance is provided. They suggest that for these millions of poorer farmers with land holdings of less than 3 hectares, joint ownership of wells with subsidies would be a possibility or, perhaps, sale of water to farmers by state enterprises that would undertake the digging of the wells (Lahiri and Nagarajan 1977:177).

2.3.3.2.3 problems with irrigation water

inefficient use of water

Water tagged for irrigation is often not properly used or not used at all. During the First Five Year Plan, for example, a potential to irrigate 2.6 million hectares of land was created, but utilization was achieved for only 1.3 million hectares. Often farmers in newly irrigated areas are not sufficiently informed of how the new water can best be used. Furthermore, irrigation water supplied from canal systems is brought only to the edge of fields; many farmers lack the financial resources or technical capability to construct the channels necessary to bring this water onto their fields (Lahiri and Nagarajan 1977:181-182).

sedimentation of reservoirs

Sediment carried by rivers, often the product of erosion resulting from deforestation and lack of soil conservation practices in watershed areas, accumulates in storage reservoirs, cutting back their holding capacity, and shortening the period of years of their usefulness. Although small irrigation reservoirs (tanks) may be cleaned up, large dams present a much larger problem. As indicated by the table below the number of years to fill up dead storage capacity (the area allowed when the dam is constructed for the accumulation of sediment) for several large dams has been seriouly underrated; some of these dams are, therefore, already functioning at less than full capacity because sediment is occupying the anticipated live storage area.

Sedimentation rates of some reservoirs
(from Chaturvedi 1976:56)

Reservoir & date opened		Originally estimated years to fill dead storage	Revised estimate of years to fill dead storage* Chat*	L&N*	Years to fill 50% live storage	Balance life:years to fill live storage
Bhakra	1959	88	47		147	105
Hirakud	1956	100	35		62	41
Maithon	1957	246	24	50	60	36
Panchet	1959	75	12	33	21	8
Ramnganga	1973	185	47		223	177
Thungbhadra	1959	36	3	22	40	37
Nizamsagar	1931	178	5		35	15
Ukai				53		
Mayurakshi				25		

*Chat=Chaturvedi 1976:56; L&N=Lahiri and Nagarajan 1977:185).

waterlogging and salininty

Waterlogging and salinity already affect large segments of the agricultural land of India (about 3.86 million hectares). Although the rise in the groundwater table that causes waterlogging may arise from natural conditions, it is also frequently a result of over-irrigation, seepage from canals, and lack of sub-surface draining. Irrigation projects have for the most part given but scant attention to the necessity of integrating drainage capabilities into irrigation systems, and the farmers upon whose shoulder the responsibility for drainage measures falls usually lack both the training and the financial resources necessary to construct tubewells for drainage purposes. With the intensification of irrigation, waterlogging and salininty problems are expected to increase to "acute dimensions." (Lahiri and Nagarajan 1977: 183-184).

2.3.3.3 Industrial water supply

In 1968-69, total industrial withdrawals were estimated at 7.30 billion liters per day (.0073 billion cubic meters), of which 8.20% was consumed within the enterprises, while the balance was returned to surface flows, primarily with varying degrees of pollution. Demands for industrial water are expected to grow to about 151 billion liters (0.151 billion cubic meters) per day by the year 2000. These estimates come to a water demand of 55 billion cubic meters per year, roughly in agreement with the projected water utilization chart above (Chaturvedi 1976:36)

Water use in industry varies, both withdrawl and consumptive, vary widely from industry to industry. Less than 10% of the industrial plants, including power demands, account for 80% of the total industrial water intake. Excluding power uses, the major users are paper industries, the cotton and jute industries, the sugar industry, fertilizer and steel plants, and refineries. Within, even in the year 2000 is expected to be only about 6% of the potential (Chaturvedi 1976:35-37).

Estimated Industrial Water Use in Billions of Liters Per day
(Chaturvedi 1976:36)

Industries	1968-69	1973-74	1978-79	1988-89	2000-01
Food products	9.12	0.16	0.22	0.46	1.37
Textiles	0.30	0.38	0.52	1.21	3.43
Paper	0.19	0.32	0.51	1.18	3.48
Mines&Metals	5.25	8.85	13.42	32.50	106.00
Glass,Cement	0.15	0.24	0.37	0.85	2.85
Chemicals	0.41	0.91	1.61	4.30	14.20
Petroleum	0.45	0.76	1.13	3.54	10.20
Machinery	0.42	0.67	1.08	2.88	9.80
Miscellaneous	0.01	0.02	0.03	0.11	0.33
Total	7.30	12.31	18.89	47.03	151.66

2.3.3.4 Domestic water supply

Withdrawals for domestic and municipal uses were estimated at 24.98 billion liters per day (9.1 billion cubic meters per year) in 1968-69. About 70% of this was for rural and about 30% for urban uses. In 1968-69, only about 5% of this villages of India had access to protected water supplies. 65% of the villages obtained their water from wells; 15 percent from rivers, lakes, and springs; 8% from tubewells; and the remainder from tanks, ponds, and other sources (Chaturvedi 1976:34-35). Water quality in most areas is poor (Chaturvedi 1976:35).

2.3.3.5 Hydroelectric power

India hydropower potential is limited considerably by the circumstance that much of the hydropower potential of her watersheds lies outside of the country in Nepal. According to estimates of the Central Water and Power Commission, the total hydroelectric power in India would be 42 million kilowatts at 60%. Only about 8% of this potential has, however, been realized. Estimates made by the power committee give a somewhat brighter picture of potential installed hydropower of betweeen 80 and 100 million kilowatts. Unfortunately, the isolation of a good bit of India's hydropower potential in the northeastern state of Assam is a strong constraint on hydropower development (Sigurdson 1976: 74-75).

Generation of electricity by region (In GWH)
(World Bank 1979:195)

	1971/72	1977/78 (provisional)
1. Thermal		
Northern	5,915	11,170
Western	10,557	18,429
Southern	4,880	7,692
Eastern	10,112	13,107
North-Eastern	248	616
All India	31,712	51,014
2. Hydro		
Northern	8,243	11,349
Western	5,518	8,650
Southern	12,286	14,846
Eastern	1,784	2,910
North-Eastern	193	245
All India	28,024	38,000
3. Nuclear		
Northern		198
Western	1,189	2,074
All India	1,190	2,272
4. Utilities (All India: 1-3)	60,926	91,286
5. Self generation in industry and railways	5,459	7,400
6. TOTAL (All India	66,385	98,686

2.3.3.6 Fisheries (see 2.3.7)

2.3.4 Degradation of water resources

Pollution of surface waters in India is most prevalent in and around urban areas, the most predominant source being city sewage and industrial wastes discharging into rivers. The encroachment of sea waters into coastal estuaries and silt and sediment carried into rivers by runoff also affect water quality. Other sources of pollution are thermal pollution of water used for cooling purposes, wastes from ships and boats, and chemicals in the rainwater from mines, all of which are still felt to be of but minor importance (Chaturvedi 1976:62).

Pollution of water resources also extends to groundwaters, although the problem is not as severe as for surface waters. The well waters which supply drinking water to the majority of the population are frequently contaminated and pose a health hazard. Samples from some of the wells that supply drinking water have indicated higher than permissible concentrations of flourides, iron, nitrates, and dissolved salts (Chaturvedi 1976:60-61).

domestic wastes

As of 1971, the last date for which extensive information could be found, only 176 of the 2,431 towns in India had sewers, while sewers were unknown in villages. Even in the large cities of Bombay and Calcutta only part of the city had sewers and some kind of primary sewage treatment. Only 10% of the cities had secondary treatment, while the balance of wastes went directly to the sea. In the top twenty largest cities only seven had modern sewage treatment plants, and these did not cover the extensive slum areas. Sewage was generally discharged untreated (Chaturvedi 1976: 61). As India's population continues to increase, the ability of the environment to absorb increased quantities of domestic wastes will become severely strained; unless appropriate measures are taken soon, water pollution may become one of India's major environmental problems (Parikh 1977:197).

pesticides

While the extent of their effect has not yet been quantified, fertilizers and pesticides used in the agricultural sector are thought to pose a problem for both groundwater and surface water quality (Chaturvedi 1976:621).

In Punjab State, however, it has been found that underground water--the main source of drinking water for the villages of Punjab--has become seriously polluted by excessive amounts of nitrogen fertilizers. It has been estimated that as much as 60% of the fertilizer used in this state may be soaking into soils and settling in underground water (WER May 9, 1977:1). Fertilizers are also said to be the source of nitrite pollute of the Dal Lak in Jammu and Kashmir State (WER Nov. 21, 1977:7).

sediment

Sediments carried by rivers not only lead to siltation of important

reservoirs but also have adverse effects on fish and wildlife. These sediments originate from crop lands, unprotected forest soils, over-grazed pastures, and land disturbances for road building and urbanizatic (Chaturvedi 1976:61).

Industrial wastes

Pollution from industrial sources is expected to increase as the use of water for industrial purposes (projected to increase some 20-fold by the year 2000) increases. Although the quantity of waste waters returned will still be low as compared with industrialized nations, the comparati higher temperatures of Indian waters and the low levels of summer flows combined with generally increased withdrawals can be expected to lead to serious pollution problems (Chaturvedi 1976: 36-37).

One source of industrial effluents are the sugar mills and the smaller Khandsari sugar units, all of which are located in rural areas, mostly in Uttar Pradesh, Bihar, Maharashtra, Andrha Pradesh, and Punjab. These sugar plants use large quantities of water in their operations and discharge two types of effluents: cooler and condenser waters, and wastes from spillage, scum leaks, the washing of equipment and production rooms, effluents from the boiler house, and wastes containing lubricants and oil from machinery. Various effects are experienced from these wastes: acidic or alkaline wastes from cleaning operations and heat exchanges can be harmful to aquatic life because of their high concentrations of salts; suspended solids may cause blockage in in drains and ditches; and organic pollutants (sugar and carbohydrates) leading to the rapid exhaustion of oxygen supplies in streams, causing foul odors and making the stream unsuitable for fish and other aquatic life. Various investigations have revealed that hazardous effects on fish and wildlife occur predominantly during the low water season but may also occur year round, with the exception of rainy periods, in small rivers. It has also been ascertained that fish kills occur every year a few days after that beginning of the crushing season in the month of May, June, and July, when the factory machines are cleaned and washed (Bandhu and Bhardwaj 1979:183-196).

Fertilizer and petrochemical plants have been identified as among the worst polluters of water. An extreme case of pollution from such a source has occurred in Goa, where a large fertilizer plant released effluents containing ammonia and arsenic, leading initially to the to the deaths of thousands of fish and later, when the pollution penetrated into paddy fields and coconut and mango groves, to skin ailments among young children. Despite attempts to avert pollution by the construction of a pipeline to carry the contaminated waters to the sea, contamination continues, although at a lesser rate, because the pipe leaks. Such dumping from chemical plants also affects other areas. A survey of fish in Thane Creek near Bombay revealed high levels of mercury contamination (WER June 18, 1979:10).

In Kerala State, where effluents released by a textile factory had resulted in fish kills and rendered water undrinkable, the state government stepped in to shut down the offending plant (WER: July 2, 1979:6).

In the State of Jammu and Kashmir Dal Lake has received pollution from

many sources. Heavy use of fertilizers in orchards and paddy fields surrounding the lake have resulted in pollution by nitrites, while domestic wastes from tourist facilities, including houseboats, and lakeshore houses, have not only polluted the lake but have also served as fertilizer for the waterweeds which, along with heavy siltation, have brought about a shrinkage in the size of the lake. The state government has now stepped in to save the lake with a program involving, among other things, reforestation of the hillsides surrounding the lake and the construction of a settling basin to prevent entry of sediments (WER November 21, 1977:7; May 21, 1979:5).

2.3.4.1 Water pollution control

See 4.1.3.1, which describes the activities of the Central Board for the Prevention and Control of Water Pollution.

2.4 SOILS

2.4.1 Soil types

Indian soils have been classified into twenty-five broad groups based on variations in the parent materials, a wide range of climatic conditions, and varieties of vegetation. This classification is indicated on the map on page 37a and by the table on page 37b, which lists the soils, the percentages of Indian territory in which they occur, and their equivalents according to the recent USDA classification.

Four major soils groups occupy nearly 65% of the total geographical area of India: red soils, black soils, alluvial soils, and laterite soils.

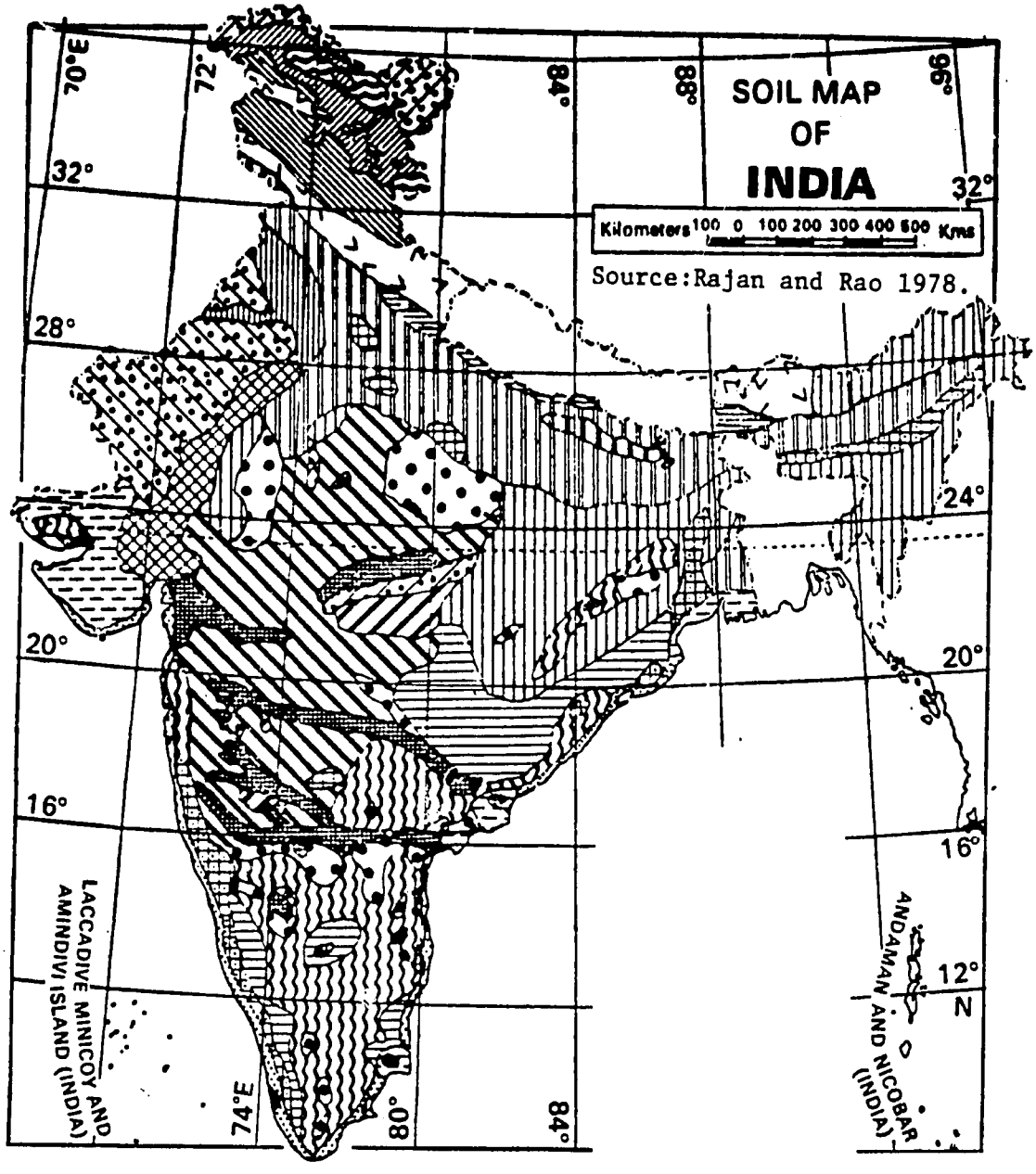
red soils (groups 1&2)

Occurring in both high and low rainfall areas, red soils are shallow to deep (20 to more than 100 cm), with a surface texture ranging from light to medium and from sandy to loamy. Red loamy soils have a pH which is neutral or slightly on the acid side, with a pH as high as 8.0 in those soils containing lime. Red sandy soils have a pH generally on the acid side (from 4.5 to 6.5), but some may also be alkaline. Available moisture ranges from 5 to 10% or 7 to 15 centimeters per 100 centimeters of soil column, which is low to medium. Because evapotranspiration needs tend to be about 5 mm per day, the stored moisture of a saturated red soil profile will sustain a standing crop from only two to four weeks. These soils, therefore, are mostly used for crops depending on the monsoon rains (kharif). With regard to soil nutrients, these soils are generally low in nitrogen, low to medium in phosphorus, and medium to high in potassium. The soils present no drainage problems when irrigated. (Bandhu and Bhardwaj 1979).

black soils (groups 5,6,7,8)

Occurring in regions of low to medium rainfall (500 to 1220 mm per year), the majority of the black soils are medium deep (30 to 100 centimeters), with some deep black soils reaching depths as great as 200 centimeters. The texture of the soils is generally heavy, clay content ranging from 40 to 60%; they are plastic and sticky when wet and very hard when dry. Available moisture capacity varies from about 12 to 20% depending on the texture or from 15 to 28 centimeters per 100 centimers of soil column. Stored moisture is low in shallow black soils, which are, accordingly used only for kharif crops. In the deeper soils, however, stored moisture may be as high as 28 centimeters, enough to support a standing crop for two to three months; these are therefore use for rabi (Spring) crops. The nutrient status of black soils is generally low to very low. The soils have low infiltration and permeability rates, and drainage and erosion are major problems. Provisions must, therefore, be made for drainage and soil conservation when these soils are developed for irrigated agriculture.

*Soil classification is from Rajan and Rao 1978 as also found in Bandhu and Barwaj 1979 and das Gupta 1976. Distributions of soil groups in das Gupta 1976 vary to some extent from those indicated here.



1. red loamy
2. red sandy
3. laterite
4. red and yellow
5. shallow black
6. medium black
7. deep black
8. mixed red and black
9. coastal alluvium
10. coastal sands
11. deltaic alluvium
12. alluvial:
    - recent
    - old
13. alluvial (highly calcareous)
14. calcareous sierozemic
15. grey brown
16. desert/regosolic
17. desert/lithosolic
18. terai
19. brown hill (over sandstones and shales)
20. sub-montane (podsolic)
21. mountain meadow
22. saline and alkaline
23. peaty and saline peaty
24. skeletal

SOILS OF INDIA: EXTENT AND DISTRIBUTION : Rajan and Rao 1978
(total area here accounted for 3,006,245; about 91% of total 3,287,000 square kilometers)
(numbers in left hand columns correspond to those on map, page 37a)

sl no	name	km2	% of total	distribution by state	equivalent in U.S.D.A. classification
1	red loamy soils	213,271	5.6%	Andrha Pradesh, Tamil Nadu, Karnataka, Kerala, Madhya Pradesh, Orissa	Paleustalfs Rhodustalfs Haplustalfs
2	red sandy soils	330,590	10.1%	Tamil Nadu, Karnataka, Andhra Pradesh	Haplustalfs Rhodustalfs
3	laterite soils	130,066	4.0%	Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Orissa, Maharashtra, Goa, Assam	Plinthaquults Plinthustults Plinthudults Oxisols
4	red and yellow soils	403,651	12.3%	Madhya Pradesh, Orissa	Haplustults, Ochraquults, Rhodustults
5	shallow black soils	31,352	0.95%	Maharashtra	Ustorthents, Ustopepts
6	medium black soils	430,383	13.1%	Maharashtra, Madhya Pradesh, Gujarat	Pellusterts, Chromusterts
7	deep black soils	112,060	3.4%	Maharashtra, Andrha Pradesh, Karnataka, Madhya Pradesh, Gujarat	Pellusterts, Chromusterts Pelluderts
8	mixed red and black soils	162,255	4.9%	Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh	Association of Alfisols and Vertisols
9	coastal alluvium soils	54,403	1.7%	Tamil Nadu, Kerala, Andrha Pradesh, Maharashtra, Gujarat	Haplaquents
10	coastal sands	4,534	0.14%	Orissa	Ustipsamments
11	deltaic alluvium soils	87,045	2.6%	Tamil Nadu, Andrha Pradesh, Orissa, West Bengal	Quartzipsamments Tropaqualfs
12	alluvial soils Khadar (recent) Bhangar (old)	356,720	10.8%	Uttar Pradesh, Punjab, Bihar, West Bengal, Assam North-Eastern	Haplaquents, Ustifluvents, Udifluvents Haplustalfs, Ustochrepts
13	alluvial soils (highly calcareous)	13,611	0.41%	Uttar Pradesh, Bihar	Calciorthents
14	calcareous sierozemic soils	45,080	1.4%	Punjab	Calciorthids
15	grey brown soils	101,572	3.1%	Gujarat, Rajasthan	Calciorthids
16	desert soil Regosolic	154,423	4.6%	Rajasthan	Calciorthids, Psamments
17	desert soils Lithosolic	n.a.	n.a.		Lithic Entisols
18	Teral soils	28,919	0.87%	Uttar Pradesh, Bhutan, Sikkim	Haplaquolls
19	Brown hill soils (over sandstones and shales)	81,242	2.5%	Uttar Pradesh, Bhutan, Sikkim, Himachal Pradesh	Palehumults
20	sub-montane soils (Podzolic)	76,695	2.3%	Uttar Pradesh, Jammu and Kashmir	Hapludalfs
21	mountain meadow soils	59,790	1.8%	Kashmir, including Ladakh	Cryoborolls, Cryochrepts
22	saline and alkaline soils	17,377	0.53%	Uttar Pradesh, Punjab, Maharashtra, Karnataka, Tamil Nadu	Salorthids, Salargids, Natrargids, some salic or natric Entisols& Vertisols
23	peaty and saline peaty soils	2,720	0.08%	Kerala	Histosols
24	skeletal soils	79,151	2.4%	Madhya Pradesh	Lithic Entisols
25	glaciers and eternal snow	29,335	0.89%	Uttar Pradesh, Kashmir	

alluvial soils

With the exception of those occurring in the Brahmaputra Valley, most of the alluvial soils in the Indo-Gangetic basin occur in areas of with rainfall of from 500 to 1000 mm per year. Deep and variable in texture, with soil moisture, correlated with silt content, ranging from 6 to about 20% or about 8 to 28 centimeters available per 100 centimeters of saturated soil column. For those alluvial soils with coarse to fine loamy textures, available moisture is about 12 to 15 centimeters per 100 centimeters of soil column, which make them capable of supporting a standing crop for four to six weeks or even longer in winter, when evapotranspiration needs are lower. These soils are used for both kharif and rabi crops. The soils are mostly base but low in available nutrients. Much of the region of alluvial soils is under irrigation (Bandhu and Bhardwaj 1979: 76-77).

Problems with these soils, especially in places where the water table is high, are salinity and alkalinity.

laterite soils

Occurring chiefly in areas of rolling to undulating topography and on steep slopes in regions of higher rainfall (1200-3000 millimeters), the laterite soils are deep, well-drained and medium to fine in texture, with favorable available moisture capacity (8 to 16 centimeters per 100 centimeters of soil column. Rainfall occurs from May to November in laterite soil areas, which suffer from a moisture deficit during the remainder of the year (Bandhu and Bhardwaj 1979: 77).

other soils

The desert soils (16 and 17), occurring chiefly in Rajasthan are mostly coarse textured with a weak horizon development. Some contain a high percentage of soluble salts (predominantly sodium) in the lower horizons. The pH is high and hard pan of CaCo3 (calcium carbonate) occurs at shallow depths. The soils are poor in organic matter and frequently subjected to drought. Kharif crops are grown when rainfall is sufficient, although some irrigated Rabi crops are also grown (Bandhu and Bhardwaj 1979: 78).

Mountain soils (19,20,21) are found mostly in the Himalayan region. Brown hill soils, from loam to silt in texture and occuring in the foot hills of the Siwalik ranges, are moderately rich in organic matter, with a pH that is neutral to slightly acidic. Sub-montane soils, mostly loam to sandy loam, are acidic and non-calcareous. Their surface layers, extending to 10 to 15 centimeters, consist of undecomposed organic matter. The mountain meadow soils are characterized by a sandy loam texture, shallow depth, and weakly developed horizons. Neutral to alkaline in pH, these soils support grasses (Bandhu and Bhardway 1979:28).

2.4.2 Soil utilization

The soils of India support a wide range of vegetation. Natural vegetation range from the moist tropical forests of the West Coast of the southern

peninsula and of the more northern states of Uttar Pradesh, Bihar, Orissa, Madhya Pradesh, West Bengal, and Assam to the desert vegetation of the Rajasthan desert.

However, in a crowded country such as India with a long history of human activity, much of the natural climax vegetation has long been destroyed. Over 50% of the land is now either cultivated or in fallow at any given time. The chief crops in terms of hectares planted are, in descending order of importance: rice, wheat, sorghum, oil seeds, a variety of beans and peas, millet, cotton, and sugar cane. Grasslands, produced chiefly by the removal of forest cover and tending to revert to forest if left to themselves, occur throughout the country.

A recent evaluation of the soil situation judges the soils to have "great potentiality particularly in the context of the present day advancement of agricultural technology provided they are used properly with respect to their behavior and physico-chemical characteristics" (Bandhu and Bhardwaj 1979:84-85). Mentioned specifically are large areas of the North East Region, swampy lands, Diara land and open lands within the forest with good soils, and coastal sandy soils, all of which are felt to have great potential if managed properly (Bandhu and Bhardwaj 1979: 85).

Soil is also used for making pottery and earthen ware (Bandhu and Bhardwaj 1979:73).

2.4.3 Soil problems

Soil problems as occurring with different types of Indian soils, affect some 20% of Indian soils. These are: erosion; salinity and alkalinity; acidity; waterlogging; drought resulting in moisture stress; and cracking resulting from shrinking and swelling.

2.4.3.1 erosion

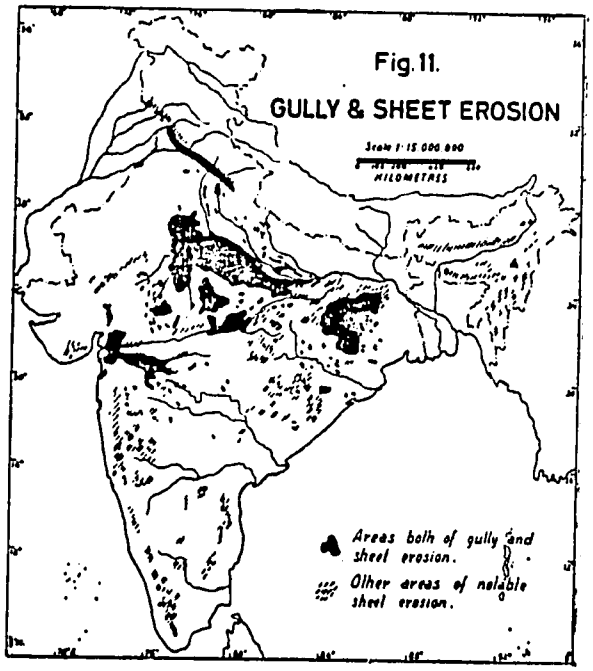
Erosion is a problem throughout much of India. Different areas experience different types of erosion: the worst type, gully erosion, associated particularly with heavy rainfall, swollen rivers, and floods, occurs with different degrees of severity, at its most extreme producing deep ravines. This type of erosion occurs most frequently during the heavy rains of the southwest monsoon and is particularly severe in the plains and river valleys of the Jamuna River and its tributaries. It is relatively unimportant in the Himalayas and in most of Peninsular India. The worst region of gully erosion is along the Lower Chambal Valley in Uttar Pradesh; other problem areas are along the Jamuna River in Uttar Pradesh, and the Sabarmati River and Mahi Rivers in Gujarat (Ahman 1973:43-50). The map on page 40 indicates areas where gully erosion is particularly severe, while the table gives a breakdown of ravine lands by state.

Sheet erosion, while less spectacular than gully erosion, is also of widespread occurrence in India. It occurs during periods of heavy rainfall and particularly effects slopes, being most severe in the steep scarps and deforested hillsides the Peninsular uplands and the Himalayas. The large quantities of sediment carried down into the plains each year by Himalayan rivers is a result of sheet erosion in the Himalayan

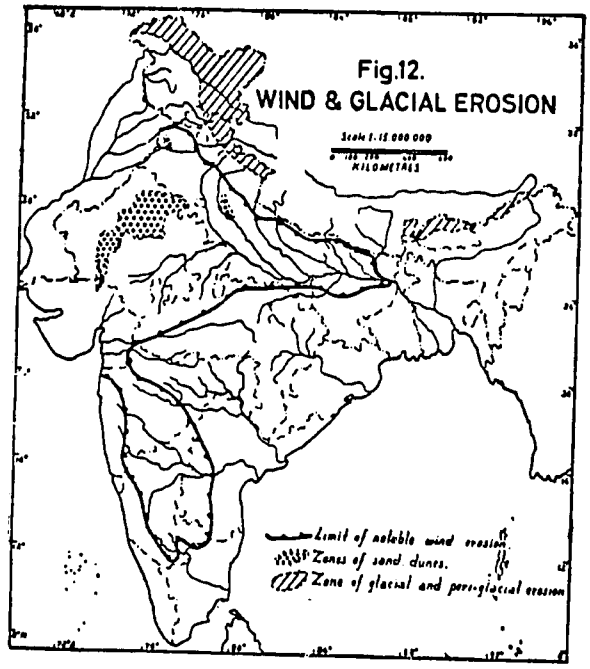
Ravine Lands by State (Bandhu and Bhardwaj 1979:29)

	Area in 100,000's of hectares
Uttar Pradesh	12.30
Madhya Pradesh	6.83
Rajasthan	4.52
Gujarat	4.00
Maharashtra	0.20
Punjab	1.20
Bihar	6.00
Tamil Nadu	0.60
West Bengal	1.04
	Total 36.69

AREAS OF GULLY AND SHEET EROSION (Ahmad 1973:63)



AREAS OF WIND AND GLACIAL EROSION (Ahmad 1973: 68)



area (Ahmad 1973:64-67).

Wind erosion is a major problem during rainless periods when soils are loose and fields are cropless. It is most severe in the desert areas of Rajasthan, in the Gujarat Plain, and in the friable and loose alluvial soils of the Indo-Gangetic plain west of the Kosi River. It is also troublesome, although to a lesser extent, in the arid tracts of Peninsular India, to the lee of the Western Ghats. The States most severely affected are Rajasthan, Punjab, Uttar Pradesh, and Bihar (Ahmad 1973: 67,83-84). Wind erosion is negligible in the Himalayas, the mountains

of the northeast, the Assam Valley, and the delta of the Ganges and, in general, in most forested areas of the country (Ahmad 1973:16).

Marine erosion along the Indian coast is most severe along the western coast, particularly in Kerala, where the southwest monsoon is the chief eroding force. On the eastern coast, the problem occur in Tamil Nadu, where the northeast monsoon strikes (Ahmad 1973: 69-70).

Erosion is caused by the forces of wind, water, and the sea, but it is aggravated by human-introduced factors such as deforestation and overgrazing of livestock, which not only eat the vegetation which might halt erosion but also pulverize soil, making it susceptible to wind erosion during dry periods and to water erosion during rainy periods, when the soil turns to mud. It has been noted, in fact, that the density of livestock may be used as indicators of both wind and water erosion in India (Ahman 1973:22). Fallow-lying agricultural land are also particularly susceptible to erosion.

Erosion results in the loss of soil and soil fertility, both of which are indispensable in a country attempting to grow enough food to feed its ever-growing population. Erosion also results in large sediment loads in rivers. Often these sediments, when deposited, can contribute to soil fertility. As already pointed out above, the fertile Indo-Gangetic Plain is a result of sediments desposited by rivers flowing from the Himalayas. On the other hand, sediments can damage irrigation works and fill reservoirs meant for the storage of water for irrigation and hydropower (see 2.3.3.2.2), and, if deposited in large quantities, can block the channels or rivers, changing their courses and contributing to flooding. The courses of most of the big rivers (the Ganges, Jamuna, Sutlej, Beas, Brahmaputra, Kosi, Krishna, Cauvery, for example) have become widened as soil has been carried to the sea or deposited in their courses; their average width is from 8 to 10 kilometers. Islands formed in the middle of these rivers occupy 15,000,000 ha in Uttar Pradesh and 9,000,000 ha in Bihar. Torrents from the hills carry large quantities of coarse debris which are spread on the fertile plains. An estimated 3,000,000 hectares in northern Punjab, Haryana, and Himachal Pradesh are thus affected each year, with about 500 hectares devastated in Hoshiapur district alone (Bandhu and Bhardwaj 1979: 80).

2.4.3.2 salinity and alkalinity

By a 1971 estimate, a total of 7,000,000 hectares are affected by salinity and alkalinity, resulting in 20 to 25% reduction in yield for these areas. These problems occur chiefly in areas of red, black, and alluvial soils. Frequently, the problem is aggravated or brought about by irrigation, which may cause salts accumulated just below the surface to rise. Improperly drained alluvial soils may also experience these problems, while on the coast of the Deccan Peninsula, salinity is caused by intrusions of seawater. Problems are most severe in Gujarat, as indicated by the table below:

Distribution of Saline, Saline-Alkali and Alkali Lands in Different States
(source: Bandhu and Bhardwaj 1979:83)

State/ Territory	Total area affected (hectares)	Soil group affected	Districts affected	
			saline	saline-alkali and alkali
Andhra Pradesh	240,000	deltaic alluvium, medium and deep black soil	East Godavari West Godavari Krishna, Guntur	Nizamabad, Karimnagar, Mahbubnagar, Kurnool, Anantpur Guntur, Cuddapah
Bihar	4,000	alluvial soil on Indo-gangetic alluvium	Muzaffarpur, Shahabad	
Gujarat	1,214,000	coastal saline, desert and grey brown soil;	Kutch, Jamnagar Banaskantha, Mehsana, Ahmedabar, Surendranagar	
		medium and deep black soil		Broach, Surat, Bulsar, Bhavnagar, Kaira
Haryana	526,000	alluvial soil developed on Indo-gangetic alluvium;	Hissar, Bhiwani	Karnal, Kurukshetra, Rohtak, Sonepat, Jind, Gurgaon
Karnataka	404,000	medium and deep black soil	Belgaum, Raichur, Bellary	
Kerala	16,000	acid sulfate soil of the deltaic region	Alleppey, Kottayam, Ernakulam	

2.4.3.3 Acidity

Acidity occurs chiefly in those high rainfall areas such as the Himalayas, the Western Ghats and the Assam Valley, where heavy rainfall has led to leaching of bases from the soils. High quantities of available aluminum, manganese, and iron and the absence of calcium and magnesium in these soils adversely affect crop growth. The laterite and red-yellow soil areas of the Peninsula are particularly acid.

2.4.3.4 Waterlogging

Waterlogging has many causes: the restriction of the flow of water by the construction of roads, railroads, airports, canals, and buildings; the obstruction of natural drainage by culverts and bridges; and the rising watertable in canal-irrigated areas.

The National Commission on Agiculture in 1976 reported some 6 million hectares as affected by waterlogging. Over half of these are caused by surface flooding (West Bengal, Orissa, Andrha Pradesh, Punjab, Uttar

Pradesh, Gujarat, Tamil Nadu, Kerala), while the remainder results from a high water-table affecting the root-zone of plants. Canal irrigation affected some 8,000 lake ha in Punjab and Haryana alone, while 6 to 7% of the Nira Irrigation Project has been damaged annually because of waterlogging.

Waterlogging is not judged to be a serious problem in Assam, Orrisa, Andrha Pradesh, Tamil Nadu, Kerala, and Gujarat, and is a problem only in some areas of the Kashmir Valley in Jammu & Kashmir.

Waterlogging by State and Territory (National Commission on Agriculture and other sources as reported in Bandhu and Bhardwaj 1979:83-84).

State/Territory	hectares
Punjab	1,090,000
Haryana	620,000
Uttar Pradesn	810,000
Bihar	117,000
Rajasthan	348,000
Gujarat	484,000
Madhya Pradesh	57,000
Karnataka	10,000
Andrha Pradesh	339,000
Maharashtra	111,000
West Bengal	1,850,000
Orissa	60,000
Tamil Nadu	18,000
Kerala	61,000
Delhi	1,000
Jammu & Kashmir	1,000

2.4.3.5 Cracking

Because of cracking the black soils are frequently difficult to cultivate (Bandhu and Bhardwaj 1979: 85).

2.4.3.6 Desert soils and desertification

About 22 million hectares in the areas of Western Rajasthan, Southern Punjab, Haryana, and Northern Gujarat exhibit desert characteristics: high temperature, scanty rainfall, sands, and sand dunes. Forest land is this area is quite scarce (about 1.58% in the area in 1970-71). Vegetation in general is quite meager, but species of high economic value (Acacia senegal, Butea monosperma, etc.) are numerous. Plants are generally classified as either productive or protective, although productive plants may also share with protective plants the charteristic of working as protective elements in the conservation of soil binders, wind breaks, and shelter belts. Of particular importance are the areas of sandunes stabilized by vegetation, which occur in the eastern areas of the zone.

Here wind erosion is a serious problem, and frequent periods of drought leave the coarse textured soils unable to sustain plant growth (Bandhu and Bhardwaj 1979: 85).

Although a large portion of the northern territory of Jammu and Kashmir is also arid, the area in which the problem of desertification is most pressing is the desert area mentioned above. It is, consequently, the area in which most Indian interest in this problem has been focussed.

Desert conditions in this area are brought about and aggravated by several, frequently interacting conditions: low rainfall and frequent occurrence of droughts; frequent dust storms, particularly in years of reduced rainfall; high evaporation, which in combination with low precipitation leads to the salinization of the area and accumulation of minerals in both groundwater and surface water; and poor soil development because of the generally low quantities of organic waste obtained in the area. The large number of rodents in the desert area--ranging from 74 to 523 per hectares in density--have also contributed to continuing desert conditions through voracious consumption of desert vegetation, as are also the desert locusts (Schistocerca gregaria).

human activity and desertification

The arid zone of Rajasthan is, as stated in the Indian report to the 1977 United Nations Desertification Conference "...climatologically and in its other natural conditions, a marginal zone, with a very delicate natural dynamic equilibrium liable to be upset by the slightest fluctuations in natural conditions" (NCECP 1977:39). Human activities are significant in upsetting this balance and accelerating the deterioration of the area. Human population in the arid zone of Rajasthan, which has normally been highly populated as compared with other arid areas of the world, increased from 3,567,000 in 1901 to 10,236,000 in 1971. This increase in human population was accompanied by an increase in livestock population (from 10,000,000 in 1951 to 16,440,000 in 1971. The land per household has been reduced from 17.77 hectares in 1951 to 12.40 hectares in 1971 and it is projected that by 2000 only 7.52 hectares per houshold will be available.

Changes in land use brought about by the increases in population and livestock numbers include the bringing under cultivation of large areas of the zone, often extending to marginal land, slopes, and other fringe areas which are not naturally suitable for farming. This has had several adverse effects. Farming of stabilized dune areas and removal of roots and stubble after cropping has led to accelerated wind erosion, while increase in the livestock population has led to further depletion of vegetal cover. Pressure by livestock (chiefly goats, sheep, and cattle, but also camels and buffalo) has led to overgrazing resulting in extensive removal of both herbaceous and woody cover with consequent erosion hazards.

Irrigated agriculture, frequently introduced without adequate drainage measures, has led to accumulation of minerals and salts in the soil and near surface formations. In some locations, there has been a rise in the water table with accompanying increases of salinity and deterioration of the soil regime (NCECP 1977:40-41).

Furthermore, the establishment of new settlements, often on stabilized dune areas, urbanization, construction of roads,. railroad tracks, and canals without consideration for the geomorphological peculiarities of the zone have led to rapid mobilization of stable sand belts and consequent desertification by removal of the vegetation and wind erosion. Thus settlements in the arid zone often become the centers of sand mobilization and movement, a situation further exacerbated by overgrazing and felling of trees for fuel. Other activities contributing to desertification are increased mineral exploitation in the zone and its eastern fringe, resulting in denudation of hill slopes and large scale loosening of rock faces (NCECP 1977:42-45).

The deterioration of the environment in the desert zone and its fringe areas is evidenced not only by problems within the zone itself (increase in mobilized dunes, loss of vegetation, etc.) but also by the appearance of mobile sands and erosion outside the climatic limits of the zone. There is evidence that sand from the desert zone is being transported across the zone and carried through "wind gaps" of the Aravallis mountains that flank the desert to the east and deposited in the semi-arid region beyond the zone itself. It is feared that under conditions of prolonged drought, these sand accumulations in fringe areas, many of which are themselves stabilized dunes, may cover farmlands and lead to the extension of the desert (NCECP 1977:45).

2.4.4 Soil management programs and government actions

The steadily increasing population of India requires and the limited amount of land available to produce food for this population make proper soil management practice imperative. It has recently been estimated that each person requires about 0.08 hectares of land for habitation and 0.4 hectares for food, or about 0.48 hectares per person; however, in India, only about 0.34 hectares person are available. Increasing population raises this requirement about 5,000,000 hectares each year. Because of the high costs of damages resulting from soils loss and flooding, about 232 watersheds in 26 major catchment areas have been selected for receiving "saturation treatment" in a soil conservation program scheduled to cover from fifteen to twenty million hectares (UNEP ROAP 1978:18).

ravine land reclamation

Measures to reclaim ravine lands include: establishment of forest plantations with economic fuel and fodder species; terracing; construction of diversion bunds; contour and peripheral bunds with a suitable drop structure to dispose of surplus water; gully plugging; fencing for protection of land from indiscriminate grazing; the establishment of orchard-grass-tree systems; and the canalization of hill torrents. The National Commission on Agriculture has estimated that foodgrains production can been boosted by 3,000,000 tons per year through the reclamation of ravine lands and that fruit, fodder, fuel, timber, and industrial raw materials can also be obtained (Bandhu and Bhardwaj 1979:86).

salinity and alkalinity control

Salinity and alkalinity can be controlled by several means: lowering of the water table; stoppage of seepage by lining of irrigation canals; the

construction of proper drainage channels to dispose of stagnant water along canals. The Central Soil Salinity Research Institute in Karnal has evolved technology for ameliorating soils already affected by salininty and alkalinity. The application of gypsum, manure, molasses, pressmud, and "green manure"(vegetation) have helped to improve soil conditions and increase crop production. Improved drainage and consequent leaching down of salts have been achieved through the mechanical breaking of hards pans form by the subsoils, while the flooding of saline and alkaline areas with fresh water has also assisted in leaching salts down below the root zone (Bandhu and Bhardwaj 1979:86). Despite the available of technology, however, no large scale reclamation projects for saline, alkaline or waterlogged soils have been initiated (Bandhu and Bhardwaj 1979:87).

waterlogging

Measures used for salinity and alkalinity control also act to alleviate waterlogging: the sinking of tubewells, lining of irrigation canals, and drainage of irrigation channels.

government programs for control of desertification

Responsibility for the control of soil degradation falls in the first instance to the state governments. The government of the state of Rajasthan, for example, has developed programs relating to the use of arid lands and the control of desertification. These include programs for introduction of rationalized dry land farming, improvement of farming techniques, groundwater exploration, prevention of soil erosion, afforestation, creation of shelter belts, management of livestock, and dairying and wood production. The Desert Development Board and the Commissioner for Desert Development of Rajasthan are responsible for the coordination of different programs, including relief measures for drought-affected areas (NCEPC 1977:54).

Within Rajasthan desert development schemes were initated in the early 1970's. Covering several districts these projects included: rehabilitation of forests on hillsides; grassland development for fodder banks; development of pastures; reclamation of saline soils; and wind-break plantations. Programs for the reclamation of saline soils are intended to convert these lands into productive land for cultivation by salt-resisting plants. Another important project is the Rajasthan Canal Project, a major irrigation scheme intended ultimately to cover an area of 1.35 million hectares. Measures to prevent overgrazing and to encourage sand dune stabilization are important facets of this project include the prohibition of human settlements on high dune lands (NCEPC 1977: 59-60).

At the national level a Drought Prone Area Program (DPAP) was initiated during the 1970-71 fiscal year for the development of area chronically affected by drought. This program covers most of the districts which are part of the Indian desert. The objectives of the program are: restoration of the derelict eco-systems and promotion of ecologically integrated development, and generation of income and employment for the local population, specifically for the small and marginal farmers and agricultural laborers. The major features of the program involve soil and water management, sand dune stabilization, creation of wind breaks, development and management of the pastoral economy through groundwater development, and restructuring of

cropping patterns and land use practices. As part of the effort to raise livestock productivity, pilot schemes for settlement of the nomadic population have been initiated. Soil and agro-economic surveys are being organized to rationize land use practices and optimize the use of natural resources (NCEPC 1977: 55-57).

Other important work is being done in conjunction with the Programme for Integrated Rural Development, scheduled to begin with 20 selected rural areas, including some within the arid and semi-arid regions of Rajasthan, Gujarat, and Haryana. This program aims to transfer science and technology for the improvement of the economic and environmental conditions of rural settlements throughout the country (NCEPC 1977: 58).

Of particularly importance at the national level is the work of the Central Arid Zone Research Institute at Jodhpur, Rajasthan.

Despite the efforts of these and other agencies, India's Report to the 1977 United Nations Conference on Desertification, states that "no significant break-through has been achieved." This failure is attributed to a lack of an integrated approach to the problem: "Most of the efforts for halting desertification and reclamation of arid areas have been sectoral in nature without adequate cognizance of the collateral issues. The available scientific information on the rational use of ecosystem resources is yet to be converted into action programmes. So far, the absence of a judicious resource utilization policy inter alia land, water, and energy, has been the major impediment towards effective implemention of development programmes"(NCEPC 1977:70).

2.4.5 soil surveys

Although general characteristics of the soils of India have been established (see, for example, Rajan and Rao 1978), extensive detailed studies of soil characteristics have not been conducted. At the time of the compilation of the South Asian section of the FAO-UNESCO Soil Map of the World in the early 1970's, systematic soil surveys were available for only a small part of the country and soil reconnaissance data for a considerably larger area, but for the bulk of the country only general information with local observations were available. Among the materials used by the FAO in preparing its own maps was a draft soil map of the country (scale of 1:3,000,000) prepared by the All India Soils and Land Use Survey in 1965 (FAO-UNESCO 1977:8).

The National Commission on Agriculture in its 1976 report recommended that measures be taken to prepare the soil map of India on a scale of 1:1,000,000 and urged the strengthening of technical capabilities in order to facilitate this work (India. NCA 1976: vol. 5: 281).

2.5 FORESTS

According to most sources, forests comprise approximately 22 to 23% of the total territory of India; however, as more exact data becomes available, this figure may have to be readjusted downward (see deforestation below). As advocated in the National Forest Policy as laid down in 1952, however, about one-third of the country should be forested: 60% in the mountains and 20% in the plains. With regard to the general value of this forest resource, it has been estimated that only about a third of the present forest area contains good timber wood, the remainder being either scrub or wood that is subject to indiscriminate felling by local populations (Sharma 1978:6).

Major surveys of the forest types of India have been made by Champion and Seth (1968) and a Atlas of Forest Resources of India has been published (India. National Atlas Organisation. 1976).

2.5.1 Forest types *

Forest types and their distribution are shown on the map on page 48a. and indicated below. It must be emphasized that the map indicates for most areas only the type of forest or vegetation native to that area; in many areas this vegetation has been removed or degraded as a result of human activity. The map on page 48b, which indictes the density of forest land in relationship to area for individual Indian states, gives some idea of where forests actually still occur.

Forests are unevenly distributed throughout the country. They are located mostly in hilly terrain or remote areas. Madhya Pradesh, which boasts the largest forest area of any Indian state, accounts for about 23% of the forest area. Extensive forest area also is found in Andraha Pradesh, Assam, Himachal Pradesh, Karnataka, Maharashtra, Orissa, Rajasthan, Uttar Pradesh, and Andaman and Nicobar Islands (Lal, Sham 1977:75). The table on page 49 indicates forest distribution by state and union territory.

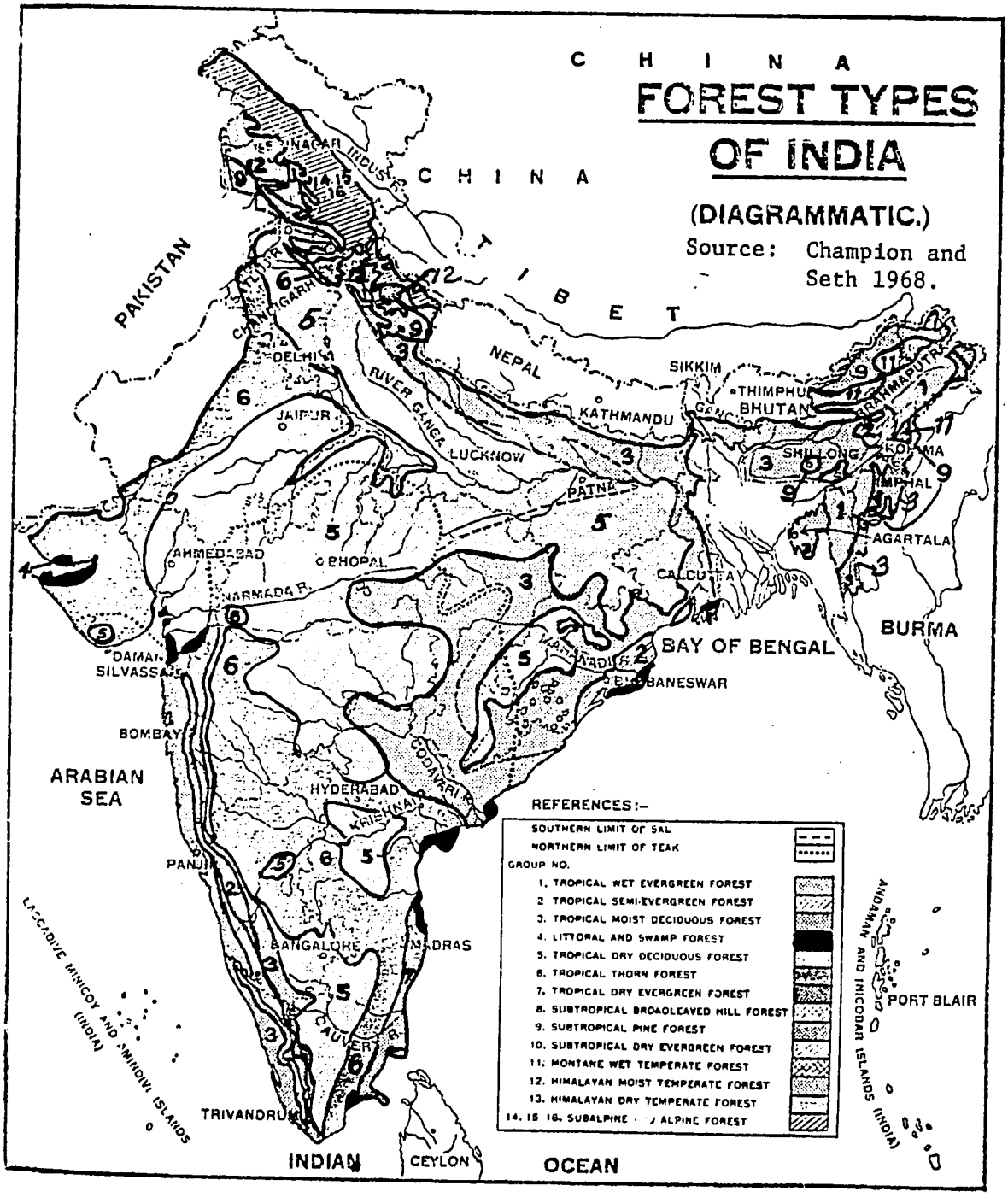
2.5.1.1 Moist tropical forests (groups 1-4 on map, page 48a).

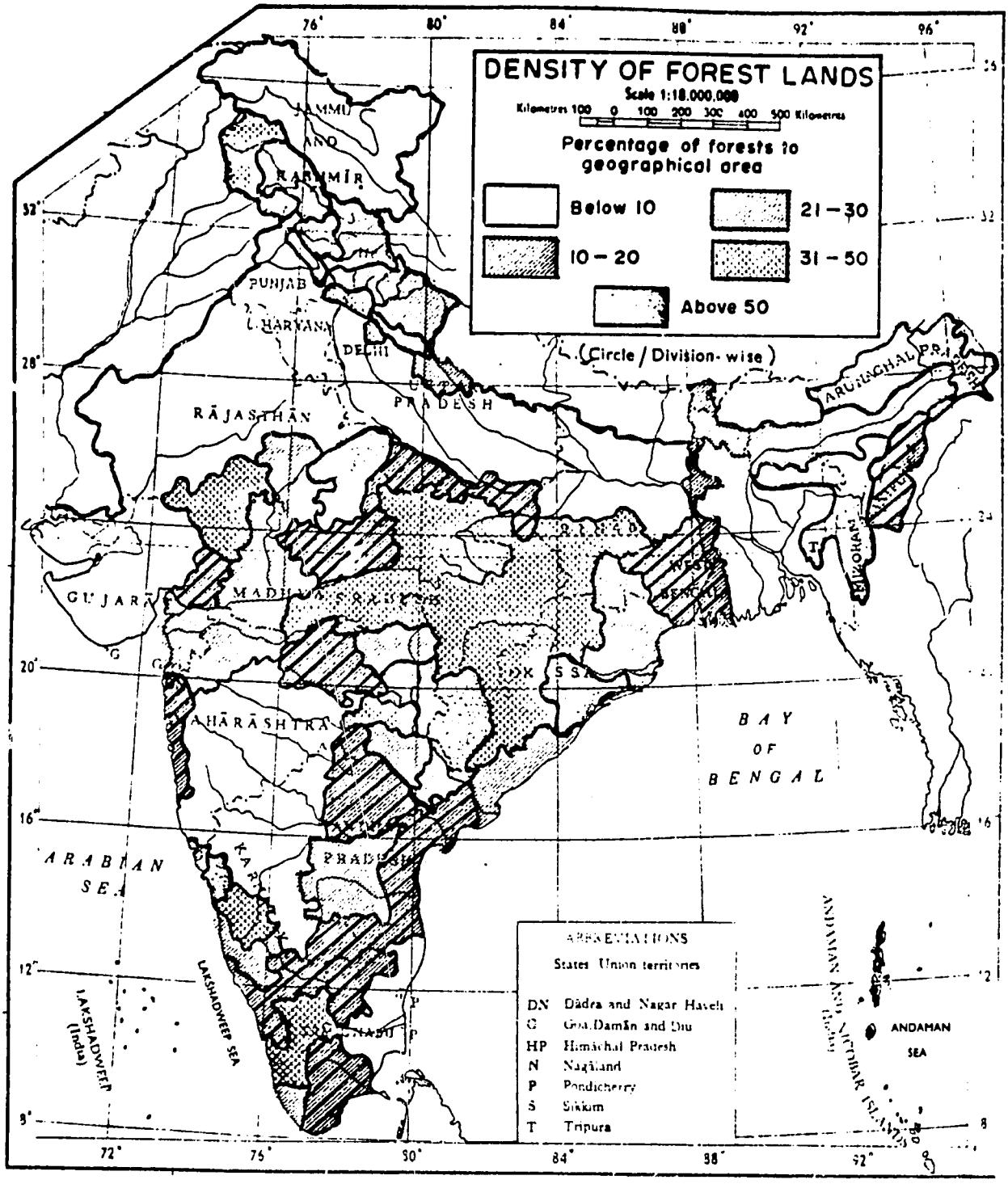
1. TROPICAL WET EVERGREEN FORESTS: 4,503,000 hectares**

Southern tropical wet evergreen forests occur on the Deccan peninsula (Maharashastra, Karnataka, Tamil Nadu, and Kerala) and in the Andaman Islands. The most widely distributed genera are Dipterocarpus and Hopea, while other typical genera are: Guttiferae, Anacardiaceae, Sapotaceae, Meliaceae, Artocarpus, Eugenia, and Elaeocarpus.

Northern tropical wet evergreen forests, occurring in West Bengal, Assam, and Orissa, are very similar to their southern counterparts. Dipterocarpus and Shorea form the only large trees. Lauraceaa, Magnoliaceae, Quercus, and Castanopsis are more important and varied than in the south, and bamboos are more usually present than in the south.

*The following material is based largely on Seth and Champion 1968.
**Estimates of forest areas are from Lal 1977:75-76


FOREST TYPES
OF INDIA
(DIAGRAMMATIC.)
Source: Champion and Seth 1968.
C H I N A
C H I N A
T I B E T
PAKISTAN
NEPAL
SIKKIM
BHUTAN
DELHI
JAIPUR
KATHMANDU
LUCKNOW
PATNA
AHMEDABAD
BHOPAL
CALCUTTA
AGARTALA
BURMA
BAY OF BENGAL
BOMBAY
HYDERABAD
BANGALORE
MADRAS
TRIVANDRUM
PORT BLAIR
ARABIAN SEA
INDIAN OCEAN
CEYLON
REFERENCES:-
SOUTHERN LIMIT OF SAL
NORTHERN LIMIT OF TEAK
GROUP NO.
1. TROPICAL WET EVERGREEN FOREST
2. TROPICAL SEMI-EVERGREEN FOREST
3. TROPICAL MOIST DECIDUOUS FOREST
4. LITTORAL AND SWAMP FOREST
5. TROPICAL DRY DECIDUOUS FOREST
6. TROPICAL THORN FOREST
7. TROPICAL DRY EVERGREEN FOREST
8. SUBTROPICAL BROADLEAVED HILL FOREST
9. SUBTROPICAL PINE FOREST
10. SUBTROPICAL DRY EVERGREEN FOREST
11. MONTANE WET TEMPERATE FOREST
12. HIMALAYAN MOIST TEMPERATE FOREST
13. HIMALAYAN DRY TEMPERATE FOREST
14, 15 16. SUBALPINE & ALPINE FOREST



SOURCE: Das Gupta 1976: plate 26

Forest territory 1972-73 (from Sharma 1978)
(in thousands of hectares; 1977-78 figures --not available for all jurisdictions are from recent issues of The Indian Forester)

State	Geographical area	Forest area under Forest Dept.	Other Forest area	Total Forest area	% of Forest area to geographical area	1977-78 (state admin.)
Andrha Pradesh	27,681	6,450	30	6,480	23.40%	
Assam	7,852	1,330	1,525	2,855	36.36	
Bihar	17,388	2,932	---	2,932	16.86	
Gujarat	19,599	1,697	---	1,697	8.66	
Haryana	4,422	100	52	152	3.44	146
Himachal Pradesh	5,567	2,010	157	2,167	38.93	2,176
Jammu&Kashmir	22,224	2,070	34	2,104	9.47	
Karnataka	19,177	3,360	248	3,608	18.81	2,894
Kerala	3,887	1,128	--	1,128	29.02	
Madhya Pradesh	44,284	16,620	193	16,813	37.97	
Maharashtra	30,776	5,640	1,015	6,655	21.62	6,610
Manipur	2,236	602	---	602	26.92	
Meghalaya	2,249	70	753	823	36.59	
Nagaland	1,653	80	208	288	17.42	
Orissa	15,578	6,620	173	6,793	43.61*	
Punjab	5,036	100	113	312	4.23	
Rajasthan	34,221	3,410	179	3,589	10.49	
Sikkim	730	---	---	---	---	
Tamil Nadu	13,007	2,090	144	2,234	17.18	
Tripura	1,048	605	---	605	57.73	
Uttar Pradesh	29,441	4,080	1,052	5,132	17.43	
West Bengal	8,875	1,160	23	1,183	13.47	
Total States	316,841	62,154	5,899	68,053	21.48	
Union Territories						
Arunachal Pradesh	8,538	5,140	14	5,154	61.67	
Mizoram	2,109	769	--	769	36.46	
Others	1,290	880	21	901	69.84	
All U.T.'s	11,937	6,789	35	6,824	57.17	
All-India	328,778	68,943	5,934	74,877	22.77	

*Landsat data from November 1975--wet season in Orissa--indicated that forest lands covered only 31.7% of total land area or 48,965 square kilometers (4,896 thousand hectares). The breakdown by forest type was highland forests, including diptocarpss: 17.6%; lowland forest, including mangrove: 12.3%; and conifers forest anomalies, including casuarine and teak: 1.8% (IBRD 1977).

2. TROPICAL SEMI-EVERGREEN FORESTS

In the southern area these occur only in the moist Western Ghats. Typically occurring deciduous species are are Xylia and Terminalia, but evergreen Dipterocarpus, Balanocarpus, and Hopea also occur. Bamboos are usually present.

In the northern areas these are found in the moderately heavy to heavy rainfall areas of Assam and Bengal, extending down the east coast of the peninsula to Puri in Orissa. The forest is dense-storeyed high forest (24-36 meters) with evergreens (chiefly Syzgium, Cinnamomum, Magnoliaceae, and Artocarpus) predominating, particularly in the lower canopy, but with a mixture of deciduous trees, particularly Terminalia spp., Tetrameles, and Stereospermum. Bamboos are often absent.

3. TROPICAL MOIST DECIDUOUS FORESTS 23,303,000 hectares

Nearly half of Andaman Islands (lying in the Bay of Bengal well off the coast of the Deccan Peninsula) are covered with tropical moist deciduous forest with species such as Pterocarpus dalbergiodes and Terminalia spp.

South Indian moist deciduous forests occur in all parts of the southern area with medium rainfall. These closed high forests (30-36 meters or more) are found in Madhya Pradesh, Gujarat, Maharashtra, Mysore, Karnataka, and Kerala. They include the important teak-bearing forests (Tectona grandis). Other important species are Terminalia spp, Pterocarpus spp., and Lagerstroemia spp.. Bamboos are not necessarily present.

North Indian Tropical Moist Dedicuous Forest occur in Uttar Pradesh, Bihar, Orissa, West Bengal, Assam, and Madhya Pradesh. These forests are quite similar to their southern counterparts, but in this area sal (Shorea robusta) replaces teak as the ecologically characteristic and economically most important species. Sal has proved to be more tenacious and generally more resistant to human encroachment than other species because of its features such as coppicing power, resistance to burning, regeneration under burning and grazing, and adaptability to soil and site conditions, and longevity. Planned forest management has intenstified its dominance in this area.

4. LITTORAL AND SWAMP FORESTS

Littoral forests, also designated as beach and dune forests, are distributed all along the coast, wherever permitted by a fair width of sand beach.

The most chartacteristic species is the tall evergreen but very light foliaged Casuarina, which often fringes the sandy beaches. In the Andamans Manilkara littoralis occurs in its place.

Very little of the great tidal swamp forests of the Ganges and Brahmaputra Delta now falls within Indian territory. Considerable tidal swamp forest occurs in the mouths of creeks and short rivers, while remnants occur at the estuaries of the Mahanadi, Krishna and Godavari rivers on the East coast but very little in the creeks on the West Coast. The most dominant species of these forests are mangroves (Rhizophoraceae), which are almost

confined to these areas; their preferred habitat is the newly deposited mud banks that are daily submerged by the tides. Only a few species of palms occur.

Mangrove scrub occurs in the river deltas along the edge of tidal waterways on sheltered muddy coasts from Gujarat to Bengal and occupies a large proportion of the Western Sunderbans, while actual mangrove (Rhizophora) forest is more common on the muddy coasts of the East Coast of Bengal.

Also falling within this grouping are Tropical Freshwater Swamp Forests (fairly dense evergreen closed forests--15-30 meters high--dominated by Myristica magnifica) which occur in tropical hill valleys in the Himalayan and other regions and in low lying sites in the Brahmaputra Valley.

Tropical seasonal swamp forests with species such as Altingia excelsa, Machilulus gamblei, and Szygium cumini, occur in the Ganges and Brahmaputra Valleys, while tropical riparian fringe forests dominated by Terminalia arjuna and Lagerstroemia species are found along the banks of most of the largest streams in the hilly tracts.

2.5.1.2 Dry tropical forests (groups 5 to 7 on map)

5. TROPICAL DRY DECIDUOUS FORESTS 29,154,000 hectares

Southern Tropical Dry Deciduous Forests occur throughout the Indian peninsula with the exception of the moister Western Ghats: Madhya Pradesh, Gujarat, Maharashtra, Andrha Pradesh, Karnataka, and Tamil Nadu. It merges into thorn forest wherever the rainfall drops below 750 mm. In the climax type the upper canopy is closed but not dense; typical height is from 13 to 20 meters.

There are two basic types: those in which teak (principally Tectona grandis) occurs and those non-teak bearing forests where Anogeissus and Terminalia, accompanied by Diospyros, Boswellia and Sterculia, dominate. Bamboos are often present; the chief species is Dendrocalamus.

Northern Tropical Dry Deciduous Forests occur throughout northern India, except in the overly moist eastern parts and in the overly dry eastern parts; the most extensive occurrences are in Uttar Pradesh, Bihar, Orissa and Punjab. The upper canopy is light but fairly even and continuous in the climax form but in actual occurrence the canopy is usually broken and irregular; the forest is rarely over 15 meters in height.

Although teak and other southern species do not occur in these forests. The most common types, which are also common to the moist deciduous forest and the dry thorn forest are: Anogeissus latifola in association with Buchanania lanzan, Sterculia, Bauninia spp. and poorly grown Terminalia tomentosa. Three types of sal (Shorea robusta) forest occur: dry Siwalik sal forest; dry plains sal forest; and dry peninsular sal forest. Only one species of bamboo occurs.

6. TROPICAL THORN FORESTS 5,236,000 hectares

Southern tropical thorn forests occur in the dry peninsular tract

to the lee of the Western Ghats from the extreme south up to Indore and Bhopal. They are most important in Maharashtra, Andra Pradesh, Karnataka, and Tami' Nadu.

These are open low forests dominated by thorny usually hardwood species, particularly Acacia spp.; tree height is usually from 6 to 9 meters. Apart from Acacia and related genera which are most charactersitic in these forests, there are fleshy Euphorbiae, while Capparis and Opuntia are also of frequent occurrence.

Northern tropical thorn forests occur in the semi-arid regions of Uttar Pradesh, Madhya Pradesh, and in the major portion of the semi-arid regions of Punjab, Rajaputna, and northern Gujarat, including Saurashtra and Kutch.

As true desert vegetation, these forests differ from their southern counterparts in their generally small size (4.5 to 10 meters in height). Acacias are characteristic but less predominant and Eurphorbias are less widely distributed. Thorny Mimosae are of general occurrence with a number of other species, most predominantly Prosopis spicigera. Thorny Mimosae occur through with a number of other species of which Prosopis spicigera is the most general. Capparis decidua is the most conspicuous trees.

Northern tropical thorn forests are further subdivided into desert thorn forests (Punjab, Rajasthan, and Gujarat, with dominant types such as Prosopis spidigera, Salvadora oleoides, Acacia senegal, and Acadia planifrons), ravine thorn forest (throughout northern India regions with rainfall of between 500 and 1000 mm) with dominant species such as Acacia leucophloea, Prosopis spicigera, Capparis decidua), and desert dune scrub in southern Punjab and Rajasthan , with occurrences of Prosopis spicigera, Calligonum polygonoides and other desert vegetation.

7. TROPICAL DRY EVERGREEN FORESTS 75,000 hectares

Low tropical dry evergreen forests of from 9 to 12 meters in height but forming a complete canopy, are found only on the Karnataka coast; the most dominant species are Manilkara (Sapotaceae), Mimusops elengi, and Memecylon edule.

2.5.1.3 Montane subtropical forests (groups 8-10 on map)

8. SUBTROPICAL BROADLEAVED HILL FOREST 287,000 hectares

Southern subtropical broadleaved hill forests are native to zones of about 1000 m and 1,700 m on the higher hills of southern India, and also above 1,000 m on the higher hills of Central India.

Eugenia (Szygium) are characteristic genera and Lauraceae are very generally present, while Memecylon and other Melastomaceae usually occur.

These forests occur mostly on steep hillsides in South India and the Western Ghats; throughout the rest of the peninsula their habitat is

mostly hilltops; where these are relatively flat the areas have been completely stripped of tree growth, heavily grazed and burnt, leaving only grassland with scattered fire-resistant trees and patches of low forest or scrub in moister or sheltered spots.

Northern subtropical broadleaved hill forests of good height (generally 22 to 33 meters but often attaining 50 meters) and density occur on the lower slopes of the E. Himalayas from about 1,000 m up to 2,000 m. This type is characterized by the presence of oaks and chestnuts (Quercus and Castanopsis) which are usually present and often form an important part of the crop. Other temperate genera are Alnus, Prunus, and Betula. A few Dipterocarps occur. Pines are absent.

Khasi subtropical wet hill forests, dense evergreen forests rarely exceeding 20 meters in height, occur in the upper slopes of the Khasi, Jaintia and adjacent hills in Manipur, Tripura and Assam. Dominant species are oaks (Quercus spp), Beilschmiedia, Saurauja, and Engelhardtia.

In many parts of the Khasi and adjoining hills, repeated shifting cultivation with felling and burning, have cleared and greatly altered the original forest cover. Climax forest has been replaced by open grassland with scattered trees adjoining pine forest or broadleaved evergreens, sometimes with pines. On the Naga Hills are treeless grassy hill tops (Champion and Seth 1968:266).

9. SUBTROPICAL PINE FORESTS 3,740,000 hectares

Forests of Pinus roxburghii, attaining heights of 20 to 35 meters in some areas, are found throughout the whole length of the Western and Central Himalayas from the Northwest Frontier to Sikkim and West Bhutan between 1,000 meters and 1,800 meters extending on ridges down to 600 meters, and up to 2,300 meters on southern hillsides. This pine forest does not occur in Kashmir.

In the Khasi, Naga, and Manipur hills, forest of Pinus insularis occurs at similar altitudes.

Pine is the predominant species in these forests and creates an environment inimical to most broadleaved trees; Quercus is the most typical broadleaved associate along with Rhododendron, Lyonia, and Syzygium cumini.

Some of the Upper or Himalayan chir pine areas have been heavily grazed and occasionally burnt prior to enclosure, leaving a dense grass cover (Champion and Seth 1968:273).

10. SUBTROPICAL DRY EVERGREEN FORESTS 173,000 hectares

These low practically scrub forests of small-leaved evergreen trees and scrubs occur in the Bhabar, the Siwalik hills and the foothills of the Western Himalayas, extending up the main valleys to about 1,000 m.

Predominant species include the olive (Olea cuspidata) and Acacias (Acacia modesta), as well as Dodonaea viscosa.

2.5.1.4 Montane temperate forests (groups 11-13 on map)

11. MONTANE WET TEMPERATE FORESTS 1,613,000 hectares

Southern montane wet temperate forests of low height (about 6 meters) occur in the higher hills of Tamil Nadu and Kerala.

Important tree growth includes Ternstroemiaceae and Eugeniae, along with Melioosma, Eurya, Symplocos, and Lauraceae. Rhododendron nilagiricum is common and conspicuous.

Northern montane wet temperate forests--closed evergreen high forest rarely reaching heights above 25 meters--occurs in the eastern Himalayans from Eastern Nepal eastwards on the higher hills of Bengal and Assam from 1,800 meters to 3,000 meters.

Oaks and chestnuts characterize the forest at higher altitudes, while laurels (Lauraceae) are abundant and more numerous than oaks at lower levels. Also present are Magnoliaceae, Engelhardtia, Schima as well as maples (Acer), Prunus, and Ulmus.

In the Eastern Himalayas, forests have suffered varyingly from clearing for uncontrolled shifting cultivation, which has pushed the forest back along the periphery of permanent settlement. At the higher altitudes grazing and graziers have affected the forest, and fires through bamboo brakes have led to the replacement of a good deal of the forest with pure bamboo. Much of the forest has been destroyed as a result of the extension of potato cultivation (Champion and Seth 1968:285).

12. HIMALAYAN MOIST TEMPERATE FOREST 2,725,000 hectares

This forest, extending along the whole length of the Himalayas between the subtropical pine forests and the sub-alpine formation with a rainfall between about 1,000 and 2,500 millimeters, is found in Khasmir, Himachal Pradesh, Punjab, Uttar Pradesh, the Darjeeling district of of Bengal, and Sikkim at altitudes from about 1,500 meters up to 3,300 meters.

This forest area is characterized by the prevalence of conifers, the chief genera being Abies, Cedrus (Deodar), Picea, Tsuga, and Pinus. Cupressus and Taxus also occur. The coniferous forest tends to be open, with tree heights ranging from 30 to 50 meters. Among the broadleaved tree, of increasing occurrence in the eastern part of the range, several species of Quercus predominate, while Rhododendron also occurs. Temperate deciduous trees include Acer, Corylus, Aesculus, Prunus, Ulmus, Carpinus, and Betula. The oak forests are usually of low height (10 to 20 meters). Dwarf bamboos occur extensively in some areas.

13. HIMALAYAN DRY TEMPERATE FORESTS

These forests occur in the inner ranges of the Himalayas, where the southwest monsoon is weak and where such precipitation as occur comes mainly as snow in the winter months.

These are esentially open forests, exhibiting closed canopies only in some areas. Coniferous trees are the dominant species; broadleaved trees, of only occasional occurrence, attaining only poor heights. Xerophytic shrubs are common. The most characteristic conifers are Cedrus deodora, Pinus gerardiana, and Juniperus, but Abies and Pinus wallichiana occur at higher elevations. Broadleaved trees are represented by xerophytic species of Acer, Fraxinus, and Quercus.

2.5.1.5 Sub-alpine forest (group 14 on map)

14. SUB-ALPINE FORESTS

The topmost tree forest of the Himalayas, these forests are typified by small crooked trees or large shrubs with patches of coniferous overwood. The tallest tres are conifers, usually Abies, but Juniperus also occurs, as well as Pinus wallichiana. Larix occurs in a restricted area. The largest deciduous tree is Betula utilis, while Quercus semecarpifolia is found in the outer moister regions. Rhododendron also occurs.

2.5.1.6 Alpine scrub (group 15 on map)

15. ALPINE SCRUB

Several types of alpine scrub associations occur beyond the tree line in the higher reaches of the Himalayas: Birch-Rhododendron scrub forest dominated by Rhodendron and Betula utilis, Dwarf Rhododendron scrub, Dry Alpine scrub, and Dwarf Juniper scrub.

2.5.2 UTILIIZATION OF FORESTS

The table on page 56a shows production of wood and forest products as reported by the FAO for 1961-65 and 1976. The table on page 56b indicates the production of timber and fuelwood for each individual state and union territory for the 1973-74 fiscal year. The striking discrepancy between these two tables with regard to fuelwood production (FAO figures indicate between 90% and 92% of wood production as fuelwood for both 1961-65 and 1976, while the table on page 56a indicates on 62.5% of production as fuelwood) is considered under 2.5.2.2.2.

Forest area per capita in India, using recent population figures, comes to only about 0.11 hectares, as compared to the world average of 1.08. If forest area remains at its present level per capita forest area would drop to 0.07 by the year 2000. However, if loss of forest areas by removal of fuelwood and the depradation of forest by livestock grazing should continue, this per capita figure will be even lower. Average addition to forest area by reforestation per year is only 0.5 cubic meters per hectare, below the world average of 2.1 cubic meters per hectare.

2.5.2.1 Forest ownership and production

Government is the largest timber producing agency in the country. Forests are owned by the State (95.0%), by corporate bodies (3%), and by private individuals (2.0%) (Lal 1977:75).

Forest lands in India fall into three broad groups: reserved forests, owned and operated by the government; protected forests, which are owned by the government but may be used by private individuals for wood and grazing; and unclassed or civil forests, under the general control of the forest departments, which may be used by the general public (Thapar 1975: 10).

In accordance with goals established under the Fifth Five Year Plan (1974-79), State Forest Corporations have been established in many of the Indian states. In Uttar Pradesh, where the corporation was established in November 1974 with the stated purposes of improving logging practices and replacing a contract system that had allowed serious exploitaton of workers, it is reported to have played an important role is ensuring fair wages to forest workers, providing them also with services such as food and medical facilities. By providing jobs for graduates in science and commerce, the Uttar Pradesh Forest Corporation has helped to relieve the unemployment problem among the educated population. It is expected to provide more jobs for this group as it extends its activities into new areas (Indian Forester 1978:884-886).

2.5.2.2 Forest products

2.5.2.2.1 Industrial wood

Important economic species include coniferous trees, which cover some 3,765,000 hectares, and various broadleaved species, of which teak and sal are the most frequently exploited. As indicated by the table on

page 56a, most of India's industrial wood consists of hardwoods. About 16% of India's forests are inacessible. Of the remaining 84% anywhere from 45% to 63% are felt to be currently exploitable (Lal 1977:76; Thapar 1975:6).

Given the skewed distribution of present forest lands in India, it is not surprising that certain areas account for larger amounts of the value of forest produce than others. In 1970-71 Madhya Pradesh, with 14.7% had the highest share of values of forest products, Andrha Pradesh was next with about 13%, and Jammu and Kashmir next with 12.3%. Other states in which forests play an important economic role are Mahashastra, Karnataka, Uttar Pradesh, and Himachal Pradesh. Madhya Pradesh, Jammu and Kashmir, Himachal Pradesh, Andrha Pradesh, and Uttar Pradesh accounted for as much as 64% of the total value of forest produce in 1970-71. About 79% of the value of this forest produce came from major forest produce (timber and fuelwood), and the remainder from minor (bamboos, canes, gums, resins, dyes, tans, lac, fibers, floss, and medicinal plant materials) (Thapar 1975:6-7).

2.5.2.2.1.1 Industrial woods

teak

Four States account for about 90% of the area under teak in India: Madhya Pradesh with 3,119,000 hectares; Maharashtra with 1,404,000 hectares; Gujarat with 1,176,000 hectares; and Karnataka with 1,000,000 hectares (Thapar 1975:6).

sal

Sal (Shorea robusta) is found predominantly in Madhya Pradesh and Bihar, which together account for 80% of sal forests (Thapar 1975:6).

conifers

Conifers are most predominant in higher altitudes of Himachal Pradesh, Jammu and Kashmir, and Uttar Pradesh (Thapar 1975:6). Important coniferous species include: deodara (Cedrus deodora), which is valued as a construction timber; Pinus roxburghii (Chir pine), the second most valued construction timber, which is also used as a source of resin; and Abies pindrow (fir) and Picea smithiana (spruce), used for the pulp and paper industry.

bamboo

Found throughout most of the country, bamboo, valued for its industrial uses, occurs in heavy concentrations in Assam, Tripura, Maharashtra, Madhya Pradesh, Mysore, and Orissa.

2.5.2.2.1.2 wood products

sawnwood

There are approximately 3,000 saw mill units in the country with capacities ranging from 10 to 200 tons per day. Sawmills are increasingly being opened

in the various forest department of India so as to increase rational utilization of wood (Lal 1977:77).

The greatest part of the products of sawmills is used for railway ties, construction, furniture, plywood (especially tea chests), agricultural equipment, and for wooden handicrafts. The demand for sawnwood has increased as sawnwood, rather than the more traditional roundwood, has been increasingly used for house construction.

Other important products are pulp and paper, the production of which has increased substantially since 1961-65, plywood, veneer sheets, particle board, and fiber board. Bamboo continues to be the major sources of raw material for the paper industry in India (Varma 1978:129). Another significant forest industry is the match production, which consumes an estimated 250,000 tons of timber annually. Soft-wood plantations are being planted in several states to meet the growing needs of this industry, which is expected to grow along with the increase in population (Thapar 1975:19). The match industry, which started in 1922, has a mechanized and a non-mechanized sector. By one recent count there were six large factories producing about half the supply of matches in the country; the remainder were manufactured by the small sector. The industry is said to suffer from logistical problems (Thapar 1975:19).

2.5.2.2.2 Fuelwood

According to the most recent FAO statistics about 90% of the wood used in India is fuelwood. Indian sources, however, tend to place the percentage much lower: the Times of India 1977 Yearbook, for example, places it at 60%. A consideration of the discussion contained in Sharma 1978 makes it clear, however, that this lower percentage applies only to recorded sources of firewood. Sharma estimates that over 90% of the fuelwood used annually comes from unrecorded sources. By his calculations, for example, 203,000,000 cubic meters of fuelwood were consumed in 1970-71 (about 95% of total wood production for that period), only 12,090,000 cubic meters of which--about 6.3%--came from recorded sources (Sharma 1978:209-210).

By one recent report (Indian Forester 1979:241), the present fuel wood needs in India are 233 million cubic meters per year, while the Planning Commission has projected the estimated demand at 256 million cubic meters by 1980 and 300 million cubic meters by 1990 (Indian Forester 1979:241).

In his review of the Indian fuelwood situation, Sharma presents several disturbing facts. Fuelwood requirements by 1980 will be as high as 256 million cubic meters, most of which will come from non-recorded sources. People in rural areas consume fuel in the proportion of about 9%5 of non-commercial fuels--not only firewood but also bagasse, wastes from saw mills, cowdung, paddy husk, and some vegetable and food wastes--to only 5% for commercial fuels. By his estimate, wood already produces some two-fifths of the total energy consumed in India as a whole.

Furthermore, it is not expected that other fuels will quickly replace such non-commercial fuels, particularly firewood for heating and cooking

Furthermore, it is not expected that other fuels will quickly replace such non-commercial fuels, particularly firewood for heating and cooking purposes, particularly not in rural areas where no commercial source of domestic energy is available. The rural energy needs met by firewood include: cooking and lighting, operation of pumps for irrigation and drinking water, and energy for the development of agro and village industries (Sharma 1978:206).

In Sharma's judgement, the "unrecorded sources" of firewood, which include not only wood from community lands, farm lands, and waste lands, but also wood either poached from forest reserves or removed by wood gatherers in excess of their removal privileges, are rapidly depleting. Writing in the mid-1970's Sharma emphasizes that fuelwood supply is already lagging behind demand and predicts a crisis in fuelwood supply by 1980-81.

Environmental writer Erik Eckholm reports that for the state of Gujarat alone 4.8 million tons of fuelwood were consumed in 1975, only 200,000 tons (about 4.2%) of which was extracted from forest reserves. The remainder of this wood was taken from community lands, imported from other states, or poached from reserves. The increasing shortage of fuelwood in Gujarat is evident in soaring prices not only for firewood but also for wood poles used in housing construction (Eckholm 1979:20-21). In other areas such as parts of the Himalayan region of Uttar Pradesh people are forced to walk as far as five miles to gather their daily firewood needs (Agarwal 1978:16).

2.5.2.2.3 Other forest products and functions

Nonwood forest products include grass and leaves for cattle, traditional medicines, foods, and assorted barks and leaves. In Haryana, for example, the barks of the babul tree (Acacia arabica), used for tanning, and katha, an important ingredient for betel leaf (pan) are important revenue earners from the state's forests (Sharma 1978:18).

It cannot be forgotten that forests, apart from their functions as sources of wood and other products, also serve as wildlife habitat and as watershed protectors. As Erik Eckholm points out, the forests of Madhya Pradesh, the nation's most heavily forested state, serve the neighboring states by protecting the headwaters of five major river systems. He cites the observation of a colonial inspector general of forests that if Madhya Pradesh were to cut down all of its strategic forests "it would actually do more harm to other states than to its own" (Eckholm 1979:17).

2.5.3 Deforestation

Population increases in India, and the need to feed, clothe, and provide domestic fuel for this growing population have put tremendous pressures on India's remaining forest lands, leading to deforestation in many areas. Forests are also used for grazing of animals, and trees are often lopped for fodder (Sharma 1978:208).

By one estimate about 4.0 million hectares of forest area have been lost during the past two decades; about half of this was lost

to agriculture, while the remainder can be accounted for by river valley schemes and the relocation of persons displaced by those schemes, industry (over 120,000 hectares), and road construction (about 57,000 hectares) (Bandhu and Bhardwaj 1979:216; WER March 26, 1979:4). Forest fires present another threat to forest resources; records for indicate that between 1968-69 and 1972-73 an average of about 258,000 hectares of forest per year were lost to fires (NCA 1976:vol. 9:381).

In Jammu and Kashmir, for example, it was reported that of the some 21,037.44 square kilometers of forest area, some 5,683.11 square kilometers was deforested as of 1969, chiefly as a result of fuelwood exploitation (Bandhu and Bhardwaj 1979:229-230). In Uttar Pradesh, the last three decades have seen the loss of 16,000 kilometers of forest to cultivation, and of an additional 1,120 square kilometers for dam, reservoir, and road construction (WER, Nov. 6, 1978:5). All indications are that the extent of deforestation may, in fact, may be much greater than shown by official figures: "...even in the protected areas one finds considerable tracts of small shrubs that have gone through tremendous qualitative changes which have remained unrecorded and unnoticed, while it is not uncommon to find vast areas of open grounds which support only shrubs although they were formerly forested and are still counted as forests in official statistics because of the unrecorded deforestation"(Parikh 1977:194).

Recent satellite studies in Orissa have indicated a large deviation between Forest Department statistics and actual forested areas. Whereas forest department statistics indicated that over 43.6% of the state was in forests as of 1972-73, Landsat findings from 1975 placed the forest area at only 31.7% of the state's territory (see page 49).

The grim outlook for Madhya Pradesh, Indian most heavily forested state is summarized by Erik Eckholm: "Already, according to a recent field survey, the annual cutting of firewood and timber exceeds new growth in twenty-six of the state's forty-five districts. If current trends persist, sixteen of these deficit districts will be virtually bereft of trees within twenty years; more than half the state will be devoid of trees within fifty years" (Eckholm 1979:17).

effects of deforestation

Rapid deforestation has a tendency to change eco-systems, leading to erosion as well as to changes in the climatic conditions. The exploitation of tree growth on farm lands and community lands for fuelwood has not only exhausted fuelwood supplies but also led to accelerated erosion (Sharma 1978:207).

In parts of the Himalayan areas, removal of protective forest cover has drastically reduced the water holding capacity of the areas, and rains, rather than being held by vegetation and the humum of the forest floor, are swept away, carrying with them millions of tons of silt. Streams consequently dry up once the rainy season ends and drinking water shortages occur, forcing women to walk long distances to gather water (Bandhu and Bhardwaj 1979:253-254). Furthermore, much of the silt blocking India's hydroelectric dams comes from this source (Sharma 1978:207).

Deforestation in the Himalayan region of states such as Uttar Pradesh has been linked to the increasingly disastrous flooding both in the

Himalayas and in the Gangetic valley. The Director of Forestry in the of Uttar Pradesh, in discussing the unprecedently severe flooding of 1978, attribued the problem to the combined effect of rapid draining of denuded catchment areas and the silting of rivers, with consequent loss of carrying capacity--both of which can be directly traced to deforestation (WER: Nov. 6, 1978: 5). To complicate matters, however, India's flooding problems can be accounted for not simply by deforestation within its own boundaries but in Nepal, where many of its rivers originate. Adequate control of the problem would therefore necessitate cooperation between Nepal and India and involve massive reforestation programs in each country (WER: Nov. 6, 1978:5).

In Jammu and Kashmir state, deforestation, resulting from heavy felling of trees, gathering of fuelwood, overgrazing in forests, and clearing of forest lands by nomadic peoples for cultivation, as well as from over-grazing of pastures and other practices, has led to the denudation of hilltops, reductions in wildlife numbers, erosion, and consequent silting of water bodies. (Bandhu and Bhardwaj 1979:231).

In Rajasthan's Udaipur district, which differs from the remainder of that otherwise arid and sparsely forested state in supporting a comparatively luxurient vegetation, human pressures by growing numbers of tribesmen, who depend forest resources for their livelihood, have stripped the hillsides near the city of Udaipur, making reforestation efforts imperative (Bandhu and Bhardwaj 1979:235-236).

In the Himalayan state of Himachal Pradesh, where forests play an important role in supplying timber for construction, fuel for domestic purposes, and fodder for domestic animals, there has been heavy clearing of forest lands to supply more agricultural land for the growing population. Because the soils are poor, however, erosion follows rapidly upon forest clearing; heavy grazing by domestic animals in forests and village waste lands exacerbates the problem enormously (Bandhu and Bhardwaj 1979:252-253).

Excessive runoff during the monsoon months and insufficient water supply during summer from rivers, wells, and springs are recurrent problems which could be significantly alleviated throught afforestation of watersheds; it has been urged that forest policy emphasize adequate reafforestation of watersheds and the designation of such forests as protective forests (Bandhu and Bhardwaj 1979:220).

2.5.4 Forest policy

The Indian National Forest Policy was first announced in 1952. It called for about one-third of Indian territory under forest cover: 60% in the mountains and 20% in the plains. The policy stressed the promotion of village forests, and moves inspired by this policy attempted to promote tree-consciousness among the people, including an annual tree festival called Vanamahotsava (Eckholm 1979:14).

Forestry has been a component of India's five year plans. Under the Fifth Plan (1974-79), the chief objective of forest policy was to secure optimal benefits from forest resources, existing or to be created. Environmental conservation was to be an important consideration here.

The second objective was to meet the requirements of the nation and forest industries to achieve self-sufficiency in forest products. The plan also urges increased exports of forest products to earn foreign exchange and increase employment opportunities (Sharma 1978:28).

It has recently been reported that the government, alarmed by large losses of forest areas is planning to revise its forest policy by considering environmental effects before allowing river valley clearing projects. Furthermore, the National Commission of Agriculture has suggested that the consent of state legislatures should be required for essential deforestaiton (WER March 26, 1979: 4).

A recent draft for a revised Forest Policy, prepared by a sub-committee of the Central Board of Forestry, has the following salient features: (1) emphasis on the need to manage forest resources for aiding economic progress in the country, with particular attention to tribal welfare; this includes attention to recreational and touristic activities that do not damage natural habitats and other forest resources; (2) in view of the fact that only about 22 to 23% of Indian territory is under forest cover--as opposed to the 33.3% recommended in 1952--the revised policy recommends that State Legislature approval be required for the diversification of forest areas to non-forest uses; (3) forests are classified into: state forests; community and village forests; forests on other lands; and private forests and tree groves; recommendations are made concerning the regulation, containment, and replacement of shifting cultivation; (4) the role of forests in environmental conservation, production, social benefits (recreation, grazing, agriculture, timber, fuel wood, minor forest production) is treated at some length; (5) the financing of forest development activities through institutional finance is proposed; areas identified as requiring urgent allocation of resources are: watershed protection; nature and environmental protection; development of communications; forest-based industries; export promotion and import substitution; and recreation and domestic needs; (6) emphasis is placed on the need for a uniform forest law with adequate enforcement mechanisms; the need for efficient forest administration is detailed; because forestry is an important source of employment, the formation of cooperative and labor societies is also recommended; (7) the involvement of the school and college community in forest management policy implementation is also recommended; also recommended are: nature conservation and environmental preservation as school and college subjects; uniform forestry education for forestry officers; a comprehensive analysis of long-terms needs for forest research programs (Bandhu and Bhardwaj 1979:215-217).

2.5.6 Forest plans

As of 1975 about 70.4% of the India exploited and exploitable forests were covered by forest plans, designed to ensure the scientific, planned, and useful exploitation of the forest resources. Because the state owns most of the forest land (about 93-95%) the responsibility for developing such plans is a state responsiblity (Thapar 1975:9).

2.5.7 Forest preserves and forest plantations

Man-made forests (afforested areas) comprise about 2% of the total forest area of India. These forests are concentrated in the south and south-eastern part of the country in Karnataka and Tamil Nadu, where the major species are teak and eucalyptus. Plantings in the northern regions, particularly Uttar Pradesh and Bihar, are chiefly of bamboo and sissoo (Thapar 1975:9). Up to 1968-69, the most planted species, in descending order of importance were: teak, eucalyptus, conifers and soft woods, cashew nut, bamboos, sisso, babul, khair, casuarine, wattles, sal, rubber, and sandal (Thapar 1975:62).

Reforestation efforts fall under several categories: economic plantations for industrial and comercial use, plantations of quick growing species, and farm forestry-cum-fuelwood plantations (Sharma 1978:13). Under the Fourth Plan is was found that plantations of fast-growing species entailed the highest expenditure per hectare (Rs. 743), economic plantation for industrial and economic use slightly less (Rs. 704), and fuelwood plantations considerably less (Rs. 568 per hectare).

2.5.7.1 Social forestry

The government has expressed increasing concern over the declining real income of the 72% of the Indian population in the agricultural sector of the economy; one facet of the effort to improve this situation is the establishment of a chain of rural cottage industries based on the raw material, such as trees, that can be made available locally.

The social forestry program calls for the planting and protection of trees on waste land, mainly within established agricultural areas, including margins of roads, railways, irrigation channels, and living areas as well as the planting of tree crops on portions of small farms and village commons land unsuitable for other crops (World Bank 1979: 53). In the draft sixth plan, the social forestry program is considered in terms of its benefits in yields of firewood, land conservation, and the production of raw materials to form the basis for employment in cottage industries (World Bank 1979:53).

As recognized in the draft plan, which sets no quantitative targets for land area planted or for production, difficult organizational problems are involved in the planting and protection of trees in scattered small areas. It is emphasized that in order to succeed, strong local support from local government, Panchayats, and voluntary organizations will be indispensable, as well as Forestry Department assistance in the form of provision of proper seedlings and technical support. Most states still lack the institutional framework for a successful social forestry program. It has been suggested that such programs could benefit from inclusion in the general extension service, particularly where Forestry Departments are able to provide inputs and technical support (World Bank 1979:53)

Recent statistics for Uttar Pradesh indicate that about 14,000 square kilometers (1,400,000 hectares) of cultivable wasteland would be immediately

available for such plantings plus an addition 3,000 square kilomters along roads, canals, and railway tracks, on vacant mounds of village tanks, and on village common lands, etc. Although tree planting over much of this area is considered a troublesome proposition, a number of useful species suitable for planting and useful for supplying raw materials for cottage industries have been identified. These include: mahua (Madhuca latifolia), neem (Melia azadirach), kanji (Pongamia pinnate) aonla (Phyllanthus emblica), babool (Acacia arabica), mulberry (Morus alba), arjun (Terminalia arjuna), sisso (Dalgergia sisso), dhak (Butea monosperma), keo-babool (Leucaena glauca), august (Sesbania grandiflora), sirsa (Albizzia lebbeck), and species of eucalyptus (Bandhu and Bhardwaj 1979:221-222).

Cottage industries based on such social forestry operations might include: rearing of silk worms on the leaves of mulberry and arjun; village dairy industries based on leaf fodder from trees such as keo-babool and august; paper pulp industry based on quick growing species such as august; match production using poplars and arru (Allanthus) in latitudes above 28 degrees north; oil extractions from the seeds of mahua, neem, and kanji; production of furniture, windows, doors, and bullock carts using species such as babool; canning operations based on the fruits of the mango, guava, and aonla; tanning using the bark of babool and arjun (Bandhu anmd Bhardwaj 1979:223-225).

Cost estimates for social forestry operations run as high as Rs. 5,000 to plant a hectare of 1,000 trees of economic value. Costs are high because of the difficulties of raising trees in some marginal areas. The envisioned program for Uttar Pradesh would, by this calculation, require an investment of Rs. 50,000,000 to plant a total of 1,000 square kilometers during the course of the sixth five year plan. In a pilot project at Bihar, the Ford Foundation established a cost of Rs. 7,400 per hectare to plant mulbery and arjun for silk worm rearing (Bandhu and Bhardwaj 1979:222-225).

Besides the creating of jobs, other benefits, arising to a large extent from the contribution of forests to soil conservation and watershed protection, are expected from social forestry: prevention of air pollution; decrease in the intensity of floods; an anticipated 10% rise in the productivity of agricultural land; creation of habitat for birds and small wild life; an increase in underground water sources; a decrease in waterlogging as a result plantings along canal banks (Bahdhu and Bhardwaj 1979:225).

Advocates of the social forestry program, emphasize above all the opportunities it offers for employment of the rural poor. The Director of the Social Forestry Program in Uttar Pradesh has estimated that the scheme of raising village forests over about 1,000 square kilometers would provide employment over a five year period to about half a million people now living in extreme poverty. He concludes: "...it is clear that if we want to stem the tide of rising poverty and all that goes with it there is no escape from implementing a programme of planting trees and raising village forest on a massive scale particularly in thickly populated areas where there are very few forests and

a large number of villagers are living below the grinding poverty line, by making available necessary funds and by creating an effective organization to implement is, so that a chain of rural cottage industries could be established"(Bandha and Bhardwaj 1979:225-226).

2.5.7.2 preservation plots

Preservation plots are miniature reserves that serve to protect representative areas of the chief types of forest and of exceptional trees of India. Although the first preservation plot was set aside as early as 1905 in the sal forests of Bihar, major moves in this direction were only taken after the meeting of the Third Silvicultural Conference in 1929. By 1939, the date of the Fifth Silvicultural Conference, 112 plots had been laid out in different areas; this conference recommended that action be taken to designate further plots, with the object of (1) preserving examples of existing forest as far as possible in their present form and (2) preserving such selected forest plots from all forms of injury, so as to permit progression towards the climax form. As of 1974, when the first extensive survey of these plots was completed, there were 188 preservation plots throughout the country (163 in natural forests and 25 in plantations) covering an area of 8,422.35 hectares (8395.18 in natural forests and 22.17 in planatations). Sizes of plots ranged from 0.01 hectares in Himachal Pradesh to 4,000 hectares in Assam. Thirteen of the states and union territories have no plot (Preservation Plots...1975: Preface, 1).

2.5.7.3 the chipko movement

An interesting grass-roots attempt to save India's dwindling forest resources is the Chipko Movement among the hill people of Uttar Pradesh. Led by a disciple of Ghandi, Chandi Prasad Bhatt, the Chipko ("hug the trees") movement, with headquarters in Gobeshwar, consists mostly of literate or semi-literate people who are concerned not only because they must travel increasingly further distances to gather firewood for domestic uses but also because they recognize the relationship between the deforestation and soil erosion and drying up of water resources. Although the Chipko movement has focused its efforts on the prevention of further tree cutting (its most famous victory was achieved when a group of women, in the face of armed opposition, prevented a logging company from cutting down a forest by refusing to let go of the trees), its leaders also look to the future, advocating a rational forest policy that will take human needs into consideration. Among other things they argue for more small-scale participation in forestry operations and the establishment of small-scale local industries based on forest products to enable local people to reap more of the economic benefits from the forest resource instead of simply earning small sums as lumberjacks for large logging companies. They believe that increased earnings resulting from these and other job opportunities will enable people to afford fuels other than wood for cooking and heating purposes, a development that would be doubly beneficial, taking some of the pressure off the limited forest resources and relieving people of the drudgery of lenthy wood-gathering expeditions. For the short range, however, leaders of the Chipko movement are calling for the development of cheap devices to make wood carrying less difficult (Agarwal 1978:16-19).

2.6 WILDLIFE

2.6.1 Wildlife resources *

India has a great diversity of fauna corresponding to its diversity of physical and climatic conditions. There are an estimated 500 species of mammals, 1,200 species of birds, and some 30,000 insect species as well as abundant fish life and reptiles (India, Min. of Inf. 1978: 4).

India has offered a wide and rich variety of wildlife habitats: the Himalayas to the north; the mangrove swamps of the eastern coast; the western deserts; the deciduous forests of the central plateau; and the reed jungles of the valleys of the Ganges and Brahmaputra.

2.6.1.1 mammals

Among the cat species are: the snow leopard of the Himalayas (Panthera uncia); the Asiatic lion (Panthera leo persica), once common throughout the plains of the Ganges and into the desert zone of Rajasthan but now limited to the Gir Forest in Gujarat; the Indian tiger (Panthera tigris) --the national animal of India--, whose habitat has covered much of peninsular India and areas of the north and north east; and the leopard (Panthera pardus), which was once widely distributed throughout most of india but is now found only in sanctuaries. There are also the clouded leopard (Neofelis nebulosa), the golden cat (Felis temmincki), the jungle cat (Felis chaus), the fishing cat (Felis viverrina), the Rusty spotted cat (Felis rubiginosa), the marbled cat (Felis marmorata), the lynx (Felis lynx), Pallas's cat (Felis manul), and the caracal (Felis caracal).

Deer and antelope species include the rare Kashmir stag or hangul (Cervus elaphus hanglu), about 250 of which are left in the forests around the Vale of Kashmir; the swamp deer or hardground barasingha (Cervus duvaucelli branderi), about 3,000 of which remain in isolated marshes and open woodland in the east, northeast, and north of the country; the brow-antlered deer or thamin (Cervus eldi), limited to about 25 individuals in the marshlands of Manipur State; the musk deer (Moschus moschiferus) a unique Indian species, of the moist mountainous forests of the north; the blackbuck or Indian antelope (Antilope cervicapra), scattered occurrences of which are found throughout its earlier range, which had included almost the whole of present-day India with the exception of the northeast; the diminutive mouse deer or Indian chevrotain (Tragulus meminna); the Chousingha or four-horned antelope (Tetracerus quadricornis)--the only four-horned mammal and a uniquely Indian species found in hilly areas in southern India; ; the chinkara (Gazella gazella); the nilgai (Boselaphus tragocamelus), fairly common in Bihar and Madhya Pradesh; the sambar (Cervus unicolor), a forest deer found throughout the southern Peninsula; the chital (Axis axis), a quick-breeding species still surviving in large numbers in most of the southern peninsula; and the muntjac or barking deer (Muntiacus

*The inventory of Indian widlife presented here represents a synthesis of several sources: Putnam 1976; India. Indian Board of Wildlife 1970; Krishnan 1975; and Mani 1974.

muntjak), confined to the hill forests in the southern peninsula.

Wild goat and sheep species include: the markhor (Capra falconeri), about 250 of which make their home in India's Himalayan foothills; the Himalayan tahr (Hemitragus jemlahicus), a shaggy goat thinly scatter betwsen Kashmir and Bhutan; the Nilgiri tahr (Hemitragus hylocrius), about 1,000 of which inhabit steep cliffs in the Western Ghats in Kerala and Tamil Nadu; the ladakh urial (Ovis , which survives in scattered herds along the upper Indus in the Himalayas; the ibex (Capra ibex); the Assam takin (Budorcas taxicolor taxicolor, occurring in the mountain of Assam; the serow (Capricornis sumatraensis); and the bharal or blue sheep (Pseudois nayaur) of the Himalayan areas.

There are two varieties of wild asses: Equus heminous kiang--the kiang, and Equus hemionus khur--the Indian wild ass, now limited to something over 700 individuals in the Rann of Kutch in Gujarat.

Wild ruminants include the gaur or Indian bison (Bos gaurus), an animal whose numbers have been greatly reduced by domestic livestock diseases such as rinderpest; its greatest concentrations are now in the low-elevation hill forests of the south; and the wild buffalo (Bubalus bubalis)(the source of most strains of domesticated Indian buffaloes), about 2,000 of which still survive in jungles and riverine marshes mostly in Assam, but also in Orissa, Andrha Pradesh, and Madhya Pradesh. The wild yak (Bos grunniens) survives in small numbers in remote mountain areas on India's border with Tibet.

The larger ungulates are represented by the Asiatic elephant (Elephas maximus), found in the hill forests along the Western Ghats in the South in the interior hill-forests of Orissa and Bihar, in similar habitats in Uttar Pradesh, as well as in West Bental and Assam. By a recent estimate about 7,000 of these animals, which have also been domesticated, remain in the wild. The great Indian rhinoceros (Rhinoceros unicornis), whose habitat had extended to the whole Ganges basin, is now limited to about 900 individuals in Assam, 700 of which are in Kaziranga National Park.

The sloth bear (Melursus ursinus), the only bear of the Indian peninsula, is becoming increasingly rare in this area; it is found in parks and sancutaries in Tamil Nadu and Maharashtra. Not a bear, but rather a relation of the raccoon is the red panda (Ailurus fulgens), which occurs in the Himalayas.

The many monkeys include: the bonnet monkey (Macaca radiata); the Rhesus monkey (Macaca mulatta); the lionTailed macaque (Macaca silenus), with about 500 indivuals surviving in the evergreen forests of the Western Ghats in Tamil Nadu and Kerala; the capped langur (Presbytis pileatus) of Assam; the common langur (Presbytis entellus); and the Nilgiri langur (Presbytis johni). The golden langur, a rare species, is found only on the Bhutan border. The hoolock (Hylobates hoolock), a small gibbon, is confined to the rain forest of the northeast.

Common throught the southern peninsula is the small Indian civet (Viverricula indica), which is found in open deciduous forest and scrub jungles and is also found around villages; found in similar areas is the common palm civet (Paradoxurus hermaphroditus). The common mongoose (Herpestes edwardsi) is also common in open scrub areas throughout the peninsula, while the stripenecked mongoose (Herpestes vitticollis) occurs most frequently in deciduous forests along the Western Ghats. The binturong (Arctictis binturong), another types of civet, was listed among the species threatened with extinction by the Expert Committee in 1970.

The wild pig or boar (Sus scrofa cristatus) occurs throughout India; in the peninsula its most common habitat is open forests, from which it makes raids into cultivated fields. The pygmy hog (Sus salvanius), however, is limited to belts of marshy grassland in Assam and the Himalayan foothills; because sightings of this animals are so rare, the 1970 Expert Committee listed it as presumed extinct.

Wild canine species also occur in India. The striped hyena (Hyaena hyaena) occurs in both forests and in rocky bush country in the southern peninsula, but is also widely distributed throughout the rest of the country, including the Rajasthan Desert. A well-known scavenger whose howling has been one of the common features of the nighttime hours in India, the jackal (Canis aureus) occurs throughout India; in the peninsula its presence has been noted particularly around villages on the forest's edge, while in the desert area of Rajasthan it dwells in caves, where the wolf (Canis lupus) is also found. The dhole or wild dog (Cuon alpinus), found chiefly in forests in southern India, has often been considered a nuisance animal and therefore the object of government bounties.

The smaller mammals of India include the large brown flying squirrel (Petaurista petaurista phillippensis), the Indian giant squirrel (Ratufa indica), the Indian porcupine (Hystrix indica), the Indian hare (Lepus nigricollis), the hispid hare (Caprolagus hispidus), the hog badger (Arctonyx collaris), many bats, and large numbers of rodents, which are especially common in the desert areas of India, where their assaults on the sparse vegetation are cited as a cause of desertification (NCEPC 1977).

2.6.1.2 birds *

The abundance of colorful bird life includes the peacock, the national bird. In the forests and wetlands are found pheasants, geese, ducks, mynahs, parakeets, pigeons, cranes, hornbills, and sunbirds.

The abundance of bird life in India includes some 17 orders and 63 families, and 1,200 species, including (by order and common English designation): Podicipitiformes: grebes; Pelecaniformes: pelicans, cormorants, darters;

*This brief outline of Indian birdlife is from Salim Ali, The Book of Indian Birds, 10th edition (revised and enlarged). Bombay: Bombay Natural History Society, 1977. The most recent exhaustive work in this area is contained in Salim Ali and S. Dillon Ripley, Handbook of the Birds of India and Pakistan, 10 volumes, Oxford University Press, 1968-74.

Ciconiiformes: herons, egrets, bitterns, storks, ibises, spoonbills, and flamingoes; Anseriformes: ducks and geese; Falconiformers: hawks, vultures, and falcons; Galliformes: pheasants, junglefowl, patridges, and quails; Gruiformes: button and bustard-quails, cranes, rails, coots, and bustards; Charadiiformes: jacanas, oystercatchers, plovers, curlews, whimbrels, godwits; painted snipe, stilts, avocets, stone curlews, coursers, gulls, and terns; Columbiformes: sandgrouse, pigeons, and doves; Psittaciformes: parrots; Strigiformes: barn owls and owls; Caprimulgiformes: nightjars; Apodiformes: swifts and crested tree swifts; Coraciiformes: kingfishers, bee-eaters, rollers, hoopoes, and hornbills; Piciformes: barbets and woodpeckers; and Passeriformes: pittas, larks, swallows, shrikes, orioles, drongos, swallow-shrikes, mynas, crows, tree pies, cuckoo-shrikes, minivets, loras, bulbuls, babblers, flycatchers, warblers, thrushes, chats, robins, tits, nuthatches, pipits, wagtails, flowerpeckers, sunbirds, white-eyes, house and yellowthroated sparrows, weaver birds, munias, rosefinches, and buntings.

Although each part of the country has its own most common species, the most common birds throughout the country are the sparrow and the house crow, followed by mynas and bulbuls. The common peacock (Pavo cristatus), the Indian national bird, is found in dense scrub and deciduous jungle both on plains and in the foothills through India and occurs locally up to 5000 feet in the Himalayas. The rarest birds include the mountain quail (Orphrysia supercilliosa), Jerdon's courser (Cursorius bitorquatus), and the Pinkheaded duck (Rhodonessa caryophyllacea). These birds are considered endangered as are also the great Indian bustard, a large heavy groundbird whose range once included most of the Peninsula and the Indo-Gangetic plain but which now occurs only in scattered locatation in grasslands in western India; the western tragopan (Tragopan melanocephalus), a type of pheasant limited to the Western Himalayas in Himachal Pradesh; the Siberian white crane (Grus leucogeranus), once a regular winter visitor to much of the Ganges but now seen only in Keoladeo Ganga Sanctuary; and the white-winged wood duck (Cairina scutulata), a rarely seen inhabitant of secluded jungle areas of Assam.

2.6.1.3 reptiles

The rivers and lakes of India provide habitat for crocodiles and gharials, the latter of which are unique to their order. Endangered are the gavial or gharial (Gavialis gangeticus), formerly common in the Ganges and Brahmaputra Rivers and their tributaries but now severely depleted by hunters. An investigation in 1973 along some 5,000 kilometers of waterways formerly serving as habitat for the gavial uncovered only six in the course of three months. The mugger crocodile (Crocodilus palustris), once common throughout India, even in the larger lakes of the Indian Desert, is also listed as an endangered species as is also the once widely distributed estuarine crocodile (Crocodylus porosus), which is now limited to mangrove areas of Orissa and the Sunderbans of West Bengal (Singh 1976: 540).

Probably the most famous of the India reptiles is the deadly cobra (Naja naja), which along with the krait (Bungarus caerulus) is among the most deadly poisonous snakes in the world. Other common poisonous snakes are Ruselis viper (Vipera russelii russelii), found in dense jungle hills, open plains, and paddy fields, and the saw-scaled viper (Echis carinatus), a denizen of arid, rocky, and sandy regions. The Indian desert has some 18 species each of lizards and and snakes, the most common of which is the viper (E. carinatus).

2.6.1.4 Insects

Among the estimated 30,000 species of Indian insects are the malaria-carrying mosquito and the destructive moths and locusts. The desert locust (Schistocerca gregaria) is the most voracious destroyer of greenery, swarms of about one square kilometer in size being capable of destroying 200 to 300 tons of vegetation in a day (NCEPC 1977:26).

2.6.2 Utilization of wildlife

Wildlife and wildlife areas today serve as tourist attractions. Trade in wildlife products such as skins and feathers, etc. is a practice which continues despites severe restrictions. Wildlife also serve as a source of products such as traditional medicines. Wildlife are certainly a source of food, especially for tribal groups, but no information on this practice could be found.

Elephants in the past have been captured as beasts of burden, and there are indications that this practice still takes place (Putnam 1976). Forest agencies in the Indian states still use elephants in timbering operations in national parks. An estimated 30 to 35 are in use at Mudumali Park in Kerala. Elephants and other wildlife all serve as tourist attractions. In some parks, tamed elephants are used to transport tourists through the parks (Personnal communication: International Division of the U.S. Park Service).

2.6.3 A brief history of wildlife conservation in India

India is said to have had a long tradition of wildlife protection and conservation. In ancient times, for example, forests and their wild inhabitants were protected as part of religious practice, and activities such as hunting, fishing, or felling of trees were forbidden in the vicinity of a temple. Later this respect for nature was translated into laws. As early as the reign of Chandra Guptas in the third century B.C. regular game laws were enforced through the agency of a regular forest organization headed by a superintendent. Afforestion was considered essential, while wild animals and forest products were strictly protected. Even the king--the one person permitted to hunt--limited his activities to one elaborate hunt each year. This protection of wildlife and forests continued over the centuries, becoming more complex under the Guptas (400-600 A.D.), during whose period of ascendancy the king himself was prohibited from killing certain species such as the peacock (Mani 1974: 362-363).

The deterioration of forests and consequent declines in wildlife have been traced to the onset of Moslem rule from the eighth century A.D. onward, during which period conservation laws and practices fell into neglect, to be revived only with the coming of the era of Moghul rule in 1526 A.D. During the 16th and 17th centuries hunting became a fashionable sport among the ruling Moghul class, with elephant, lion, tiger, buffalo, wild goat, and blackbuck the most prized animals. With the coming of the European colonists to Indian, another element was introduced onto the scene, as items such as panther-heads and skins, rhinoceros horns, and elephant tusks became prized trophies for British officers to ship home to England (Mani 1974: 364-365); later, however, the British colonial government also introduced the laws for wildlife protection which formed the basis for recent legislation in this area.

The 18th and 19th centuries also saw the beginning of massive environmental changes such as the clearing of forests areas following the foundation of Calcutta in the 18th century. The reclamation of swamps land for industrial development and the extension of agricultural activity and human settlements into the areas surrounding Calcutta led to the disappearance from these areas of animals such as the Javan rhino, the wild buffalo, the swamp deer, the barking deer, and the fishing cat (Mani 1974: 365-366).

The factor of human influence on the disappearance of species has intensified in importance since the period just preceding and following independence in 1947. This has been a period of rapid population growth during which the Indian population has nearly doubled, undergoing an increase of nearly 300,000,000 persons. The increase of population alone has created pressure on wildlife habitat. But other factors have also come into play. According to one observer of the situation: "...the cult of civil disobedience, propagated by political leaders during the freedom struggle and regularly practiced by diverse parties since then, has had the result of generating a...contempt for all laws, including forest and game protection laws, so that killing of wildlife flourishes completely unchecked, particularly because there is a flourishing export market for such goods (Mani 1974:366). It has been estimated that this disregard for law and a growing skepticism towards religious taboos and customs combined with the used of modern weapons has resulted in the loss of wildlife habitat since the beginning of the 1950's equivalent to or even greater than that experienced during the entire previous course of Indian history (Mani 1974:366).

2.6.4 Endangered and extinct species

"The wildlife of India," reported an Expert Committee on wildlife and national parks in 1970, "is approaching extinction." This problem is reported to have become especially severe with the onset of World War II and to have increased considerably after independence was achieved in 1947: "Crop protection and self defense were common excuses used for widespread massacre, and unrealistic shooting rules and ineffective conservation laws did the rest" (India. IBW 1970: 29).

As is clear from the brief review of Indian wildlife presented above, many species of Indian animals have experienced drastic reductions in

their numbers. Others have completely disappeared or are on the brink of extinction. Among the species now recognized as extinct in India are the cheetah (Acinonyx jubatus venaticus), the Javan rhinoceros (Rinoceros sondaicus), and the Sumatran rhinoceros (Rhinoceros sumatrensis). Other animals such as the hispid hare (Caprolagus hispidus) and the Pygmy hog (Sus salvanius) were categorized as "presumed extinct" by the expert committee in 1970, which also listed the chinkara, the sloth bear, and the leopard as locally extinct in many of its earlier habitats (India. Indian Board of Wildlife 1970).

The list of animals now considered endangered is presented on pages 72a and 72b. This list is drawn from three sources: from the 1979 edition of the U.S. Fish and Wildlife Service list of Endangered and Threatened Wildlife and Plants; from the list of animals considered endangered or extinct by the Indian Board for Wildlife in its 1970 report Wildlife Conservation in India; and the IUCN Red Data Book List of threatened and endangered mammals. It should should be noted that some of these animals may in fact already be extinct.

2.6.4.1 Causes of depletion

changes in and destruction or habitat

The 1970 report of the Expert Commission on Wildlife lists changes in habitat as the chief factor leading to the reduction of wildlife numbers.

This has come about because of the loss of land under forest and the encroachments of industrial and other commercial enterprises on reserved lands or close to sanctuaries. In many cases, government authorities have ceded large tracts of land within reserved forests or have permitted grazing, fuel collection, and other practices (India. Indian Board for Wildlife 1970: 3).

Development projects such as hydroelectric installations and multi-purpose dams have also brought about deforestation and loss of wildlife habitat, while marshy areas have been drained without concern for their importance as waterfowl reserves and breeding places. Furthermore, natural wildlife habitats have been altered as native forest areas have been planted with exotic species such as eucalyptus and wattle. Increases of human activities within or close to wildlife areas endangers wildlife habitat through the pollution of air, soil, and water that may result in the deaths of large number of animals, birds, and fish. The dangers to wildlife from increasing use of pesticides constitute a problem as well.

The construction of dams and artificial canals, along with hunting are said to have been responsible for the serious reduction in numbers of the Indian gavial. This crocodilian reptile was also killed by fisherman who caught it in their nets (Salvadori and Florio 1978:175).

As human habitat pushes closer to remaining wildlife areas, conflicts arise between agricultural interests and those of wildlife, which may enter cultivated fields or pose a threat to the lives of farmers and their families. Much wildlife has been destroyed by farmers using crop protection guns to drive animals off their fields. It has recently been reported, for example, that more elephants are now shot as a crop pro-

ENDANGERED SPECIES OF INDIA

fw: species listed in the 1979 reprinting of Endangered and Threatened Wildlife and Plants of the U.S. Fish and Wildlife Service
ib: listed in by the Indian Board of Wildlife (1970)
r: listed in the IUCN Red Book as endangered in India (applies only to mammals)
sI: animals listed in Schedule I of the Indian Wildlife Protection Act 1972: hunting forbidden
sII, sIII: animals listed in Schedules II and III of Indian Wildlife Protection Act: hunting permitted with and under the conditions specified in a license. Schedule II and III membership is indicated only for those animals already on other lists.

MAMMALS

fw	ib	r	sI	Great Indian rhinoceros Rhinoceros unicornis
fw		r		Sumatra rhinoceros Didermocerus sumatriensis
fw		r	sII	Asian elephant Elephas maximus
fw		r	sII	Seladang (Gaur) Bos gaurus
fw		r	sII	Wild yak Bos grunniens mutus
	ib	r	sI	Asian buffalo Bubalus bubalis
fw	ib	r	sI	Wild Asian Ass Equus hemionus
			sI	Takin or mishmi takin Budorcas taxicolor
			sI	Tibetan gazelle Procapra picticaudata
fw	ib	r	sI	Eld's brown-antlered deer/thamin Cervus eldi
fw			sIII	Hog deer Axis (Hyelaphus) porcinus annamiticus
fw	ib	r	sI	Swamp deer Cervus duvauceli
fw	ib	r	sI	Kashmir stag Cervus elephus hanglu
	ib	r	sI	Himalayan musk deer Moschus moschiferus moschiferus
	ib	r	sII	Nilgigi tahr Hemitragus hylocrius
	ib		sIII	Bharal Pseudois nayaur/Ovis nahura
			sI	Ovis ammon/nyan Ovis ammon hodgsoni
	ib		sIII	Indian ibex Capra ibex
	ib		sIII	Chinkara Gazella gazella bennetti
	ib		sI	Blackbuck Antilope cervicapra
fw	ib		sI	Urial or shapu Ovis vignei
	ib	r	sI	Markhor Capra falconeri
				Gibbons Hylobates spp.
fw	ib		sI	Hylobates hoolock
fw	ib		sII	Capped langur Presbytis pileatus
fw				Entellus langur Presbytis entellus
	ib	r	sII	John's langur Presbytis johnii
		r	sI	Golden langur Presbytis geei
		r		Snub-nosed langur Rhinopithecus roxellanae
fw	ib	r	sI	Lion-tailed macaque Macaca silenus
fw				Stump-tailed macaque Macaca arcytoides (listed as Assam)
fw	ib	r	sII	Leopard Panthus pardus
fw	ib	r	sI	Tiger Panthera tigris
fw	ibe		sI	Cheetah Acinonyx jubatus
fw	ib	r	sI	Snow leopard Panthera uncia
fw	ib	r	sI	Asiatic lion Panthera leo persica
	ib	r	sI	Clouded leopard Neofelis nebulosa
			sI	Leopard cat Felis bengalensis
	ib		sI	Golden cat Felis temmincki
	ib		sI	Fishing cat Felis viverrina
	ib		sI	Rusty spotted cat Felis rubiginosa
	ib		sI	Marbled cat Felis marmorata
	ib		sI	Lynx Felis lynx
	ib		sI	Pallas' cat Felis manul

MAMMALS (cont)

	lb		sl	Caracal Felis caracal
fw		r	sll	Asiatic wild dog(Dhole) Cuon alpinus
	lb	r	sl	Indian wolf Canis lupus
		r	slll	Tibetan wolf Canis lupus
		r	sl	Malabar large-spotted civet Vivvera megaspila
	lb		sl	Binturong Arctictis binturong
			sl	Spotted linsang Prionodon pardicolor
fw		r	sl	Hispid hare Caprolagus hispidus
fw	lb	r	sl	Pygmy hog Sus salvanius
	lb		sll	Hog badger Arctonyx collaris
			sl	Loris Loris tardigradus
			sl	Slow loris Nycticebus coucang
	lb	r	slll	Sloth bear Melursus ursinus
	lb		sl	Red panda Ailurus fulgens
			sl	Pangolin Manis crassicaudata
		r		Indus dolphis Platanista indi
fw	lb	r	sl	Dugong Dugong dugon

BIRDS

fw		sl	Great Indian Bustard Choriotis nigriceps
fw		sl	Pink-headed duck Rhodonessa caryophyllacea
fw		sl	White-winged wood duck Cairina scutulata
fw			Relict gull Larus relictus
fw		sl	Blyth's tragopan pheasant Tragopan blythii
fw		sl	Sclater's monal pheasant Lophorphorus sclateri
fw		sl	Western tragopan pheasant Tragopan melanocephalus
fw		sl	White-eared pheasant Crossoptilon crossoptilon
fw	lb	sl	Great White Crane/Siberian Crane Grus leucogeranus
	lb	sl	Crimson tragopan Tragopan satyra
	lb		Peacock pheasant Polyplectron bicaloratum
	lb		Bengal florican Eupodotis bengalensis
	lb		Large pied hornbill Anthracoceros malabaricus
	lb	sl	Mountain quail Ophrysia superciliosa
	lb	sl	Jordon's courser Cursorius bitorquatus
		sl	Bazas Aviceda jeordoni and Aviceda leuphotes
		sl	Cheer pheasant Catreus wallichii
		sl	Great Indian hornbill Buceros bicornis
		sl	Lammergeier Gypaetus barbatus
		sl	Narcondom hornbill Rhyticeros (undulatus) narcondami
		sl	Peafowl Pavo cristatus
		sl	Whitebellied sea eagle Haliaetus leucogaster

REPTILES

fw	lb	sl	Mugger crocodile Crocodylus palustris palustris
fw		sl	Gavial (Gharial) Gavialus gangeticus
fw			Bengal Monitor Varanus bengalensis
fw			Yellow monitor Varanus flavescens
fw			Desert monitor Varanus griseus
fw			Indian python Python molurus molurus
fw			River terrapin (Tuntong) Batagur baska
fw			Flap-shell Indian tortoise Lissemys punctata punctata
fw			Indian sawback turtle Kachuga tecta tecta
fw			Indian softshell turtle Trionyx gangeticus
fw			Peacock softshell turtle Trionyx hurum
fw			Spotted pond turtle Geoclemmys (=Damonia) hamiltonii No.India
fw			Three-keeled Asian turtle Geoemyda (=Nicoria) tricarinata Cent.India
	lb	sl	Estuarine crocodile Crocodilus porosus

tection measure than by poachers (Elephant Conference 1979).

commercial exploitation

Much of India's wildlife, particularly leopards and tigers, were killed in large numbers because of the value of their skins and furs. This activity has now been banned; however, as wildlife habitat is destroyed and human settlements come progressively closer to wildlife sanctuaries, the danger of loss of wildlife from the activities of professsional hunters and poachers increases. Animals have been trapped, netted, poisoned, and shot for their meat, ivory, horn, fur, or feathers. Motor vehicles with spotlights have been used for hunting both within and outside of forests. Village shikaris (hunters) are said to have kept watch at waterholes where they have killed every animal regardless of legal restrictions. Because there have been no provisions for wildlife protection in such areas, the destruction is reported to be most severe in uncultivated wastelands, although large scale trapping has also taken place on seashores and other areas. Poachers has also been a major problem even in wildlife sanctuaries and national parks. Furthermore, there is evidence that crop protection guns intended to frighten off animals encroaching on cultivated fields are used for outright destruction of animals as well. Illegal removal of wood and other plants from forests also contributes wildlife depletion (India. Indian Board of Wildlife 1970).

grazing

Grazing of livestock within forest areas and even within sanctuaries has created problems not only because wildlife must compete with cattle and other domestic animals for the limited food supply but also because livestock may transmit disease to wild animals. In 1968, for example, large numbers of gaur (wild ox: Bibos gaurus) in Mudumalai and Bandipur Sanctuaries were killed off by rinderpest contracted from domestic cattle grazing in the area.

2.6.5 National parks and reserves

As of 1971 the IUCN listed 14 national parks and wildlife sanctuaries meeting the criteria of size, supervision, etc. necessary for inclusion on its list; this number had been raised to 16 on the 1975 IUCN list. A recent listing (April 1979)--presumably from Indian government sources--includes 20 national parks, 190 wild life santuary covering a total of some 62,050.882 square kilometers (6,205,088.2) or less than 2% of total Indian territory (see table, page 74). There are also some 24 zoological gardens.

Density of population in India has prevented the government from declaring nature reserves of any great size. India's largest Wildlife Sanctuary (129,500 ha.) is small compared with some of the larger parks and sanctuaries in countries such as Brazil, Cameroon, Colombia, Chile, Ghana, Indonesia, Kenya, Tanzania, and Uganda.

NATIONAL PARKS AND WILDLIFE SANCTUARIES BY STATE AND UNION TERRITORIES
Source: National Parks and Sanctuaries in India (Mimeographed). April 1979.

state	Natl. Parks	Sanc-tuar-ies	area in square kilometers	
Andra Pradesh		13	8,683.10	
Andaman and Nicobar		4	20.00	
Arunachal Pradesh		4	3,000.57	
Assam	1	6	1,315.00	
Bihar		14	4,401.39	
Goa, Daman and Diu		3	353.00	
Gujarat	2	5	6,834.58	
Haryana		1	1.20	
Himachal Pradesh	1	26	2,286.30+	
Jammu and Kashmir		4	196.80+	
Karnatka	3	15	5,750.58	
Kerala	1	6	2,299.00	
Madhya Pradesh	3	21	11,277.75	
Maharashtra	4	8	4,276.76+	67.977 at Borivili
Manipur	1		25.00	
Meghalaya		1	85.00	
Mizoram		1	180.00	
Nagaland		1	202.00	
Orissa		13	2,803.00	
Punjab		4	249.40	
Rajasthan		11	1,548.00+	+2825443 bighas)
Sikkim	1		850.00	
Tamil Nadu	1	6	2,045.77	
Uttar Pradesh	2	11	4,833.62	
West Bengal		12	3,564.05	
TOTAL	20	190	62,050.88	

The chief difference between a National Park and a Sanctuary lies in the method by which they have been created: National Parks by an Act of the State Legislature and Sanctuaries by an executive order. Although protection for animals is more strictly maintained in National Parks than in the Wild Life Sanctuaries, a certain amount of human encroachment on the park areas is almost unavoidable for both types of area. According to a IUCN assessment of the situation in 1971, exploitation of forests in conjunction with forest management and replanting was not excluded by the granting of National Park status and livestock grazing, although prohibited in the parks, was difficult to suppress. Parks, however, contain certain areas known as inner santuaries (abhayaranya) in which strict protection is maintained (IUCN 1971: 259-260).

State governments receive central government funds for the improvement and development of national parks and sanctuaries.

The establishment and administration of national parks is constitutionally reserved to the individual Indian states. Nevertheless, the central govern-

ment, in an effort to ensure some uniformity among parks and to guarantee that parks established by states would meet certain criteria, proposed in 1957 a Model Bill for the constitution of National Parks to serve as the basis for enactments by state legislatures. 1964 saw both the preparation of a National Parks Policy and the issuance of Standards for National Parks in India under which only those areas conforming to standards laid down by the central Indian Board for Wild Life (under the Ministry of Agriculture) would be eligible for upgrading to National Park status by state legislation.

The central government body concerned with parks and wildlife is the Indian Board for Wildlife under the Inspector General of Forests within the Ministry of Agriculture and Irrigation. The Board was responsible for arriving at the official definition of National Park for India. There are also State consultative bodies with functions similar to those of the India Board for Wild Life. Most of them employ a State Wild Life Officer; some have established a Wildlife Department as distinct from the State Forest Department.

2.6.5.1 Selected national parks and wildlife santuaries (see also map, page 75a)

Bandipur National Park (Karnataka) [1977 IUCN List] PROJECT TIGER
Established: 1941: the Park offers total legal protection
Size: 874.20 km2 (IUCN 1977 states 5,695 ha.)
Animals: elephant, sloth bear, tiger, leopard, sambar, chital, muntjac, gaur; abundant bird life includes peafowl and jungle fowl; most of the best-known Indian snakes occur.

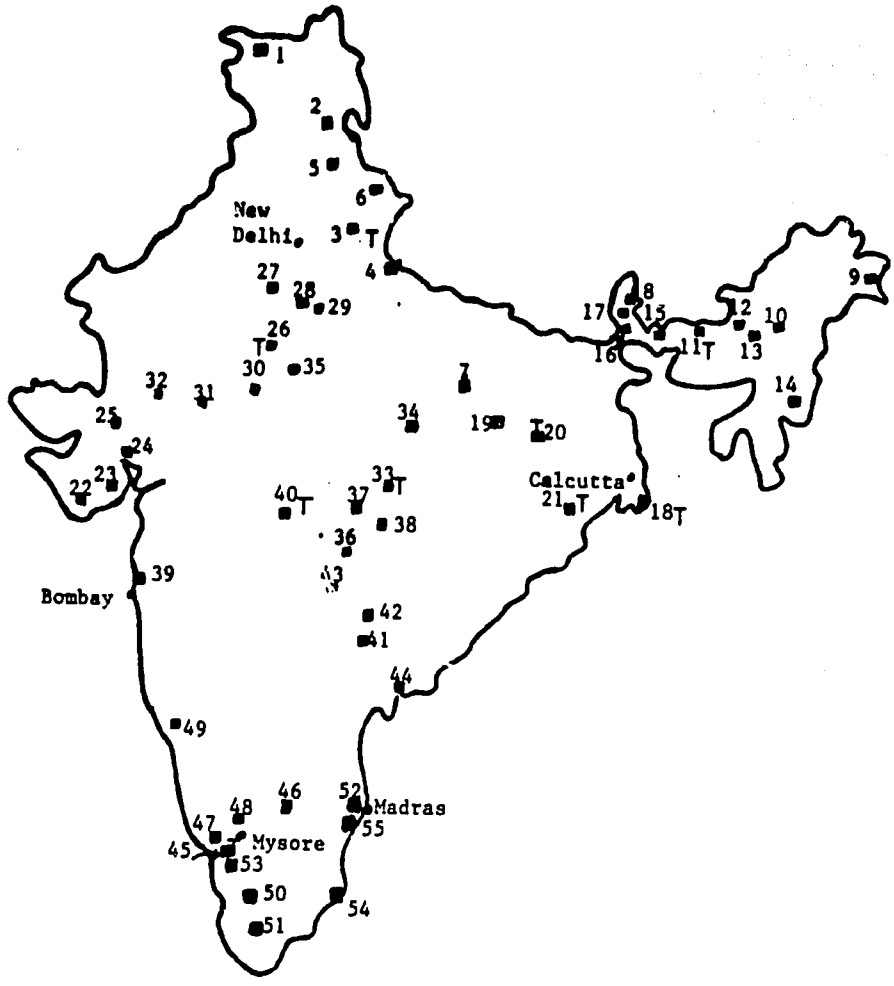
The gaur herd was much reduced by rinderpest in 1969.

Bandhavgarh National Park (Madhya Praesh)
Established: 1968 (still in the development stage)
Area: 105 km2 (also reported as 165.00 or 267.75 km2: IUCN 1977 list)

Animals: tiger, panther, gaur, chital, sambar, nilgai, sloth bear, barking deer, wild board and upland birds. The park is reported to be the home of white tigers.

Borivili National Park (Maharashtjra) [1977 IUCN List]
Established: 1969?
Size: ca. 69.30 km2
Animals: leopard, muntjac, monkeys; plentiful birdlife

Chandraprabha Varnassi Sanctuary
Established:
Size: 78 km2
Animals: nilgai, pig, chinkara, sambar, and chital; since 1957 it has been the home for the Indian lion, brought from the Gir Forest in Gujarat.



Map indicates: those areas designated as national parks; those areas recognized by the IUCN on its 1977 list*; other areas mentioned on the IUCN 1977 list; and other parks shown on the map accompanying Putman 1976.
W.S.= N.P.= National Park; W.S.=Wildlife Sanctuary; S.=Sanctuary

JAMMU AND KASHMIR
1. Dachigam W.S.

HIMACHAL PRADESH
2. Rohia N.P.

UTTAR PRADESH
3. Corbett N.P.* (PROJECT TIGER)
4. Dudwa N.P.
5. Govind Pashu Vihar W.S.
6. Kedarnath S.
7. Chandraprahba S.

SIKKIM
8. Khangchandzoanda (?) N.P.

ARUNCHAL PRADESH
9. Namdafa W.S.

ASSAM
10. Kaziranga N.P.*
11. Manas W.S.* (PROJECT TIGER)
12. Sonai Rupai W.S.
13. Lakhawa W.S.

MANIPUR
14. Keibul Lamjao N.P.

WEST BENGAL
15. Jaldapara W.S.*
16. Mahanadi W.S.
17 Sanchal W.S.
18. Sunderbans Tiger Reserve (PROJECT TIGER)

BIHAR
19. Hazaribagh W.S.*
20. Palamau W.S. (PROJECT TIGER)

ORISSA
21. Similipal W.S. (PROJECT TIGER)

GUJARAT
22. Gir Forest N.P.*
23. Velavadar N.P.
24. Nal Sarovar Bird S.
25. Wild Ass Sanctuary

RAJASTHAN
26. Ranthambore Tiger Reserve (PROJECT TIGER)
27. Sariska W.S.*
28. Keoladeo-Ghana Bird S.*
29. Vanvihar W.S.
30. Darrah W.S.
31. Jaismand W.S.*
32. Mt. Abu W.S.

MADHYA PRADESH
33. Kanha N.P.* (PROJECT TIGER)
34. Bandhavgarh N.P.
35. Shivpuri N.P.*

MAHARASHTRA
36. Taroba N.P.*
37. Pench N.P.
38. Nawegaon N.P.
39. Borivli N.P.*
40. Melghat (Lhakna-kolkaz)W.S. (PROJECT TIGER)

ANDRHA PRADESH
41. Pakhal W.S.
42. Tadwai W.S.
43. Kawal W.S.
44. Kolleru Pelicanary

KARNATAKA
45. Bandipur N.P.* (PROJECT TIGER)
46. Bannarghatta N.P.
47. Nagerhole N.P.
48. Ranganthittoo Bird S.
49. Dandeli W.S.

KERALA
50. Eravikulam Ramjallay N.P.
51. Periyar W.S.*

TAMIL NADU
52. Guindy N.P.
53. Mudumalai W.S.*
54. Point Calimere
55. Vendanthangal Water Bird S.

Corbett National Park (Uttar Pradesh) [1977 IUCN List] PROJECT TIGER
Established: 1935 as Hailey National Park; renamed in 1957
Size: 525.47 km2
Animals: tiger, leopard, sloth bear, elephant, chital, sambar, hog deer, muntjac, wild pig, hyaena, jackal; crocodile Crocodilus palustris and gharial Gavialis gangeticus; red jungle-fowl, peafowl, black partridge F. francolinus; osprey Pandion haliaetus; many song birds.

Dachigam Sanctuary (Jammu and Kashmir)
Established:
Size: 145.00 ; 142.45 km2 (1979 list)
Animals: Hangul/Kashmir stag; black bear; pig; brown bear; baboon; serow; musk deer

The park is heavily grazed by sheep--as many as 2,200 as of 1975 despite regulations placing the permissible number at 800--and also suffers from grass burning and large quantities of pedestrian and motor traffic, all of which disturb the populations of some 200 Hangul. The presence of 15 Indian army infantrymen within the park has resulted in the end of poaching activities (Jackson 1977:103).

Dandeli Wild Life Sanctuary (Karnataka)

Established: 1955
Size: 874.20 km2 (IUCN 1977: 5,729.07 km2)
Animals: elephant, bisons, panther, tiger, sambar, chital, sloth bear.

[Keoladeo] Ghana Bird Sanctuary (Bharatpur, Rajasthan) [1977 IUCN List]
Established: 1956
Size: 29.00 ha
Animals: bird sanctuary: Siberian crane, cormorants, storks, spoon bill, quails, coot, heron, teal, terns, etc.; as well as sambar, chital, black buck, wild boar, civet, etc.

The sancutary has breedoming waterbirds from July to October and migrants from Sepember through March. The Sanctuary is the principal winter refuge of the Siberian crane.

Gir Forest National Park(Gujarat) [IUCN 1977 List]

Established: 1965--with full sanctuary status
Size: 140.40 km2 129,500
Animals: the last remaining habitat of the Asian lion (about 200 lions and cubs) Panthera leo persica,; also leopard, sambar, wild pig, sloth bear, hyaena, nilgai Boselaphus tragocamelus, chinkara G. Gazella bennetti, chital or spotted deer A. axis, four-horned antelope Tetracetus quadricornis; many bird species including large numbers of peafowl.

Local grazing activities have constituted a major threat to the Park and its animals. In 1970, some 500,000 head of cattle and some 4,800 people lived within the Park area. According to the IUCN's 1977 listing of parks and reserves, this situation was slowly changing.

Hazaribagh Wildlife Sanctuary (Bihar)[IUCN 1977 List]

Established: 1955
Size: 186.36 km2
Animals: tiger, leopard, sloth bear Melursus ursinus, muntjac, wild pig, hyaena H. hyaena, sambar Cervus unicolor; birds, including peafowl Pavo cristatus, red jungle-fowl Gallus gallus, green pigeon Crocopus phoenicopterus, and partridges

Jaisamand Wildlife Sanctuary (Rajasthan) [IUCN 1977 List]
Established: 1955 (Under the Rajasthan Wild Animals and Birds Protection Act of 1951)
Size: 52.67 km2
Animals: tiger, leopard, sloth bear, sambar, chital, four-horned antelope, chinkara, wild pig; grey partridge Francolinus pondicerianus, spurfowl, quail, migratory duck in winter, minivets, and other woodland birds.

Jaldapara Wildlife Sanctuary (West Bengal) [IUCN 1977 List]

Established: 1941
Size: 104.64 km2
Animals: great Indian rhinoceros, leopard, sambar, barasingha or swamp deer, a few elephant, tiger and bear. Abundant birdlife includes peafowl and jungle fowl.

Kanha National Park (Madhya Pradesh) [IUCN 1977 List]

Established: 1935: raised to status of national park in 1955; area extended in 1964.
Size: 318.26 ha.
Animals: Indian swamp deer, chital, black duck (?), Indian bison, sambar, and various carnivores; nearly a hundred species of birds.

Kaziranga National Park (Assam) [IUCN 1977 List]
Established: 1908 (National Park status since 1974)
Size: 430.00 km2. plus a no-shooting buffer zone of 16,825 ha.
Animals: great Indian rhinoceros, elephant Elephas maximus, buffalo, hog deer, muntjac, swamp deer or barasingha Cervus duvaucelli, wild pig Sus scrofa, tiger, leopard Panthera pardus, bear

Rhinoceros poaching, which has been a serious problem in the park, is reported by the IUCN in its 1977 listing of parks and reserves to have been brought under control.

Manas Wildlife Sanctuary (Assam) [IUCN 1977 List] PROJECT TIGER
Established: 1928, enlarged in 1965
Size: 80 km2 [IUCN 1977 List states 271.95 km2]
Animals: Great Indian rhinoceros Rhinoceros unicornis, buffalo Bubalus bubalus, gaur Bos gaurus, hog deer Axis porcinus, muntjac Muntiacus muntjak, black bear Selenarctos thibetanus, tiger Panthera tigris; plentiful birdlife

Melghat[Lhakna-kolkaz] Wildlife Sanctuary PROJECT TIGER
Established:
Size: 381.58 km2
Animals: tiger, sloth bear, sambar, barking deer, four horned antelope, wild boar, chital. Plentiful bird life.

Mudumalai Wild Life Sanctuary (Tamil Nadu) [IUCN 1977 List]
Established: 1940
Size: 321.16 km2 (more recent 29,500 ha.)
Animals: elephant, gaur, tiger, leopard, sloth bear, chital, muntjac, sambar, four-horned antelope, hyaena, monkeys, squirrels, jackal Canis aureus, jungle cat Felis chaus, wild pig, otter L. lutra, crodocile, python P. molurus; plentiful birdlife includes peafowl, grey jungle fowl, partridges and spurfowl Gallo-perdix sp., many birds of prey, and song birds.

Nagarhole National Park (Karnataka) (228 km from Mysore via Mercara)
Established: 1955
Size: 571.55 km2
Animals: wild el phant, deer, panther, jackal, occasionally a tiger.

Palamau Wildlife Santuary (Bihar) PROJECT TIGER
Established: 1976
Size: 979.27 km2
Animals: elephant, tiger, panther, leopard, wild board, barking deer, gaur, chital, sambar, pea-fowl,

Periyar Wildlife Sanctuary (Kerala) [IUCN 1977 List]
Established: 1940
Size: 777.00 km2 [perhaps only 67300 ha)
Animals: wild elephants, Indian bison, sambar, stray panther, tiger

Ranthambore Tiger Reserve (Rajasthan) PROJECT TIGER
Established:
Size: 392.20 km2
Animals: Tiger, panther, hyena, jungle cat, civet, sambar, chital, nilgai, bear, wild boar, partridge, green pigeon, red spurfowl, etc.

Rangathittoo Bird Sanctuary (islets in the Kaveri river in Karnataka)
Established:
Size: 26.70 km2
Animals: a variety of storks; breeding places for herons; also white ibis, Indian dartar, cormorant, and cattle egret.

Sariska Wildlife Sanctuary (Rajasthan) [IUCN 1977 List]
Established: 1955; redeclared in August 1958 under the Rajasthan Wild Animals and Birds Protection Act 1951
Size: 195.00 km2
Animals: Tiger, leopard, sambar, chinkara, wild pig, four-horned antelope, nilgai, chital, palm civet Paradoxurus hermaphroditus, small Indian civet Viverricula indica, caracal Felis caracal, ratel Mellivora capensis, porcupine Hystrix indica, hyaena; peafowl, spurfowl and many other species of birds.

Shivpuri National Park (Madhya Pradesh) [IUCN 1977 List]

Established: 1955 as Madhya Bharat National Park; new name as of 1959
Size: 156.00 km2
Animals: sambar, chital, nilgai, chinkara, the Indian tiger, sloth bear, hyaena, four-horned antelope, blackbuck, wild pig; numerous birds;

Simlipal Tiger Reserve (Orissa) PROJECT TIGER
Established:
Size: 2,770.00 km2 (IUCN 1977)
Animals: tiger, rhesus monkey, porcupine, wild dog, sloth bear, hyena, elephant, wild boar

Sunderbans Tiger Reserve (West Bengal)
Established:
Size: 2,585 km2
Animals: tiger, different species of deer, wild bear, estuarine crocodiles, Gangetic dolphin; the reserve is the only known habitat of the goliath heron (Ardea goliath).

Poaching has been a problem in the reserve.

Taroba National Park (Maharashtra) [IUCN 1977 List]

Established: 1935, upgraded to national park in 1955
Size: 116.54 km2 plus a 15,000 ha protected zone surrounding the park in which shooting is prohibited
Animals: tiger, leopard, sambar, chital, gaur; crocodiles

Vedanthangal Bird Sanctuary (54 miles south of Madras)

Established:
Size: .30 km2
Animals: breeding place for white ibis, night heron, spoon bill, open bill stork, Indian dartar, grey heron, egret and two species of cormorant.

Wild Ass Sanctuary, Rann of Kutch (Gujarat)
Established:
Size: 4,840 km2
Animals: wild ass

2.6.5.2 MAB [Man and the Biosphere] Reserves

The Indian Government has not yet officially designated areas to serve as Biosphere Reserves under UNESCO's MAB Program. The Indian Mab National Committee, under the aegis of the Department of Science and Technology (Ministry of Science and Technology), however, has undertaken preliminary investigations of 12 areas which have potential as reserves. These are: 1) an area of the Nilgiri Range and the Mysore Plateau in Kerala; 2) Khangchendzonga National Park in Sikkim; 3) Nanda Devi Sanctuary in Uttar Pradesh; 4) Simplipal and Jeypore Hill Forests in Orissa;

5) Kanha National Park in Madhya Pradesh; 6) the North Islands of the Andamans and the Jarawa Tribal Reserves in the Anadman and Nicobar Islands; 7) Namdapha in Arunachal Pradesh; 8) Lalichipri in Arunachal Pradesh; 9) Pakkul in Arunachal Pradesh; 10) Tawang in Arunachal Pradesh; 11) Walong in Arunachal Pradesh; 12) Sunderbans in West Bengal (India. MAB National Committee 1979).

2.6.5.3 Project Tiger

Initiated in 1972, Project Tiger, undertaken in cooperation with the World Wildlife Fund, is a Rs. 5,000,000 scheme to save the threatened Indian tiger, whose numbers as dropped to as low as 2,000, at all costs. Nine areas were selected for intensive protection and restocking with natural prey. The effort is considered notable because it emphasizes the protection of total biotypes rather than an isolated species (Biological Conservation, vol. 5, no. 3, July 1973). The project is thus helping to preserve not only the tiger but also such endangered species as the wild dog, the leopard, the sloth bear, the swamp deer, the four-horned antelope, the Indian gazells, the crocodile, the gavial, the capel langur, the golden langur, and the great Indian one-horned rhinoceros (Jackson 1977:99).

The areas designated for Tiger preservation are: Manas in Assam; Palaumau in Bihar; Simlipal in Orissa; Corbett in Uttar Pradesh; Ranthambhor in Rajastnan; Kanha in Madhya Pradesh; Malghat in Maharashtra; Bandipur in Karnataka; and Sunderbans in West Bengal. Each of these widely scattered reserves represents a different habitat, within which an area of not less than 300 square kilometers is to be maintained as a central area absolutely free from human influence. Other features of the program are the improvement of communications within the preservation areas; improvement in the protection of both flora and fauna; the eviction and resettlement of villagers from the reserves; and improved fire protection and general habitat improvement. The effects of the program are clear in a marked rise in tiger population within the areas from as little as 27 to 32 in Malghat to as much as from 17 to 50 in Simlipal. (Jackson 1977:98).

2.6.5.4 Other conservation programs

Other programs operating with funding from the World Wildlife Fund inare a project designed to study the general ecological, physiological, a behavioral aspects of the Asiatic wild dog (Cuon alpinus), a pack hunting animals whose attacks on endangered deer and antelope species have caused it to be declared as vermin subject to shooting or destruction in many Indian states. The study is designed to examine the role of the wild dog as a predator important in keeping down the populations of some animals whose increase numbers might otherwise damage vegetation both within and outside the forest (Jackson 1977: 111).

In the Dachigam Sanctuary near Srinagar a World Wildlife Fund grant has been used to study the habits and ecology of the Hangul or Kashmir stag, whose habitat is threatened by several factors: sheep farming within the sanctuary, grass burning, pedestrian and motor traffic, and until quite recently, poaching (Jackson 1977:103-104). In this sanctuary sheep grazing within the area of the sanctuary is the most serious threat to not only the survival of the Hangul or Kashmir stag

but also the stability of the ecosystem. Although it has been agreed that 800 is the absolute limit for the number of sheep which can safely graze the area, 2,200 were still being grazed in Dachigam in 1975 (Jackson 1977:103-104).

In the wetlands and marshes of the Tibetan plateau region of Ladakh, a joint World Wildlife Fund/Bombay Natural History Society team led by Salim Ali has studied the fauna and ecology of the area, with special emphasis on the black-necked crane (Grus nigercollis) and the barhead goose. This wetland area is threatened by the increase of human activity in the form of various development around villages on its edges (Jackson 1977:112).

In December 1976 the first crocodile bank was inaugurated under the auspices of the World Wildlife Fund India and the Madras Snake Park Trust at Vadanemeli, Tamil Nadu. Set up with World Wildlife Fund support at a cost of Rs. 200,000 the bank was scheduled to begin with about 150 crocodiles representing the three species of endangered Indian crocodiles (Jackson 1977: 107).

2.6.5.5 public opinion and conservation education

According to a 1976 Gallup poll only 46% of the people of India would like to see more done to conserve wildlife and threatened species: this compares with 97% in the U.S.; 89% in Western Euopre; 85% in Japan; 75% in Africa; and 94% in Latin America (Norman Myers. 1979. The Sinking Ark. New York: Pergamon Press.)

The World Wildlife Fund in July 1976 initated a youth movement under the name "The Nature Clubs of India" designed to: "expose children to the importance and beauty of the natural environment, to produce an emotional and intellectual involvement with its preservation, and to provide insights into the meaningful interrelationships between the various subjects--geography,botany, zoology, etc.--to which a child is exposed through the traditional school curriculum." The launching of the program, in three languages--English, Marathi, and Gujarati--and in two states, was assisted by messages of encouragement from from the Prime Minister and from ministry officials of the two states: Maharashtra and Gujarat. The program uses various types of materials and approaches, including photographic exhibtitions, television and radio shows, advertising in a large number of periodicals, and "Nature Orientation Camps." One camp, with the theme "Conservation for Rurual Development," covered a 10-day period and reached over 500 persons who will ultimately be working as teachers or administrators on the village level (Jackson 1977: 108-111).

2.7 COASTS AND BEACHES

2.7.1 The resource

India's coastline stretches some 5,700 kilometers, a distance almost equally divided between the coastal zone of the Arabian Sea to the west and the Bay of Bengal to the east. Large stretches of this coastal zone remain undeveloped or poorly developed. There are extensive stretches of swamps such as the Sunderbans in West Bengal and the Rann of Kutch in Gujarat. Fishing is the major economic activity along the coast. Exploitation of petroleum resources is just beginning. There are some centers of recreational activity and a few sea resorts along the coast, but the potential for such centers is felt to be much greater than has been realized till now. It is expected, however, that with continued development of both coastal and marine fisheries that fishing harbors and fishing complexes will multiply, while oil and mineral development will bring additional activity to the coastal zone (NCST 1975:195). It is anticipated that simultaneous development of recreational, fishing, and mineral resources will generate conflicts that will call for a unified policy for the proper planning, management, and control of the coastal zone (NCST 1975:196).

As of 1975 research into and exploitation of coastal resources as well as coastal zone management were still not well developed. In its 1975 report on India's marine resources and potential the Panel on Marine Resources of the National Committee on Science and Technology stated: "It has been the conviction of all those who have participated in the preparation of this document and the various planning group reports that a time has come when our country must give serious and systematic attention to our marine environment and to the potential resources of the oceans. This will require a national commitment to take the necessary steps to stimulate marine exploration, science, technology and financial investments on a vastly augmented scale" (NCST 1975:9).

2.7.2 Harbors and ports

India has ten major and more than 160 intermediate and minor ports scattered along its coastline.

Major ports are Bombay, Calcutta Cochin, Kandla, Madras, New Mangalore, Mormugao, Paradip, Tuticorin, and Visakhapatnam. Bombay, the largest port, handles about a fourth of India's foreign trade. Calcutta is the largest terminal port in South Asia.

The some 160 intermediate and minor ports handle both coastal and overseas traffic. In an effort to encourage the development of such ports, the Fifth Plan has set aside Rs 100 million.

Coastal activities related to port and shipping are ship-building and ship-repairing. As of 1975 there were five major ship yards, the largest being at Visakhapatnam in Andhra Pradesh, while a sixth yard was being developed at Cochin. Repair facilities were available at 11 locations, the largest at Visakhaatnam (NCST 1975:22).

2.7.3 Fisheries (see 4.7)

2.7.4 Minerals, oil, and water: non-living resources of the sea

2.7.4.1 Off-shore oil

Exploration for off-shore oil has been the function of the Oil and Natural Gas Commission (ONGC) at Dehra Dun, which in 1973 began drilling for oil in the Bombay High structure in the deep waters off the western coast of the country. Production from the first two development wells began in May 1976, and there are now three more drilling units operating in the Bombay High area. These offshore fields are expected to produce 10 million metric tons of oil per year beginning in 1980.

2.7.4.2 Minerals

Seawater is seen as an excellent source of minerals such as salt, potassium, magnesium, and bromine, while mineral-rich beach sands have been found on the coasts of Kerala, Tamil Nadu, Maharshtra, Andhra Pradesh, and Orissa. Most of India's salt output comes from the evaporation of seawater in the Gulf of Kutch in Gujarat and the drier coasts of Tamil Nadu and Maharashtra, while beach sands of the southwest coast are exploited for both monazite and ilmenite. Dredging for lime sand is carried out in the shallow areas off Jamnagar in the Gulf of Kutch, with a production of over one million tons in 1971, and about 94,000 tons of lime shells were dredged from Vimbanad Lake in Kerala during the same year(NCST 1975:19).

Indications of other coastal minerals have been found, but as of the time of the National Committee on Science and Technology's sectoral report on marine resources in 1975, there had been little attempt to survey them and no effort to exploit them. Among these are ferro-manganese nodules of 2.5 centimeter size and "appreciable" quantities of nickel and cobalt, which have been sampled at different locations in the deeper part of the Indian ridge in the south-east Indian Ocean. Also reported have been offshore occurrences of calcareous deposits suitable for chemical and cement production in bottom samples in the area of the Andaman and Nicobar Islands, as well as off the coast of Kerala and the Laccadive Islands (Lakshadweep). Other minerals reported are phosphate nodules and barium concentration off the west coast and Laccadive Islands and chromite in the sea floor rifts in the Indian Ocean. As of 1975 there had been little effort to survey most of the offshore mineral resources and no efforts to exploit them (NCST 1975:7).

2.7.4.3 Use of seawater

2.7.4.3.1 desalinization

Studies of desalinization of seawater have been carried out by the Bhabha Atomic Research Center, Division of Desalination and Effluent Engineering in Bombay and the Central Salt and Marine Chemicals Research Institute in Bhavnagar, Gujar, the latter of which has several pilot plants in operation with capacities varying from 80 to 30,000 liters per day. (Varma 1978:25; NCST 1975: 214).

2.7.4.3.2 algal resources

Seaweeds form the basic raw materials for products such as agar agar, algin, and carogeneen. An industrial unit at Ahmedabad was, as of 1975, producing about 200 tons of sodium alginate from naturally occurring seaweeds, while several units had been established with the capacity for producing about 60 tons of agar agar per year. The area exploited for raw materials for agar agar has been the coastal area of Ramanathapuram District in Tamil Nadu, which was showing signs of depletion of natural supplies of agarophytes as of 1975, thus threatening the supplies of raw materials for this industry (NCST 1975:214).

2.7.4.3.3 sea water irriculture

Work on the use of sea water for agricultural irrigation is being carried out at the Central Salt and Marine Chemicals Research Institute at Bhavnagar in Gujarat (NCST 1975:214).

2.7.5 Coastal zone problems

2.7.5.1 Sea erosion

Sea erosion occurs at different places along the some 5,700 kilometers of India's coastline but is of a serious nature in a length of about 320 kilometers in Kerala on the west coast as well as in Orissa and West Bengal on the east coast. Other problem areas are the Bombay coast and the coast of Tamil Nadu in the area of Tirshander and Madras. The average loss of land per year has been reported to be about two to five meters (NCST 1975:192,197).

Action against this erosion were initiated under the First Five Year Plan and by the end of the Fourth Plan, a length of 100 kms on the Kerala coast had been brought under protection at a cost of about Rs. 177 million. Special financial assistance totalling Rs. 140 million was provided to the Government of Kerala during the 1972-73 and 1973-74 fiscal years to enable better progress under the Fourth Plan. Under the Fifth plan about Rs. 200 million has been marked for anti-sea erosion measures; in 1974-75, however, only Rs. 10 million was actually expended for these measures; an outlay of Rs. 30 million had been proposed for 1975-76 (Lal 1977: 71).

2.7.5.2 Siltation

The problem of siltation is most urgent in harbors where depths must be maintained. Harbors have succeeded in maintaining their depths by dredging (NCST 1975:192).

Active in the study of coastal erosion and siltation are the Central Water and Power Commission, the Geological Survey of India, the National Institute of Oceanography on the central level and institutes such as the Hydraulic Study Department of the Calcutta Port Commissioners and the Kerala Engineering Research Institute at Peechi on the state and local level. With

U.N. assistance, a Coastal Engineering Research Centre has been established at the Central Water and Power Research Station in Khadakvasla(NCST 1975: 192).

2.7.6 Marine pollution

Marine pollution problems in India are not yet great but can be expected to grow as economic activity in coastal zones increases. Sources of pollution are domestic wastes from the coastal population and waste from coastal industries, which together add an estimated 150 cubic kilometers of waste to the sea each year. Added to this is inland domestic and industrial waste carried to the sea by rivers--by one recent estimate still only 5% of the waste reaching the sea. About 34,000 tons of agricultural chemicals and about 110,000 tons of synthetic detergents are used each year in India; it has been estimated that as much as 25% of these will enter the marine coastal environment (Bandhu, Bhardwaj and Bhat 1979:107-108). Oil spills pose a threat to coastal recreational and fishery resources. An estimated 750-1,00 tons per year of tar-like material from spills and washings in the heavily-travelled Arabian Sea are deposited along the beaches of India's west coast during the monsoon months (Bandhu, Bhardwaj and Bhat 1979:108).

Marine pollution is reported to be severe only in certain areas such as, for example, Bombay, where the inorganic phopshate content of offshore waters have increased about 50% during the last twenty years (Bandhu, Bhardwaj and Bhat 1979:109). Other heavily polluted areas are the Hoogly estuary downstream from Calcutta and the outlets of the Krishna, Godavari, Canveri, Cooum, and Caliyar Rivers on the peninsula (Bandhu, Bhardwaj and Bhat 1979:86).

2.8 FISHERIES

India is presently the world's seventh largest fishing nation in terms of total fisheries production. Its fishing areas include a coast line of 5,700 kilometers, an economic zone extending 200 miles beyond territorial waters, rivers, lakes, estuarine waters, reservoirs, and a cultivable inland fisheries area of about 1.6 million hectares. According to FAO statistics for 1977, about 36% of total catch is from inland and the remainder from marine fisheries.

2.8.1 Inland fisheries

Statistics for inland fisheries are reportedly not as accurate as those for marine fisheries, but in recent years inland fisheries have accounted for as much as 40% of total catch, and these fisheries continue to grow as the government stresses programs of fish culture in tanks and reservoirs. In its 1977-78 report, the Department of Agriculture (Ministry of Agriculture and Irrigation), the central government agency responsible for fisheries, states that "the scope for increasing production is almost unlimited by virture of the large areas still requiring to be brought under fish capture/culture as well as the possibility of increasing the yield levels" (India. Dept. of Ag. 1978:114).

Inland fisheries, as review by the National Commission on Agriculture, may be broken down into two basic groups: freshwater fisheries and brackish water fisheries. Within both of these groups are capture fisheries--those relying on natural stocks--and culture fisheries--those requiring stocking of seedfished followed by periodic harvesting. As already mentioned, the growth in culture fisheries, the major emphasis on fisheries development during India's five-year plans, has been responsible for the growth of inland fisheries production from 218,000 tons in 1951 to 690,000 tons in 1971 and 930,000 tons in 1977. In contrast to the culture fisheries, capture fisheries are much more susceptible to adverse effects of floods, droughts, construction of dams, and water pollution (India: NCA 1976: vol. 8:1-6).

In contrast to the catches of India's marine fisheries, the entire yield of inland fisheries goes towards direct human consumption.

2.8.1.1 Freshwater inland fisheries

2.8.1.1.1 Riverine fisheries

India has an estimated 29,000 kilometers of potential fisheries in its main rivers and tributaries. As covered in section 2.3, India's rivers are divided into two basic groups: the Himalayan Rivers and the rivers of the Southern Peninsula. The Himalayan Rivers (the Indus, Brahmaputra and Ganges systems), because they are snow-fed contrast with the rainfed rivers of Peninsula in having reliable year-round flows; for this reason they also have considerably more flourishing fisheries.

In the plains the riverine systems are characterized by warm water fisheries, while those in high altitudes have cold water fisheries.

INDIA FISH CATCHES (in metric tons): 1972, 1975, 1977
Source: FAO Yearbook of Fishery Statistics 1977

		1972	1975	1977
FRESHWATER FISHES	misc.	665,800	850,000	930,000
DIADROMOUS FISHES				
Hilsa-like Shads	Hilsa(=Paralosa) spp	13,700	18,398	23,073
MARINE FISHES				
Indian Oil-Sardine	Sardinella longiceps	125,400	182,819	208,874
Clupeoids NEI	Clupeoidei	71,200	117,233	205,544
Croakers,Drums NEI	Sciaenidae	39,100	115,402	103,612
Bombay-duck	Harpadon nehereus	51,500	106,842	90,292
Hairtails, Cutlassfishes	Trichiuridae	36,300	63,060	82,336
Indian Mackerel	Rastrelliger kanagurta	121,200	49,604	73,636
Anchovies NEI	Engraulidae	29,600	42,925	57,205
Ponyfishes (Slipmouths) NEI	Leiognathidae	32,600	55,816	56,783
Cartilaginous Fishes misc.		45,200	69,092	65,985
Butterfishes,	Stromateidae	18,900	26,731	37,707
Sea catfishes	Arius(=Tachysurus)spp	41,200	72,868	52,337
Jacks,Trevallies	Caranx spp.	26,900	23,684	33,552
King Mackerels NEI	Scomberomorus spp	21,200	20,584	24,711
Tuna-like fishes	Scombroidei	6,000	10,365	22,612
Percoids NEI	Percoidae	14,400	34,722	20,050
Wolf-Herrings	Chirocentrus spp	9,800	12,385	19,825
False Trevally	Lactarius lactarius	6,600	12,180	14,558
Threadfins	Polynemidae	7,100	14,696	13,604
Flatfishes NEI	Pleuronectiformes	9,400	13,311	12,030
Pike-Congers NEI	Muraenesox spp.	4,400	5,694	8,708
Goatfishes	Upeneus spp.	5,900	2,637	6,599
Lizardfishes NEI	Synodontidae	4,500	14,782	6,481
Carangids NEI	Carangidae	3,200	4,517	4,798
Barracudas	Sphyraena spp.	2,400	2,246	3,359
Mullets	Mugilidae	1,500	3,340	2,219
Halfbeaks	Hemirhampus spp.	700	2,099	1,516
Flying fishes	Exocoetidae	1,400	1,853	991
Unicorn-Cod	Bregmaceros macclellandi	5,500	1,102	372
Pompanos	Trachinotus spp	0	67	53
Pomfrets				
Marine Fishes misc.		42,400	109,170	98,179
SHRIMPS,PRAWNS,CRUSTACEANS				
Shrimps&Prawns NEI	Natantia	159,700	237,804	206,685
Marine Crustaceans NEI	Crustacea	11,600	22,173	36,868
Marine Molluscs NEI	Mollusca	1,000	7,789	14,486
TOTAL		1,637,300	2,328,000	2,540,000

Warmwater fisheries

Warmwater fisheries account for the bulk of riverine fish production in India. The catch is mainly carps, catfishes, feater-backs, murrels and hilsa or Indian-shad. The most favored fish are the major Indian carps: (catla, rohu and mrigal), which are present in the warm water fisheries of the Himalayan rivers but nearly absent from those of the rivers of the peninsula. Fishing is done by a variety of methods: shore-seines, boat-seines, gill-nets, hook and line fishing, and various types of traps. Fishing intensity along rivers varies with conditions such as the velocity of the current, the terrain of the river bed, etc., and this variance has hindered the generation of reliable statistics on riverine fish production. However, figures compiled by CIFRI (the Central Inland Fisheries Research Institute near Calcutta) indicate that the average catch per fisherman is a low 150 kilograms per year (India. NCA 1976:vol. 8:5-6).

Problems

Problems have occurred because of overfishing in certain areas. On the lower Godavari (peninsula), for example, it was noted that fish stocks had declined because of the use of overly-fine meshed netting by fisherman determined to make up their catch no matter how small the fish and despite the long-range effects of this practice on fish stocks (India. NCA 1976: vol.8:6).

As of the early 1970's no studies had been conducted on the effect on riverine fisheries of reduced water flows resulting from damming of rivers for river valley projects. Among other effects of such projects it has been conjectured that dams might effect the important shad fisheries that are found in almost all of the Indian rivers by reducing the spawning stretches of this migratory fish (India: NCA 1976: vol. 8:8).

Coldwater fisheries

Streams and lakes in the high altitudes comprise the cold water fisheries, whose production is considerably less significant than the warm water fisheries of the lower elevations. The most important species are the mahseer (species of Barbus, including B. puititora, B. tor, and B. mosal), the snow trout, (species of Schizothorax and Oreinus), and various exotic species of trout, including the brown trout (Salmo trutta fario) and the rainbow trout (Salmo gairdneri), both valued sport fish. Although developmental work in cold water fisheries has concentrated chiefly on the exotic trout species, the National Commission on Agriculture has pointed out the advantages to be gained by the development of indigenous cold water fisheries as well.

Problems

The production of snow trout in high lakes has been adversely affected by the introduction of the mirror carp (Cyprinus carpio var specularis) (India. NCA 1976: 10-11).

2.8.1.1.2 Reservoir fisheries

Extensive reservoirs, intended in the first instance for irrigation or hydropower generation, have been formed by the impoundment on rivers. These reservoirs--accounting for some 3.0 million hectares of waterspread area by 1976--are also important areas for inland fisheries development. Because the indigenous fish in most of the reservoir consist of predators such as Wallago attu, Mystus species and Channa species, trash fishes such as species of Ambassis, Oxygaster, and Barilius, and species of minor carps, it has been recommended that reservoirs be stocked with the Indian major carps. Fisheries thus initated attain their benefits, however, only when the carps reach the phase of natural breeding and stocking is no longer necessary; according to the National Commission on Agriculture "the natural breeding of major carps in reservoirs is the most important factor in the context of increasing fish production." A noticeable increase in production has occurred on the Bhavanisagar and Stanley Reservoirs in Tamil Nadu, where stocked carps have reached the breeding stage (India. NCA 1976: vol. 8:12-13).

Problems

In some of the states, the authorities controlling the reservoirs intended exclusively for domestic water supply have not allowed fishing because of fear of contamination. It has been pointed out, however, that fisheries could be developed on such reservoirs without causing deterioration of water quality (India. NCA 1976: vol. 8:14-15).

2.8.1.1.3 Ponds and tanks

Freshwater fish culture has been practiced in ponds and tanks (small impoundments of water mainly for irrigation purposes) for centuries, chiefly in West Bengal, Bihar, Orissa, and Assam, where the rivers have been rich sources of spawns of Indian major carp that can be collected in large quanities during the summer monsoon months. After independence in 1947, fish culture activities expanded considerably under the Five Year Plans and campaigns designed to increase food production. Of an estimated 1.5 million hectares of culturable waters, about 1.0 million had been brought under fish culture by 1972. Production from these waters has tended to be low, mainly because of a shortage of seedfish, but it is now thought that increasing improvements in fish culture technology should eventually lead to maximization of fish production per unit water area.

2.8.1.1.4 Ox-bow lakes

Ox-bow lakes are long, narrow and bent courses of waterspreads which were formely beds or river of streams which have changed their courses. Because most of these are connected by channels to nearby streams, carps and other fish can enter them during floods, and these lakes have in fact yielded good quantities of fish. For a variety of reasons, including siltation and blocking of mouths and connecting channels, many of these ox-bow lakes, which occur in Bihar, West Bengal, Assam, and Uttar Pradesh, have fallen into neglect, are now covered with aquatic

water weeds, and yield only small quantities of fish. It has been suggested that these lakes could be converted into freshwater fish-farming ponds, each of which could become an source of occupation for several fish farmers (India. NCA 1976: vol. 8:17-18).

2.8.1.2 Brackish water fisheries

2.8.1.2.1 Estaurine fisheries

Estuarine fisheries include the output from the mouths of rivers, the large brackishwater lakes, the abundant tidal creeks and backwaters along the coast, and the coastal canal systems. Estuarine waters have an estimated spread of 2.6 million hectares. Although waters are saline, they are not as saline as seawater and during rainy season experience a sharp decrease in salinity, becoming in some cases nearly fresh. (India. NCA 1976: vol. 8:18-19).

Important estaurine systems are the Hooghly-Matlah estaurine system in West Bengal; the Mahanadi estuarine system in Orissa; the Godvari estaurine system in Andhra Pradesh; various estuaries in Tamil Nadu; coastal lakes such as Chilka Lake in Orissa and Pulicat Lake on the border of Tamil Nadu and Andhra Pradesh; the backwaters of Kerala; and the deltaic estuaries of the Narbada and Tapi Rivers; and hundreds of coastal streams on both the east and west coasts of the peninsula. The most important yields of these various systems are prawns and various fish, including mullet, Bombay duck, and catfish. Although most of these fisheries are capture fisheries, fish culture in brackish waters is a long-standing practice in India, mainly in the Sundarbans area of West Bengal and in the paddy fields along the edges of backwaters in Kerala; by one estimate about 12,000 hectares of the total 1.42 million hectares of coastal saline swamps are under brackish water cuiture (India. NCA 1976: vol. 8:45).

Problems

Problems with estuarine fisheries include sedimentation at river mouths which restrict the inflow of water, restricted drainage from river systems, and a decline in fish numbers resulting from indiscriminate catches of large quantities of brood fish and juveniles (India. NCA 1976:19-21).

2.8.2 Marine fisheries

Marine fishing has a long history among the coastal people of India. Marine fishing potential of the Indian continental shelf has been estimated to be as high as 2.4 million tons, including 0.7 million tons from demersal and 1.7 million tons from pelagic fisheries (India. NCA 1977:404), while the ocean waters beyond are said to contain vast, still unexplored resources (NCST 1975:235). Although the total catch of marine fisheries has increased from 0.68 metric tons in 1961 to some 1.6 million in 1977, it still falls short of the stated potential.

The marine fisheries are characterized by the presence of a large number

of species. In terms of catch quantities, the most important species are the oil sardine (Sardinella longiceps), exploited along the west coast between Ratnagiri in Maharashtra and Quilon in Kerala; the Indian mackerel (Rastrelliger kanagurta), found on both coasts; Bombay duck (Harpodon nehereus), which is the focus of a major fishery along the northwest coastal area of Maharashtra and Gujarat; lesser sardines, mostly in Tamil Nadu, Kerala, and Andhra Pradesh; species of sharks, skates, and rays, occurring all along the coastline; silver bellies, mainly in Tamil Nadu, Andhra Pradesh, and Kerala; sciaenids; catfishes; pomfrets, most of which are caught in Gujarat and Maharashtra; seerfish; perch; polynemids; tunas; and jackfish. Only a negligible portion of the catch has consisted of deep sea fish. Various crustaceans (prawns, lobsters, and crabs) constitute an important part of India's fishery resources. Prawn fisheries are concentrated chiefly along the southwest coast, particularly in Kerala, where penaeid prawns are found; non-penaeid prawn fisheries are found along the Maharashtra coast. Research efforts have also brought about the discovery of deep water lobsters and prawns. Important shell-fisheries are the chank and pearl oyster fisheries of the Gulf of Mannar, the edible oyster fisheries of the estuaries and backwaters of the east coast, and the brown and green mussel fisheries in Kerala and other locations along the west coast. Recent finds have been significant concentrations of edible squids and cuttle-fishes in the shelf waters along the southeast and southwest coasts (NCST 1975:246-247).

Fishing methods

The most intense fishing area is a coastal belt of approximately five miles in width. The bulk of the catch (about 60%) is landed by traditional methods (shoreseines, boatseines, gill-nets, and hooks and lines, using catamarans, dug-out canoes, and plank built boats), but the number of power boats has been increasing, growing from only 13 at the beginning of the first Five Year Plan in 1951 to about 14,400 by 1978. Progress has also been made in developing deep sea fishing capabilities. By March 1978, 30 trawlers were expected to be in operation, while some 109 deep sea fishing vessels were scheduled for delivery by the end of the March 1979 (India. Dept. of Ag. 1978:114-115).

Fishing harbors

The India government, under the Central Scheme of Landing and Berthing Facilities at Minor Ports, has completed sizeable fishing harbors at Tuticorin (Tamil Nadu), Karwa (Karnataka), Kavaratti (Lakshadweep), Port Blair (Andamans and Nicobar Islands) and Vizhinjom Stage I (Kerala). Ten other harbors were either nearly completion are under construction as of mid-1978 (India. Dept. of Ag. 1978:117-118).

Fisheries surveys and projects

The Exploratory Fisheries Project, Bombay, has been conducting exploratory surveys with the object of charting the fishing grounds and exploring the commercial possibilities of deep sea fishing. During 1977-78, the project operated 23 steel trawlers, which resurveyed an area of about 20,000 square kilometers.

With a view toward development of deep sea fisheries, the government of India, in conjunction with the government of Poland, chartered a large freezer trawler during the 1977-78 fiscal year, surveying the northwest coast of India and landing 500 tons of fish in 1500 hours of actual fishing. The project, which has helped to introduce certain important marine fishing methods, has released bulletins describing the results of its resources survey along both the west and coasts of India and the the Andaman Islands (India. Dept. of Ag. 1978:116-117).

2.8.3 utilization of the fish catch

Almost the entire catch of inland fish is brought to market fresh, either with or without ice.

The marine catch, on the other hand, is not only sold fresh but is also processed into different forms such as canned, frozen, and cured products for human consumption and is used for the production of fish meal, fish oil, manure, and other industrial products.

Indian exports of fish products for one year in the early 1970's totalled 52,279 tons with a value of 895.1 million rupees. 74% of the quantity of these exports and 84% of the value were accounted for by frozen prawns while frozen frog legs and lobster tails contributed another 5% of the value. Processed fish-product exports were (by % of value): canned prawns (6.3%), cured or dried prawns (0.19%); fish (0.87%), shark fins and fish maws (1.11%), fish meal (0.77%), and miscellaneous products (1.87%). Importing countries were Japan, the United States, the United Kingdom, Australia, Hong Kong, Sri Lanka, Mairitius, Singapore, Iran, Italy, West Germany, Belgium, France, the Netherlands, and Canada (India. NCA 1976: vol. 8:269).

2.8.4 water pollution and fisheries (see 2.3.4)

2.9 MINERALS

2.9.1 Mineral resources and development*

India's mineral deposits are not significant when compared with other large countries such as the USSR, the U.S.A., and South Africa. By recent figures, mining and quarrying supplied only 1.5% of total gross domestic product, while the most ocent detailed employment figures (1971) indicate that mining activities occupied only about 0.5% of the total work force.

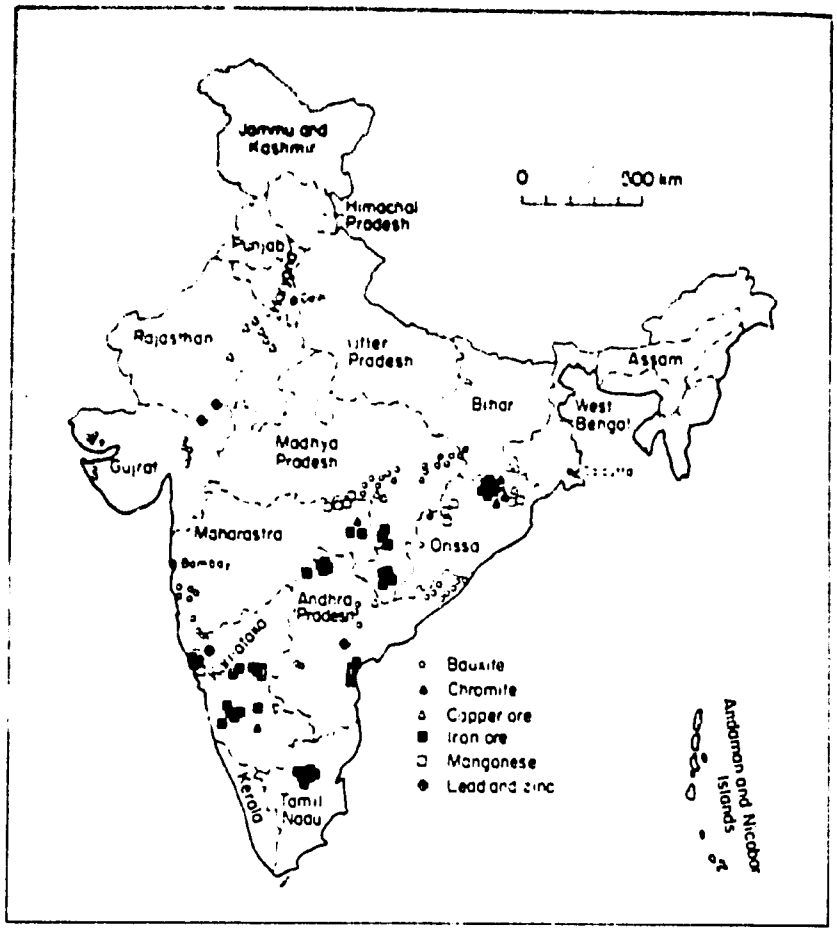
The development of India's mineral resources began in earnest in the 1960's, and mineral production in general continues to increase annually. The government, recognizing the need for proper exploration of mineral resources has, through agencies such as the Geological Survey of India, actively pursued exploration for new mineral resources, and these efforts have borne fruit in the discovery of important deposits of minerals such as rock phosphates, wolframite, dolomite, barite, bauxite, and coal. The mid-seventies saw the discovery of additional reserves of coal, hematite, copper ore, bauxite, magnetite, manganese ore, dolomite, and barite. India still has not uncovered deposits of non-ferrous metals such as nickel, tin, silver, lead and zinc sufficient to meet her needs, and these must be imported. Although assessments of mineral deposits are still far from complete, available data is felt to be adequate for the formulation of national policies for mineral exploitation and planning of industries based on these resources (Ray 1978).

The importance which the Indian government has assigned to minerals development is indicated by comparing the growth rate of the mining industryg (10.9% from 1969-70 to 1974-75) with that for for other government owned industries (8.2%). Under India's present mineral policy, set forth in 1956, minerals are divided into three categories for purposes of regulation and control: 1) Schedule A minerals, whose development is the exclusive concern of the government, except where it is already in the hands of the private sector (apatite and phosphatic ores, beryl, chrome ore, coal and lignite, copper, gold, gypsum, iron ore, lead, manganese ore, molybdenum, nickel ores, precious metals and their ores, atomic minerals, sulfur and its ores, tin, tungsten ores, zinc ore, zircon, and vanadium ores; 2) all other minerals (except the minor minerals), which will be progressively state owned although private enterprise is expected to help in their development; 3) the minor minerals, whose development is to be in the hands of the private sector (Ray 1978:289-290).

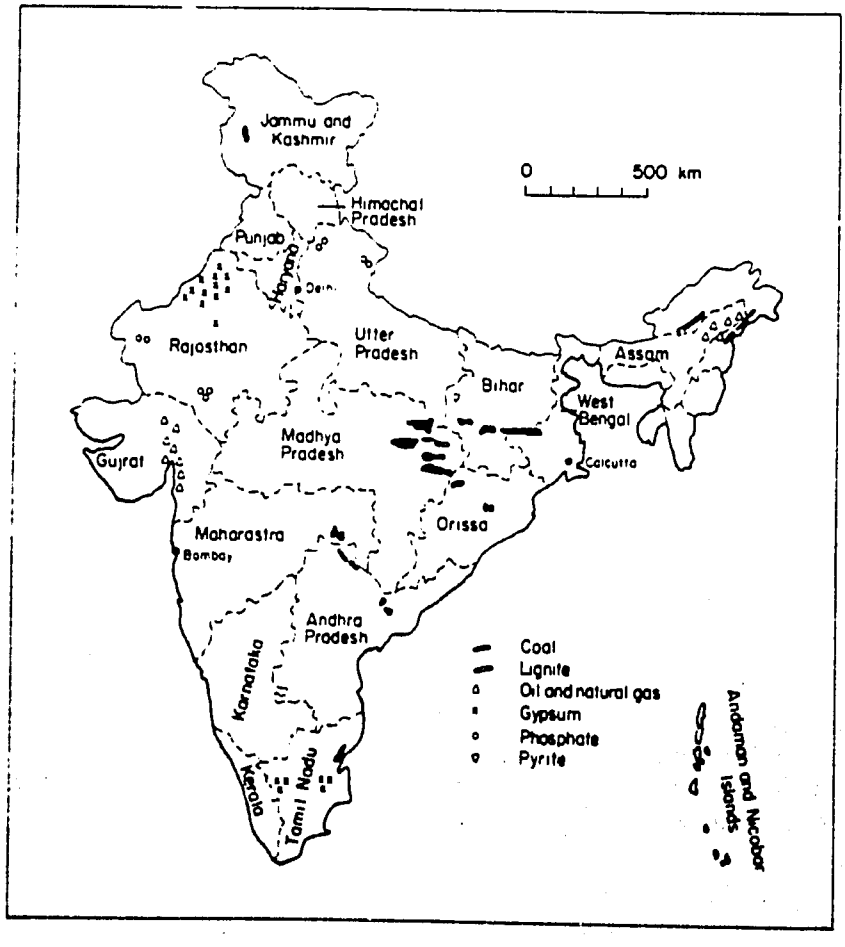
India's mineral riches are not evenly distributed throughout the country. The most concentrated area of minerals deposits is in the north-eastern section of the Deccan Plateau--in Chota Nagpur(Bihar) and the adjoining areas in Orissa, West Bengal, and Madhya Pradesh. Mineral production is dominated by the states of Bihar, Orissa, Rajasthan and Madhya Pradesh,

*This and the following sections are based on Ray 1978; India. Ministry of Inf. and Broadcasting 1978; and Lal 1976. Figures for reserves are derived mainly from Ray 1978; production figures for 1976 are from India. Ministry of Inf. and Broadcasting 1978; production figures for 1977 are from the 1978-79 edition of the Europa Yearbook.

DISTRIBUTION OF METALLIC MINERAL DEPOSITS (Ray 1978)



DISTRIBUTION OF FUEL AND FERTILIZER MINERALS (Ray 1978)



although significant contributions also come from Maharashtra, Karnataka, Andrha Pradesh, Assam, and West Bengal. Locations of major mineral deposi are indicated by the maps on page 93.

2.9.2 Metallic minerals

Iron

Iron ore is presently India's most important mineral product, India being, in fact, one of the world's major iron ore producers. Estimates of total iron ore reserves run as high as 28,110 million tons. These are comprised of hematite, magnetite, limonite, and siderite. The largest measured reserves are in the iron ore zone of Bihar and Orrisa and in Madhya Pradesh.

Production(1976): 43,443,000 tons of ore; value Rs. 828,864,000.
Use: Iron ore production is used as the basis for India's iron and steel industry and is also exported, chiefly to Japan. Iron ore accounted for 4.1% of total exports in 1975/76.

Manganese Ore

The major producing state for manganese ore are Orissa, Karnataka, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Bihar, which together account for more than 95% of national production. Total recoverable reserves for these areas were estimated at 88.8 million tons in 1971 Estimates of total manganese reserves run as high as 180 million tons.
Production(1976): 1,760,000 tons of ore; value: Rs. 156,892.
Use: Manganese ore is processed at 7 ferro-manganese plants; a major part of the output is exported.

Chromite

Although chromite (chrome iron ore) deposits occur in Orissa, Karnataka, Andrha Pradesh, Maharashtra and Bihra, Orissa supplies the largest part of the present output. Total reserves of chromite are now placed at 13.8 million tons, 90% of which are in Orissa.
Production(1976): 402,118 tons; value: Rs. 193,924,000.
Use: About half is exported and half is processed to ferro-chrome.

Copper

Copper ore, total reserves of which may run as high as 333 million tons, is found mainly in Bihar, Rajasthan, Andhra Pradesh, and Madhya Pradesh. Of some 208.8 million tons of measured reserves, 122.2 million tons are located in Rajasthan and 74.7 in Bihar.
Production(1976): 2,380,000 tons of ore; Rs. 217,041,000.
28,845 tons of copper concentrates;
Use: Copper is processed into refined copper, meeting (1973) about 14% of the country's copper needs. Copper is imported in large quantiles: 55,173 tons in 1973.

Lead and zinc

Indian has only limited reserves of lead and zinc, total reserves coming to about 85 millions tons, mostly in Rajasthan but also in Andhra Pradesh and Gujarat. The Zawar mines in Udaipur, Rajasthan, have been the chief source of lead production.
Production (1976): 15,858 tons of lead concentrates; value: Rs. 31,830,000.
45,322 tons of zinc concentrates; value: Rs. 81,070,000.
Use: Lead and zinc are refined into concentrates. Both are used for India industrial needs; neither is exported.

Bauxite

Although bauxite (the chief raw material for aluminun) deposits have been identified in most states, significant reserves occur in Bihar, Gujarat, Madhya Pradesh, Maharashtra, and Orissa, which together account for about 77% of the estimated 356 million tons of reserves.
Production (1976):1,448,000 tons; value: Rs. 41,399.
Use: India's bauxite covers its needs for aluminum production; some bauxite (about 2.1% in 1973) is exported.

Gold

Although gold deposits are found in one field in Andrha Pradesh and two fields in Karnataka, the latter of which is the only gold producing state. About 4 million tons of reserves were estimated to remain as of 1975.
Production (1976): 3,132 kilograms; value: Rs. 160,572,000.

Nickel

Nickel reserves are limited to about 15 million tons of nickel bearing ore at Sukinda in Orissa
No production.

2.9.3 Refractory minerals

Sillimanite

A huge reserve of high quality sillimanite has been located in Assam. In addition, about 13 million tons are estimated to occur in the beach sands of Kerala and Tamil Nadu, while an estimated 230 million tons with 3.5% sillimanite have been found in Orissa. India is said to have the world's richest deposits of this mineral.
Production (1975): 8,116 tons; value: not available.
Use: Internal use and export(about 51% of production in 1973).

Kyanite

Important reserves of kyanite (about 7 million tons) occur in Bihar, where the deposits in Singhbhum may be the largest in the world. Other reserves are found in Karnataka, Maharasthra, and Orissa.
Production (1976): 48,331 tons; value: Rs. 16,100,000
Use: Internal use and export (about 32% of production in 1973).

Graphite

Known reserves of about 49 million tons of graphite occur in Kerala, Andhra Pradesh, Karnataka, Jammu and Kashmir, and Gujarat.
Production (1976): 39,425 tons; value: Rs. 4,075,000

Magnesite

India has the world's sixth largest reserves of magnesite. Major reserves are in Tamil Nadu (44 million tons of recoverable magnesite) and Uttar Pradesh (110 million tons by a tentative estimate), but important reserves also occur in Karnataka and in Bihar.
Production(1976): 329,647 tons; value: Rs. 29,914
Use: Major production is used the manufacture of refractory bricks for steel work; some (about 7.4% in 1973) is exported.

2.9.4 Fertilizer minerals

Exploration in different parts of India has led to the discovery of important reserves of phosphorites in Uttar Pradesh, Rajasthan, and Madhya Pradesh--an estimated 150 million tons. Commerically important deposits of apatite (another source of phosphates for fertilizer production) are found in both Bihar and Andhra Pradesh. Pyrite, a source of sulfur for fertilizers and other chemicals, occurs in several locations, with economically important deposits in Bihar, Rajasthan, and Karnataka. Deposits of gypsum--an estimated 1,216 million tons--occur chiefly in Rajasthan and to a much lesser extent in Gujarat and Tamil Nadu; gypsum is used for both agricultural and construction purposes.
Production(1976): phosphorites: 644,119 tons; value: Rs. 170,108,000
apatite (1976): 38,180 tons; value: Rs. 7,373,000
pyrite(1976): 51,951 tons; value: Rs. 12,727,000
gypsum (1976): 727,000 tons; value: Rs. 13,770,000

Use: Production of fertilizers.

2.9.5 Other minerals

Mica

Economically important deposits of mica are found in Andhra Pradesh, Bihar, and Rajasthan. India produces some 75% of the world mica (Dutt 1973:42).
Production(1976)[provisional]:9,356 tons of crude mica; value: Rs.19,757,000.
Use: Mica insulation brick manufacturing units using mica waste are located in Rajastan, Bihar and Andhra Pradesh; exports of processed mica--almost its entire output--came to 20,918 tons in 1973.

Diamonds and gemstones

The only diamond producing areas in the country is the Panna diamond belt, which stretches across parts of Madhya Pradesh and Uttar Pradesh. In the south is a diamond field spread over several districts in Andhra Pradesh. Indian mineral production also includes emeralds, and garnets.
Production(1976): diamond: 20,487 carats; value: Rs. 9,987,000
emeralds: 825 carats;.
garnets(gem): 3,570 kilograms.
Use: Internal consumption and export(3.1% of total exports in 1975/76).

Limestone and other building materials

Limestone, used for a wide scope of purposes, including building materials, chemicals, fertilizers, and lime, occurs throughout the country, but high grade deposits suitable for cement manufacture are more abundant in the southern and western regions, which together produce about 2/3's of the country's cement. The best reserves are the Vindhyan limestones of the Son Valley of Bihar but good reserves are present in Andhra Pradesh, Mysore, Tamil Nadu and Gujarat. Other important building materials are the peninsular granites, the Himalayan and Andhra slates, the marbles of Rajasthan and Jabalpur, and the purple Vindhyan sandstones (Dutt 1973:42)
Limestone production (1977): 30,201,000 tons
Use: Domestic cement production

Dolomite

Production(1976): 1,862,000 tons; value: Rs. 48,324,000
Use: Domestic cement production.

Rare Minerals

The beach sands of Kerala and Tamil Nadu are a source of radioactive monazite, a mineral which contains thorium (convertable into atomic fuels), uranium oxide, phosphate and a large percentage of rare earth oxides. Total reserves have been estimated at about one million tons. Ilmenite is also found in the beach sands of Kerala and Tamil Nadu; reserves are estimated at from 100 to 150 million tons. Reserves of uranium are estimated at 76,000 tons; they occur in Bihar, Himachal Pradesh, and Uttar Pradesh.
Production (not available)

Salt

Most salt production comes from the evaporation of seawater in the Gulf of Kutch in Gujarat and on the coasts of Tamil Nadu and Maharasthra. The remainder comes from the Sambhar and Didwana lakes in Rajsthan. Rock salt comes only from the Mandi district in Himahacal Pradesh (Dutt 1973: 42).
Production(1976): 4,438 tons of rock salt; value: Rs. 754,000.

2.9.6 Fuel Minerals

Coal

Coal occurs in a number of states, although only West Bengal, Bihar, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Assam have significant minable reserves. Recent estimates of total reserves run as high as 83,674 million tons; however, reserves of coking coal suitable for metallurgical processes are estimated at only 21,000 tons, most of which are found in West Bengal and Bihar.
Production (1976):101,036,000 tons of hard coal; value: Rs. 7,103,892,000

Lignite

Lignite (brown coal) deposits occur in Gujarat, Jammu and Kashmir, Rajasthan, and Tamil Nadu. Of the estimated 2,100 millions tons of reserves about 2,000 million are found in the Neyveli lignite deposit in Tamil Nadu.

Production (1976): 3,895,000 tons; value: 184,806,000

Petroleum

Proven petroleum reserves occur in the onshore fields in Assam and the Cambay Basin in Gujarat (about 700 million tons of which about 200 million are recoverable), while the off-shore reserves in the Bombay High are estimated to contain over 800 million tons, with recoverable reserves of up to 200 million tons. Additional potential oil-bearing areas are located in Tripura; Manipur; West Bengal; Punjab; Himachal Pradesh; the coastal areas of Tamil Nadu, Andhra Pradesh, and Kerala; the Andaman and Nicobar Island; Lakshadweep; and offshore areas on the continental shelf.

Production (1976) 8,430,000 tons of crude oil; value: Rs. 2,316,564.

Natural gas

Production(1976): 1,514,000,000 cubic meters; value: Rs. 52,770,000.

2.10 AIR AND THE ATMOSPHERE (see also 3.3.1)

Air pollution problems come from several sources: industrial and domestic fires; burning of petroleum and coal for thermal power production; and emissions from automobiles. In those areas of the country affected by wind erosion, there are high levels of particulate matters in the air during the dry season.

Pollution from automobiles is a problems of urban centers such as Calcutta and Bombay. Because many India automobiles operate inefficiently, they pollute at a rate estimated to be two to three time higher than that of automobiles in developed countries. It has been found, for example, that the carbon monixide level in Calcutta is higher than that in New York (Parkikh 1977:190).

Burning of fuels also creates pollution problems. Indian coal, for example, while relatively low in sulfur has an ash content of anywhere from 10% to 40%; particulates from the burning of this coal result in health problems (Parikh 1977:190). In the countryside, the burning of both wood and dung is reported to cause severe air pollution, which can be harmful to health. Furthermore, the burning of firewood and charcoal, the major domestic fuels in rural India, contribute heavily to the carbon dioxide load in the atmosphere (UNEP 1976:22-23).

Monitoring of the air in seven Indian cities (Ahmedabad, Calcutta, Delhi, Jaipur, Kanmpur, Madras, and Nagpur) over a five year period ending in July 1970 by the National Environmental Engineering Research Institute (NEERI) revealed that none of these cities exceeded permissible levels (as established by foreign governments) for either sulfur dixide or nitrogen oxides, while all of the cities with the exception of Madras exceeded average permissible levels for suspended particulate matter (Parikh 1977:190).

3.0 THE ECONOMY OF INDIA

3.1 General economic indicators (World Bank 1979)

GNP per capita(1977): $150

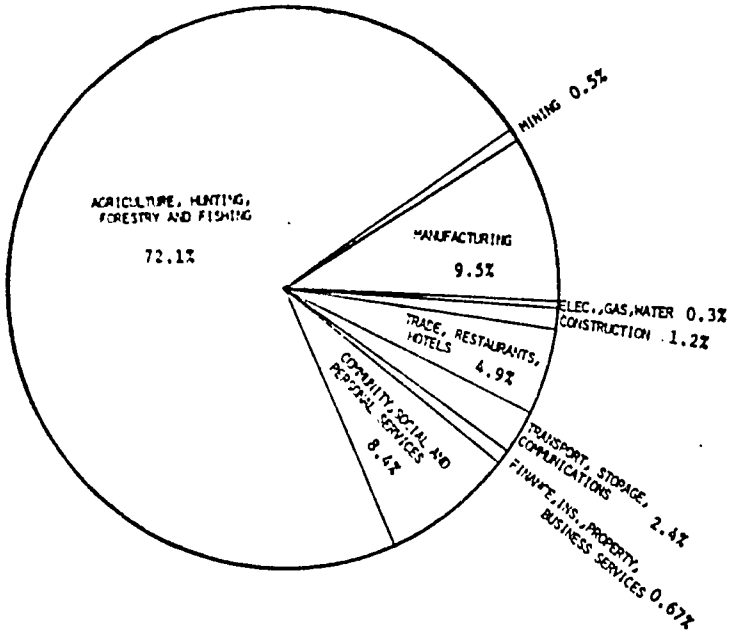
Average annual growth rate: 1.3%

Average annual rate of inflation (1967-70: 6.9%
1970-77:8.9%)

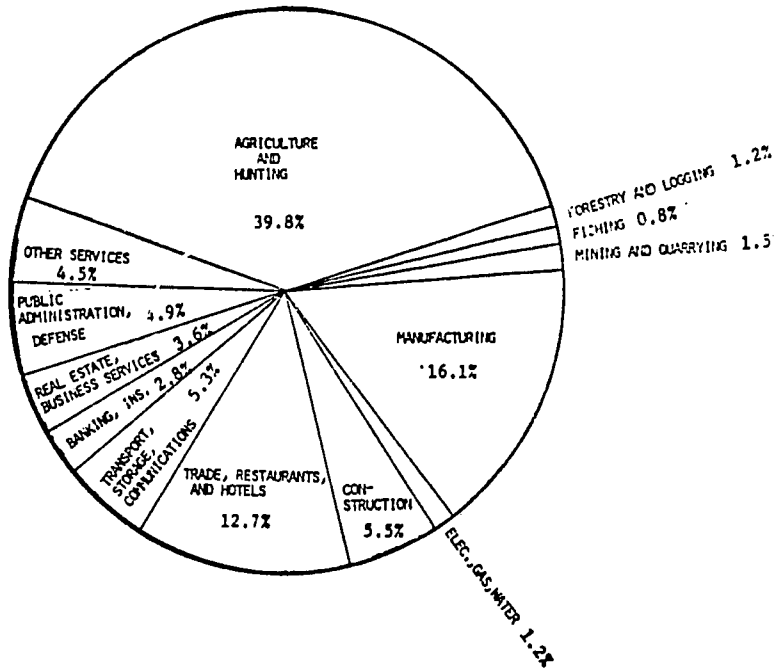
Currency and rate of exchange: the Rupee (Rs).
January 1979: Rs. 8.212=US$1

India is ranked 16 among the 37 nations designated as low income by the World Bank. It is also one of the 45 countries considered by the U.N. as most seriously affected by recent adverse economic conditions.

EMPLOYMENT BY SECTOR
(1971)



GROSS DOMESTIC PRODUCT BY SECTOR
(1974-75)



3.2 Poverty

By a recent World Bank estimate over one-third of the world's poor live in India and more than 80% of these belong to the rural households of landless laborers and small farmers (World Bank 1979:v). Under the new Draft Plan, which uses nutritional requirements as the basis for its definition of poverty, an estimated 46% of the population was below the poverty line in 1977/78 (a figure which the government hopes to reduce

to 38% by the end of the plan period) (World Bank 1979:17).

As mentioned above, the incidence of poverty in India is highest among agricultural labor households and small cultivators, who make up more than one fourth of the rural population. Just under half of the rural-labor households belong to scheduled castes or tribes. As considered in more detail below, despite various efforts, agricultural labor and small cultivator households are increasing faster than rural households as a whole. Furthermore, preliminary findings of the Rural Labor Enquiry for 1974/75 would seems to indicate that over the last decade there has been a decline in the average earning of rural laborers in real terms as well as an increase in the number of days that rural laborers have been idle because no work could be found (World Bank 1979:57).

The improvement in the standard of living of the poor depends on the overall growth of the economy, particularly on an increase in agricultural productivity, as well as on the expansion of opportunities for employment in urban areas. Higher industrial and agricultural growth are expected not only to create new jobs and permit informal sharing of incomes but also to facilitate the implementation of special programs and projects designed to benefit the poor directly (World Bank 1979:57).

Government programs to alleviate the situation of the rural poor, have fallen into three basic categories: land reform; the extension of rural credit; and integrated rural development.

The World Bank's recent assessment of the situation emphasizes that past schemes directed at relieving rural poverty, although successful in many individual cases, have, "in the context of the total economy and society" been limited and disappointing in both scope and success; the result has been a widespread cynicism within the country about the possibilities for the outcome of new programs. Political will, therefore, is judged to be as important as actual poverty-combatting mechanisms, in determining the success of such programs (World Bank 1979:58).

3.3 Development plans

India's first five-year development plan, issued in 1951, focussed chiefly on agriculture and irrigation. The two subsequent plans emphasized heavy industry and transport. The fourth plan, drastically revised after running into insurmountable problems including a crop failure in 1966/67, failed to attain its goals for foodgrain and steel production but succeeded in achieving a 12% per annum rate of growth of exports (in value terms) and a decline in dependence on foreign aid. The draft fifth plan (1974-79), released in December 1973, called for a 5.5% annual growth rate for the five year period beginning in April 1974. Under this plan, the final version of which was released in September 1976, India was able to achieve a growth rate of 3.9 percent between 1974 and 1978. The Economic Intelligence Unit attributes what it calls the "great success" of this plan to 25% growth in exports and a low import demand combined with large remittances from Indians overseas (Economic Intelligence Unit 1978: 20).

The draft sixth plan (1978-83), issued in March 1978, sets an annual growth

target of 4.8%. Its major goals are: 1)the removal of unemployment and significant unemployment, to be obtained by a program creating 49 million man years, 23 of these in agriculture and 9 in industry, predominantly cottage industry; 2)an appreciable rise in the living standard of the poorest sections, including a redistributive policy geared to the rural poor; and 3)state provision of "basic needs," including drinking water in 100,000 villages, community health workers, literacy for 66 million adults and basic nutrition and housing (Economic Intelligence Unit 1978: 20).

Public sector expenditures under the Sixth Plan (1978-83) by Sector
(Economist Intelligence Unit 1978:21)

Agriculture:	86,000	12.4%
of which		
agriculture:	58,000	8.4%
rural development	20,000	2.9%
Irrigation and flood control:	96,500	13.9%
of which		
major an medium irrigation	72,500	10.4%
minor irrigation	17,250	2.5%
Industry&minerals:		
of which		
village&small scale	14,100	2.0%
large&medium	72,520	10.5%
fertilisers&pesticides	16,880	2.4%
Energy,science&tech.	208,000	30.0%
of which		
power	157,500	22.7%
petroleum	25,500	3.7%
coal	18,500	2.7%
Transport&communications	105,620	15.3%
of which		
railways	33,500	4.8%
P&T,telecommunications	20,950	3.0%
roads&road transport	29,230	4.2%
Social Services	93,550	13.5%
of which		
education	19,550	2.8%
health&family welfare	20,950	3.0%
housing,urban development and works	25,400	3.7%
water supply	15,800	2.3%
social welfare, nutrition and labor welfare	11,850	1.7%
TOTAL	693,800	100.0%

The plan size is Rs. 1,162, 60% of which is accounted for by public sector outlays (Rs. 693,800). The outlay for agriculture and irrigation (26.3%), while significantly larger than under the fifth year plan (21.7%), is less than in earlier plans. However, total rural outlays are higher: 43.1%, as compared with 37.1% under the fifth plan.

One of the major emphases of the plan is combatting of poverty, including measures for: raising employment; land reform; improving the supply of credit for weaker sections of the society; public distribution of essential goods; and special programs to assist backward areas and to provide for basic needs (World Bank 1979:17).

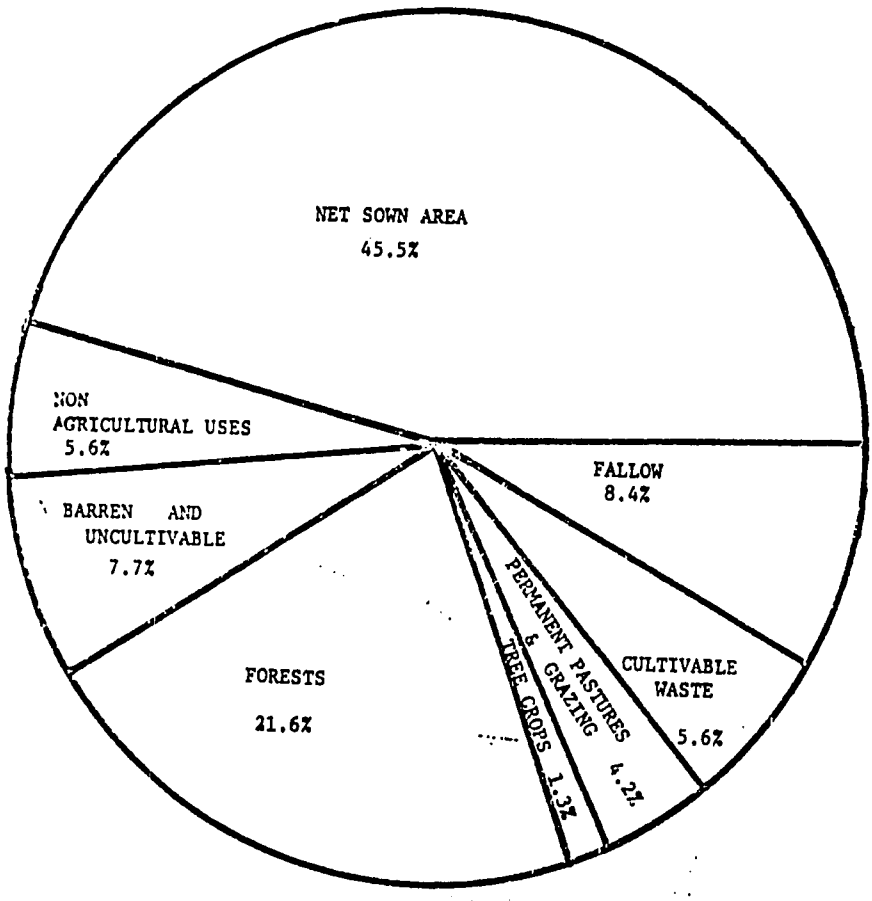
3.3.1 Foreign Assistance

All Indian development plans have relied heavily on foreign assistance. The chief channel for this aid is the Aid-India Consortium, organized under the sponsorship of the World Bank in 1958. The members are Austria, Belgium, Canada, Denmark, France, Great Britain, Italy, Japan, the Netherlands, the United States, West Germany, and IBRD/IDA. For the period 1973-75, India received $1.097 billion from all sources--about $1.87 per capita (Kurian 1978:642).

3.4 Agriculture

LAND UTILIZATION (1974-75)

(diagram covers 3,041,000 square kilometers--92.5% of total 3,287,782 square kilometers)



Agriculture continues to be the dominant economic sector of India, accounting for about 40% of Gross Domestic Product in recent years, occupying as much as 72% of the working population, and accounting for over 50% of land utilization in the country. Agriculture also supplies raw materials for a large section of Indian industry and a substantial portion of the country's exports.

India farming, however, is characterized by traditional farming methods and low unit yields for almost every crop. For example, in 1976 India, with the world's largest hectarge planted to rice (some 38,600,000 hectares), produced some 46,000,000 tons less rice than China, where total rice hectarage was 35,391,000.

3.4.1 Tenure and type of farming

The prevailing type of farming is carried out by sedentary farming engaged in the cultivation of cereals, although fibers, sugarcane, oilseed, and market gardening are equally important in some areas of the country.

Most Indian farmers are smallholders. According to the Agricultural Census of 1970/71, about 70% of all operational holdings consisted of two hectares and less; these holdings, however, accounted for only 21% of the total cultivated area. Furthermore, although only 4% of holdings were larger than ten hectares, these large holdings accounted for 31% of the total cultivated area. This imbalance is also reflected in rural assets statistics, which show that in 1971/72, the poorest 10% of the rural households owned only 0.1% of the total assets, while the richest 10% owned over half of the total assets (World Bank 1979: 58). This pattern appears to have continued unchanged. The National Commission on Agriculture has reported (1976) that "the concentration of land in the hands of more affluent farmers...continues to be intact." Despite indications that at least some states have succeeded in proportionally reducing the numbers both of the totally landless and of large landholders, the actual number of poor farmers and laborers appears to be growing. During 1961-70, the number of holdings below one hectare increased by about 51%, from 23.6 million to 36.6 million, and the number of agricultural laborers increased by about 75%, from 27.1 million to 47.5 million (World Bank 1979:57-58).

Not only are holdings predominantly small, but they are also frequently fragmented into small non-contiguous plots, partially as a result of inheritance practices and partially because farmers often prefer to plant two different crops on two different types of soils or in two different planting seasons. This situation creates several problems, among which may be mentioned the awkward necessity for farmers to move from one plot to another, difficulties in irrigation, and constraints on the use of modern implements (Dutt 1973:48).

Consolidation of these small holdings, a possible answer to the problem, has become widespread only in Punjab, Haryana, and Uttar Pradesh. Tractors are become more common, especially on consolidated holdings, but Indian agriculture still relies heavily on drought animals such as bullock and buffaloes for ploughing and carting (Dutt 1973:48).

3.4.2 Crop land and irrigation

Although the cropland per capita remains high in India as compared with

most other Asian countries, the pressure on population on land has been increasingly felt, particularly since the option of adding new crop land becomes smaller each year. Although the amount of total irrigated land has increased considerably since the 1950's, annual growth of total cropped land declined from 1.7% in the 1950's to maintain a growth of about 0.5% per year since 1961 (World Bank 1979:58). Increased production, therefore, will depend more on an increase in irrigation and on the use of modern machinery and fertilizers than on the extension of agriculture to a greater land area.

Irrigation has increased dramatically since the 1950's; in recent years as much as 24% of agricultural land has benefitted from irrigation and this proportion is expected to grow (see section 2.3.3.2 for a detailed discussion of irrigation and its problems). As of 1975 about 18% of the net cultivated area was being double-cropped.

3.4.3 Harvests

There are two harvest seasons in India: kharif (autumn or fall) and rabi (spring). The kharif crop, sown with the onset of the monsoon rains in June and July and harvested in the fall, consists principally of rice, millets, maize, jute, seasamum, and cotton. Kharif crops are essentially those of the floodplains and areas under tank irrigation (Dutt 1973:48). Rabi crops, sown shortly after the end of the monsoon rains in October and November are harvested in March and April. They include wheat, barley, pulses, linseed, rape, and mustard. These crops, grown on doabs (tracts of land between two rivers) and uplands are considerably more dependent on irrigation than are the kharif crops (Dutt 1973:48).

Exceptions to this general two-harvest pattern are crops in the warmer half of the southern peninsula, particularly Tamil Nadu, where rains fall principally from October to December, and sugarcane plantings (Dutt 1973:48).

3.4.4. Use of fertilizers and pesticides

India farmers have traditionally used fertilizers such as animal dung and other organic material, but much of this material is now burnt for fuel.

Use of inorganic fertilizers (hereafter simply referred to as fertilizers) has been on the increase, however; demand for such fertilizers increased by about 21% per year during the latter half of the 1970's, reaching 5 million nutrient tons in 1978/79 (as opposed to only 400,000 tons in 1961/62). For the most part, fertilizer use has been concentrated in a few districts (16% of the districts consume some 50% of the fertilizers) and has been associated with irrigated agriculture rather than with the some 75% of the farmland where rainfed agriculture is practiced. Recent efforts in Karnataka have indicated, however, that fertilizer use can also be increased in rainfed areas. Increases in fertilizer use are dependent both on efficient systems for transportation and marketing of these products and the ability of the farmer to pay for them; it is hoped reductions in the prices of fertilizers will lead to increased use. In addition, increased assistance to the farmer from

agricultural extension services could increase both the use of fertilizers and the efficiency with which they are used (World Bank 1979:50-51).

India does not presently produce inorganic fertilizers in quantities sufficient to cover her needs, although production has been increasing, rising from 1,427,000 tons in 1974 to 2,680,000 tons in 1977; fertilizer used in 1976-77 came to 3,411,000 tons. Fertilizer imports accounted for 8.4% of the value of imports in 1975-76, the last year for which figures could be found (India. Ministry of Information and Broadcasting 1978:211); Europa Yearbook 1979).

Nitrogenous fertilizers accounted for 72% of the inorganic fertilizers used in 1976-77, phophatic fertilizers for 18.6%, and potassic fertilizers for 9.3% (India. Ministry of Information and Broadcasting 1978:211).

Attempts are also being made to develop local manure resources, and schemes for urban compost, sewage and sullage utilization, rural compost and green manuring, mechanical compost plants, and gobar gas plants are in operation. The Fifth Plan called for the establishment of 35 compost plants. About 6,000,000 hectares are now covered by green manuring. During 1974-75 about 24,000 hectares were under sewage irrigation (India. Ministry of Information and Broadcasting 1978:211).

Use of pesticides for the 1976-77 year was anticipated at 49,874 tons, an increase of 5,000 tons over 1975-76. A target of 60,000 tons was fixed for 1977-78. During 1976-77 an area of 886,600 hectares was treated, equally divided between aerial and ground spraying; this was double the area covered in 1975-76 (India. Min. of Information and Broadcasting 1978:213). Pesticides in use in 1975 included: DDT (India was the world's largest user), BHC, lindane, aldrin, toxaphene, parathion, malathion, pyrethrum, carbamates insecticides, sulfur, lime sulfur, copper compounds, dithiocarbamates, 2,4-D, triazine, bromides, and various rodenticides (FAO Production Yearbook 1976).

3.4.5 Other types of farming

Shifting cultivation continues to be practiced by tribal people in the forests of Assam and the sub-Himalayan slopes, the less-accessible parts of Central India, and the slopes of the Western Ghats (Dutt 1973:48).

Plantation agriculture is carried out in two areas: (1) the slopes along the Brahamaputra Valley in Assam and the Valley slopes in the inner Himalayas and the Siwalik foothills in Darjeeling, where tea is the chief crop; and (2) the slopes of the Western Ghats in Kerala and Tamil Nadu, where in addition to tea, coffee and rubber are also grown (Dutt 1973:48).

3.4.6 Principal crops and growing areas (see map of crop areas and table, pages 106a and 106b)

Indian agriculture is characterized both by a wide variety of crops and by a preponderance on food crops over non-food crops. Foodgrains (including pulses) presently account for 77% of cropped area; all non-food grain

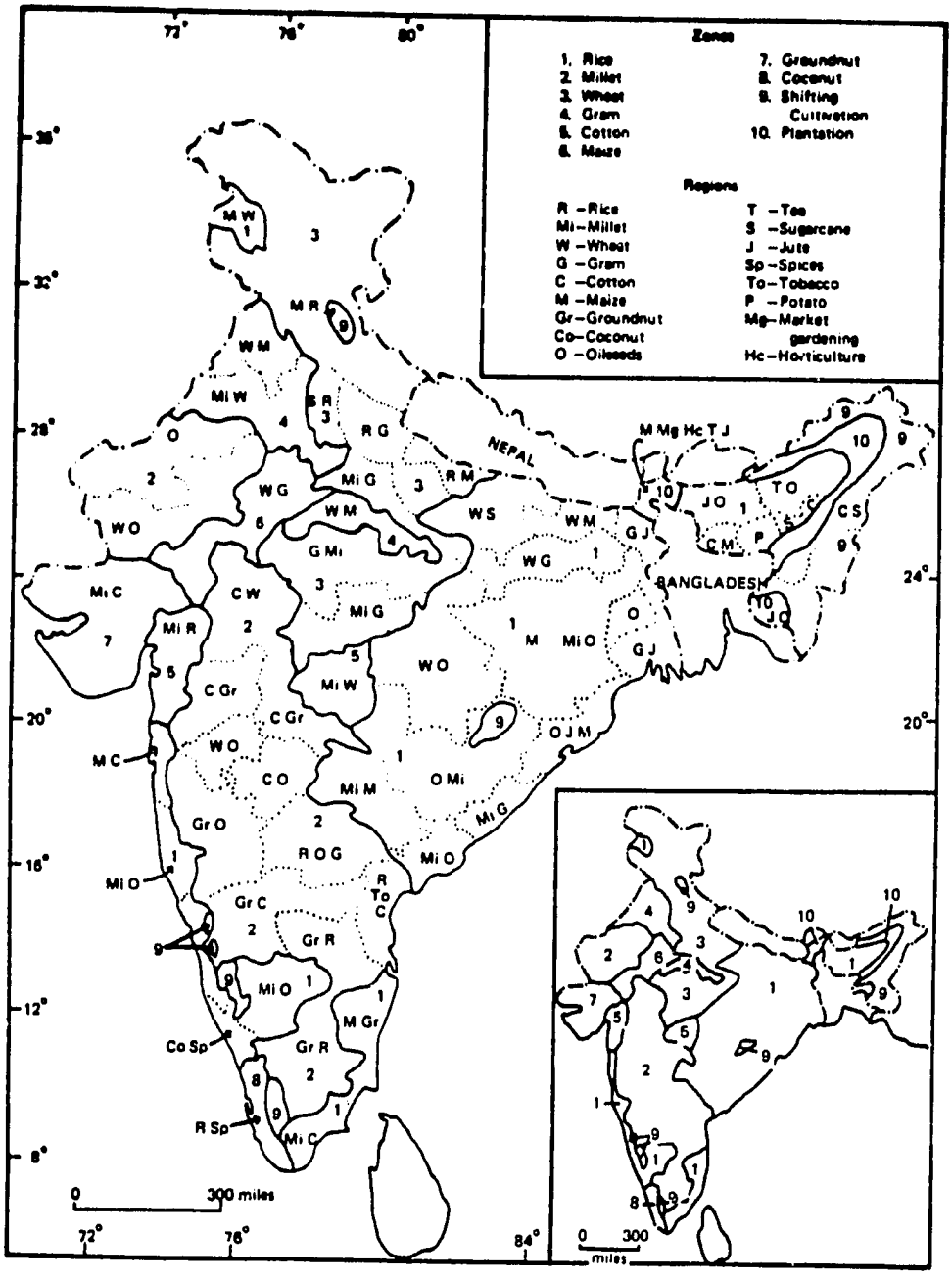
MAJOR CROPS OF INDIA

(Source: Ministry of Agriculture and Irrigation as cited in Europa Yearbook 1979)
Area in thousands of hectares; production in thousands of metric tons
Reporting period: July 1st to June 30th)

	1975-1976		1976-1977		1977-1978	
	Area	Production	Area	Production	Area	Production
FOODGRAINS						
Cereals						
Rice	39,475	48,740	38,511	41,917	40,001	52,617
Wheat	20,454	28,846	20,921	29,010	21,203	31,328
Sorghum(Jowar)	16,092	9,504	15,772	10,524	16,273	11,818
Cat-tail millet(Bajra)	11,571	5,736	10,751	5,853	11,035	4,711
Maize	6,031	7,256	6,000	6,361	5,700	5,947
Small millets	4,672	1,924	4,680	1,752	4,740	2,113
Finger millet (Ragi)	2,630	2,797	2,496	2,045	2,652	2,904
Barley	2,802	3,192	2,241	2,344	1,993	2,309
Total Cereals	103,727	107,995	101,372	99,806	103,597	113,807
Pulses						
Chick peas(Gram)	8,320	5,879	7,974	5,424	8,253	5,451
Pigeon peas (Tur)	2,671	2,099	2,566	1,725	2,623	1,888
Dry beans,dry peas, lentils and other pulses	13,463	5,061	12,443	4,212	12,660	4,459
Total pulses	24,454	13,039	22,983	11,361	23,536	11,798
NON-FOODGRAINS						
Oil seeds						
Groundnuts	7,222	6,754	7,043	5,264	7,175	6,069
Sesame seed	2,170	479	2,279	422	2,306	486
Rapeseed and mustard	3,339	1,936	3,129	1,551	3,534	1,618
Linseed	2,119	598	1,888	419	1,951	504
Castor beans	375	143	496	179	540	256
Total oil seeds	15,225	9,910	14,835	7,835	15,506	8,933
Fibers						
Cotton(lint)	7,350	5,950*	6,885	5,839*	7,815	7,103*
Jute	585	4,440**	737	5,353**	795	5,338**
Kenaf(mesta)	330	1,474	352	1,746	361	1,780
Plantation crops						
Tea(made)	363	487	364	512	n.a.	n.a.
Coffee	n.a.	93	n.a.	84	n.a.	n.a.
Rubber	n.a.	136	n.a.	145	n.a.	n.a.
Vegetables,Fruits,Condiments, Spices						
Potatoes	622	7,306	620	7,171	664	8,153
Chillies (dry)	740	520	782	419	766	468
Miscellaneous crops						
Sugar cane gur	2,762	14,413	2,866	15,847	3,220	18,778
cane		140,604		153,007		181,628
Tobacco(leaves	622	7,306	620	7,171	664	8,153

*cotton: thousands of bales of 170 kg each
**jute: production in thousands of bales of 180 kg each

MAJOR CROP ZONES AND CROP ASSOCIATION REGIONS
(Source Dutt 1973: page 51)



Zones are identified on the basis of their first ranking crop (nos. 1-8) or on the basis of type of cultivation (9 and 10). Within these zones, crop association regions--marked off by the dotted lines-are identified on the basis of second and third ranking crops (indicated by letters).

crops account for the remaining 23%. Only 17% of the land is occupied by the main non-food crop: fibers and oilseeds. In terms of the overall value of agricultural production foodgrains account for 55%, non-foodgrain crops for about 25%, livestock and dairying for 15%, forestry for 3%, and fishing for 1% (World Bank 1979:52). The principal crops are shown on the table on page 107a. Principal growing areas within the country are indicated by the map on page 107b.

Not indicated on the table on page 107a are substantial quantities of vegetables and melons, including: cabbages, tomatoes, cauliflower, dry onions and garlic (India is the world's largest producer of both), green beans, and green peas. Fruits include grapes, pears, peaches, plums, oranges, lemons and limes, grapefruit, apricots, bananas (India is the world's largest producer after Brazil), mangoes (India accounted for 79% of world production in 1976), pineapples, cashew nuts (India accounted for 41% of world production in 1976), walnuts, and coconuts (FAO Production Yearbook 1976). Among the fruits, mangoes, bananas, and guavas are grown throughout the country; oranges in Maharashtra, West Bengal, and Assam, while the western Himalayan areas of Kashmir accounts for the temperate fruits such as apricots, pears, and peaches (Dutt 1973:53).

Four distinct larger crop growing regions based on climate have been identified: the Himalayan zone, the dry zone, the sub-humid zone, and the wet zone. The Himalayan zone, only 7% of which is cultivable, has rainfall levels varying from 1000 to 25000 mm; principal crops are wheat, maize, rice, market-gardening, including potatoes and fruits, and tea. The dry zone (Punjab, Haryana, Rajasthan, western Gujarat, and the southern plateau in the lee of the Western Ghats) receives less than 700 mm of rain; dominant crops are millets and wheat but gram, maize (in the northwest), oil seeds, and cotton are also grown. The sub-humid zone , with a rainfall of from 700 to 1250 mm (the Upper and Middle Ganges Plain and the eastern half of the peninsula plateau through to Tamil Nadu) is the most heavily cropped areas of the country; major crops are wheat, sugarcane, rice, gram, maize, millets, cotton, groundnut, oilseeds and tobacco. Wheat is the chief cereal in the upper Ganges Plain, millets and wheat on the Plateau, and rice in the coastal region and the middle Ganges Plain. The wet zone (annual rainfall of more than 1250 mm) includes the northeastern section of the peninsular plateau, the Ganges Delta, the Brahmaputra Valley and the West Coast plain; rice is the dominant crop through this zone but oilseeds, gram, millets, jute, teah, sugarcane and spices are regionally important (Dutt 1973:49).

Under the Draft Sixth Plan emphasis is put on mixed farming incorporating both foodgrain and non-foodgrain crop production, animal husbandry, poultry, and forestry. It is felt that non-food grain agriculture, because it is generally less land intensive than foodgrain production, offers better prospects for faster and larger growth of income for very small landowners and for the employment of landless labor. It is expected that this emphasis could help to meet domestic demand for products such as oilseeds while only minimally reducing the amount of land marked for foodgrain production. Cotton production is particularly marked for rapid increase under the plan; this is to be brought about

by propagation and introduction of new hybrid seeds, the encouragement of cotton growing on lightly irrigated areas, and the expansion of plant protection and pest control (World Bank 1979:52).

With regard to exports, tea and jute (more precisely jute manufactures) are the most important crops, but tobacco and sugar, of which India is the world's largest producer, are also of importance. Cotton fabrics, based both on Indian grown and imported cotton are also significant exports.

3.4.7 Livestock

LIVESTOCK AND LIVESTOCK PRODUCTION (Source: FAO Production Yearbook)

	NUMBERS(thousands of heads)		PRODUCTION (in thousands of metric tons)						
	1975	1977	slaughtered	meat	milk*	butter &ghee	eggs	wool	skins
Cattle	179,457	181,092		70	8,424	570*			795.5
Buffaloes	59,853	60,398		116	16,500				
Goats	69,032	70,060		275	708				70.2
Sheep	40,000	40,352		117				greasy 32.7 clean 20.4	35.6
Pigs	8,048	8,732		63					
Camels	1,150	1,150							
Asses	1,000	1,000							
Horses	900	900							
Poultry	141,000	143,000		104			85		

*all sources

cattle

India cattle, by FAO estimates, account for some 15% of the world's cattle population. Only small numbers of these cattle are slaughtered, their main use being as draft animals or for milk. An estimated 42% of the cattle in the country are draft animals. However, because of bad feeding, the conditions under which they are kept, and their widespread status as sacred animals limits, their usefulness as both milk and draft animals is not as great as it might be (Economist Intelligence Unit 1978:12).

Dung from cattle and other animals is used both for fuel and as fertilizer. Because of acute shortages of fuelwood, particularly in non-forest areas, cowdung, a valuable manure, is burnt for fuel. By one estimate, as much as 400 million tons of dung (wet weight) are used for fuel each year in India (Indian Forester 1979:241).

buffaloes

There are about seven indigenous breeds of buffaloes. Buffaloes are considered more advantageous than cows because they are less expensive to maintain and because their milk is richer in fat content and is therefore more suitable for production of butter and ghee (Lal 1977:180).

sheep

Sheep are kept mainly by poor farmers and nomadic shepherds; they are concentrated mostly in the arid zones with low rainfall and form a major source of income for people in these areas (Lal 1977:180). Most of the sheep stock is low in productivity of both wool and mutton (Lal: 1977:180). Most of the wool produced by Indian sheep is coarse and is used in the manufacture of carpets, druggets, and coarse blankets. Better quality wool must be imported to supply the woolen textile industry (about Rs. 210,000,000 per year) (Lal 1977:180).

goats

Goats, one-sixth of the total world population of which are in India, are the major source of animal protein in India, accounting for some 37% of meat production in 1976. Goats also supply milk, skin, mohair, and dung. Although goats are found throughout the country, about 6,070,000 are found in the hot arid zone of the northwest, while large numbers also occur in Uttar, Pradesh, Bihar, and Madhya Pradesh (Lal 1977:181; NCEPC 1977:33). Important because of their yields of high quality hair are the Himalayan goats of Jammu and Kashmir, Himachal Pradesh, Punjab, and Uttar Pradesh.

poultry

Poultry numbers in India are small in comparison with more developed countries--only about 26 chickens per 100 persons. Furthermore, the annual laying capacity of Indian hens is small--about 60 small eggs in a year, as compared to 180 large eggs from Amercian breeds such as the White Leghorn (Lal 1977:181). Despite a steady increase in egg production over the past decades--the result of the introduction of the introduction of exotic species for breeding purposes--, the availability of eggs in India is estimated at only 12 per person per year (Lal 1977:181).

pigs

Pigs constitute only a small percentage of total livestock in India, and pig meat represented only about 8% of meat production in 1976. A model piggery has been set up at Gannavaram in Andrha Pradesh, and efforts are being made to set up programs in the Northeastern states, where pig meat is a popular food; these include a scheme involving production through small and marginal farmers and agricultural laborers in 10 districts (Lal 1977:181).

India earns foreign exchange (some Rs. 700,000,000) through the export of hides, skins, wool, and other animal products (Lal 1977:179).

camels

Camels are concentrated in Rajasthan and Haryana, with lesser concentrations in Gujarat. They are used for tilling and hauling and can also serve as sources of milk (Singh 1974:289).

3.4.7.1 Overgrazing

Overgrazing of domestic animals is a serious problem throughout much of India, although problems tend to be greatest in the mountainous areas, where large numbers of sheep and goats are responsible for deforestation and consequent soil erosion, and in the arid zones.

In the arid zone of Rajasthan, where livestock population exceeds human population, density of livestock (cattle, buffaloes, sheep, goats, camels) is much higher than in other parts of the country--more than 25 livestock per hectare of permanent pasture and grazing land (NCEPC 1977: 33). Here increases in livestock numbers has led to a shrinkage of cropland and the extension of agricultural to marginal land. Domestic animals, particularly sheep and goats, have contributed to depletion of vegetal cover on stabilized dunes, aggravating desertification problems (NCEPC 1977:41). The livestock pressure has led to over-grazing, deforestation, and exploitation of the woody biomass of the region, resulting in extensive removal of vegetation, with consequent erosion hazards (NCEPC 1977:45).

3.5 Industry

Industrial manufacturing contributes some 14% to the Indian GDP. Its rate of growth between 1969 and 1973 was 4.2%, down from 9 % per year during 1961-65. Within the period of the Fifth Plan (1974-79), however annual growth has averaged 6.0%(Economist Intelligence Unit 1978:13). In terms of absolute output, India is one of the ten largest industrial countries outside of the Communist bloc; however, it is among the least productive if judged by per capita industrial output (Kurian 1978:645).

The government has played an increasingly larger role in industrial development. As of 1974 there were 122 central government public corporations, accounting for over 50% of the value in large-scale manufacturing (Kurian 1978:645).

Industrial production is centered in nine states, which together account for 90% of industrial output: Maharasthra, West Bengal, Tamil Nadu, Gujarat, Uttar Pradesh, Bihar, Andhra Pradesh, Karnataka, and Madhya Pradesh. According to the 1970 industrial survey, there were 62,833 establishments employing over 10 workers each (small scale) and 13,598 employing over 50 workers each (large scale). Of the ten dominant industrial groups, the largest is textiles (about 10.2% of reporting plants). Other industries are jute, sugar, paper and paperboard, photo paper and films, iron and steel, engineering and machine tools, drugs and pharmaceuticals, and petrochemicals (Kurian 1978:645).

Industries fall into two groups: an organized and an unorganized sector. The organized sector is subdivided into large-scale and small scale industries, with the large scale accounting for 27% of all industrial plants, 84% of aggregate employment, and 84% of the aggregate gross value of output. The unorganized sector includes cottage industries, handicrafts, and most service industries (Kurian 1978:645).

Large industrial operations include the iron and steel industry, with major plants in Rourkela and Durgapur in West Bengal, and Bhilai in Madhya Pradesh. The oil refinery in Mathura (Rajasthan), scheduled for opening in 1978, has a capacity to process 6 million tons of crude oil per year; it is intended to process principally Iraqi oil piped 1,600 kilometers from the Gulf of Kutch. Among important agro-industries are cotton textiles, with 703 mills in operation at the end of 1976; the sugar industry, with 271 factories producing 48,142,000 tons of sugar in 1976-77; and the the jute industry.

Despite growth in the large industrial sector, village and small industries continue to play an important role throughout India. An estimated 20,000,000 people are engaged in these industries, about 9,000,000 of whom are in the handloom industries. Under the Draft Sixth Plan, as under earlier plans, strong emphasis has been placed on the small-scale industrial sector, particularly as a means of creating jobs. The village and small-scale industries program has set the goal of 6.8 million full-time jobs created during the plan period. Strong emphasis is being placed on the handloom industry; efforts here involve upgrading the productivity of handlooms and the quality of inputs and the creation of new export markets (World Bank 1979:viii).

3.5.1 Industrial pollution

Water pollution from industrial operations has been considered in section 2.3.4. As pointed out there, such pollution is not limited to urban areas, since sugar mills, which are among the heavier polluters, are located in rural areas. Despite the growing danger of water pollution from industry, however, water pollution today arises above all from domestic sources, which have recently been estimated to account for as much as 90% of the total pollution load (JPRS 73682, June 14, 1979: 5).

Industrial air pollution arises from industrial operations such as fetilizer production, sulphuric acid plants, refineries, thermal power plants, synthetic fiber production, and aluminum smelting. Thermal power plants, one of the major sources of air pollution, cause problems mainly through emissions of sulfur dioxide and flyash. In industrial centers such as Kampur, Calcutta, and Bombay, pollution from smoke is particularly severe. In many cases, industries are located in highly populated areas, where dangers to human health are high (Johnson and Johnson 1977:section II.1). In Delhi there were, by a recent count, about 24,000 industries in residential and non-industrial areas(WER June 4, 1979:6). Recently there has been a controversy over the location of a 3,600-ton per day fertilizer plant just south of Bombay on the west coast of India, which according to environmentalists opposing its establishment would add to the pollution level in this city, already said to be the most polluted in the country (WER January 15, 1979:1).

3.6 Energy sector

India has several basic sources of energy: electricity produced by hydro-power, thermal sources such as coal burning, and nuclear power plants; energy produced by petroleum and natural gas; and energy from non-commercial sources such as firewood and charcoal, cattle dung, and crop residues.

electricity

Of the estimated 91,282 gigawatt hours of electricity generated by India's utilities in 1977/78, 55% were produced by thermal installations burning coal or petroleum, 41.6% by hydropower installations, and 2.5% by nuclear power plants (see table on page 33). Of the estimated 68,963 gigawatt hours consumed during the same period 68.9% was consumed by industry, 14.4% by agriculture, and 23.2% by other users (World Bank 1979:97).

Part of the effort to develop rural areas has involved extending the rural electrification network as rapidly as possible. The percentage of villages receiving electricity from the grid has, accordingly, increased from 0.5% in 1950/51 to just over 38% in 1977/78 (World Bank 1979:86). The number of electrified pumpsets used in minor irrigation projects for agriculture has risen over the same period at an average annual rate of 21% from 21,000 to over 3.3 million. With regard to rural industry, use of electricity in such establishments rose from 1.2% in 1960 to

5.4% in 1970, the last date for which figures could be found(World Bank 1979:86).

Since 1970/71, growth in the electric power sector has not been able to meet demand, and shortages of electricity have consequently become quite widespread, with serious impact on the economy at large. The greatest deficits have been in the Northern and Northeastern Regions. The effects of these shortages have fallen most heavily on the industrial sector, which relies heavily on electric power, and industrial output has suffered accordi The effects of electricity shortages on the agricultural sector have been relatively minor because in most states agricultural supply is protected as a matter of policy (World Bank 1979:100-101).

non-commercial fuels

Non-commercial fuels, which in 1970/71 accounted for 48% of total energy consumed and 85% of household energy, are used more heavily in rural than in urban areas. The 20% of the Indian population living in urban areas accounted for an estimated 17% of non-commercial energy use in 1970-71 (Henderson 1975:27).

As of 1970/71 the estimated breakdown for non-commercial fuel use was: 66% in charcoal and firewood; 15% in dried cow dung; and 20% in vegetable wastes* (Henderson 1975:27).

According to recent estimates of all total energy uses in rural India, non-commercial sources including human labor, bullock work, firewood and charcoal, cattle dung, and crop residues account for 89.5.% of all energy uses; 73.7% of these non-commercial fuels are firewood, cattle, dung and crop residues. Petroleum and natural gas accounted for 3.1% of energy use, electricity for about 7.4%, soft coke for 1.2% (UNEP 1976:23).

problems and alternatives

Problems arising from the heavy use of firewood as a domestic fuel have been considered in section 2.5.2.2.2. Heavy use of cattle dung as a fuel means that it is not being as widely used as a fertilizer; this means either that no fertilizers are not being used or that expensive chemical fertilizers must be used instead.

Although electrification is being increasingly extended to rural India, electrification may be prohibitively expensive for some remote areas far from the grid system. Furthermore, the introduction of electricity often does not remove pressure from the non-commercial fuels such as wood; rather, it has tended to serve as a replacement for kerosene, a fuel which has risen in cost along with generally rising petroleum prices (Henderson 1975: 168).

*Calculated on million tons of coal replacement; in units of millions of tons the breakdown was: firewood and charcoal: 126 (54.1%); dried cow dung: 68 (29.2%); vegetable wastes: 39 (16.7%) (Henderson 1975:27).

A promising source of energy for rural areas is gobar gas, which is derived from cow dung and other natural wastes by anaerobic fermentation. Such gas, which is composed of 55% methane and 45% carbon dioxide by volume, can be used for cooking, lighting, and as a fuel for operating pumpsets. Furthermore, the residue left after gasification is a good organic fertilizer. Gobar gas plants can be operated on a small scale with a gas output as low as two cubic meter per day. One problem with this energy source is that only a small minority of rural families own the minimum number of cattle required to supply gasification units (Henderson 1975:168-69).

Other potential energy sources are urban and industrial wastes; solar energy, which has good possibilities, particularly in India s arid areas; geothermal energy, which might be derived from hot springs in areas such as the north-west Himalayan ranges, the Namada Sone Valley, the Damodar Valley, and the west coast; and wind mills, which could be used for household energy in those areas of Rajasthan, Gujarat, Maharashtra, and Gujarat where wind speeds are over 10 kilometers per hour (Lahiri and Nagarajan 1977: 239-240). Of these sources, the India government appears to have been most actively pursuing the development of solar energy. As of early 1979 some 21 institutions within India were reportedly engaged in research and development work on solar energy (WER April 23, 1979:6).

4.0 ORGANIZATIONS WITH INTEREST IN ENVIRONMENT AND NATURAL RESOURCES

India has no single central body charged with environmental conservation. Rather these functions are scattered among various ministries and departments which are responsible for taking environment matters into consideration when they formulate their programs. Furthermore, India has a federal system of government in which the primary responsibility for most matters relating to environment and natural resources falls to the state governments (see 4.2).

At the union (central) level, however, there is a National Committee on Environmental Planning and Coordination, functioning under the Department of Science and Technology, charged with reviewing environmental matters, including policy formulation, and advising the government in this area. Similar bodies keep a close watch on environmental matters at the state level, and some state governments have established Departments of the Environment (UNEP ROAP 1978:6).

4.1 CENTRAL GOVERNMENT ORGANIZATIONS

4.1.1 Planning and Coordinating Bodies

4.1.1.1 National Committee on Environmental Planning and Coordination (NCEPC) New Delhi

Established: 1972 (under the Ministry of Science and Technology)

The NCEPC was set up to identify, investigate, and propose solutions for the problems of improving the human environment in the context of the growth and distribution of population and economic development. To accomplish these goals the NCEPC is to review, formulate, and promote policies and programs covering development projects, physical planning, legislation, administrative procedures, education and public information, and research (India. NCEPC. 1976:4).

In pursuance its research goals, the NCEPC has established the Environment Research Committee (ERC) and the Indian National Man and the Biosphere Reseach Committee (MAB) to assist the Department of Science and Technology in fostering and supporting research work in various areas of environmental concern (India. NCEPC. 1976:5).

The NCEPC is involved, among other things, in major reserach work in ecology under UNESCO's programme MAB programme. The committee is engaged in research involving environment and ecology, human settlements, mass transit and water pollution control.

4.1.1.2 Planning Commission

The Planning Commission is instrumental in the production of India's Five Year Plans, which have guided India's development since the early 1950's. The draft sixth plan (1979-84) for the first time includes a section entitled "Environmental Planning and Coordination." Various divisions of the Commission are: Agriculture and Rural Development,

Employment and Manpower Planning, Industry and Minerals, Village and Small Industries, Irrigation and Command Areas Development, Land Reforms, Plan Coordination, Power and Energy, Scientific Research, and Statistics and Surveys. The Planning Commission, which approves all State and federal development projects involving financial support from the central government, will not clear projects found unacceptable from an environmental standpoint ((UNEP ROAP 1978:6).

4.1.2 CENTRAL GOVERNMENT MINISTRIES (Names of Ministries are as of mid-December 1979, at which time there were 30 ministerial posts.)

4.1.2.1 MINISTRY OF AGRICULTURE AND IRRIGATION

4.1.2.1.1 Department of Agriculture

The Department comprises eleven wings: Crops; Plan Co-ordination; Forestry; Adminstration and Coordination; Budget, Finance and Accounts; Land and Water; Land Reforms; Agricultural Census; Inputs; Animal Husbandry; and Fisheries.

National Commission on Agriculture

Constituted on August 29, 1970, the National Commission on Agriculture was charged to "examine comprehensively the current progress of Agriculture in India and to make recommendations for its improvement and modernisation with a view to promoting the welfare and prosperity of the people." It was directed to investigate and report on a) crop production, land and water development; b) animal products, fisheries, and forestry; c) research, education, and training; d) organization and supporting measures; e) employment and manpower; f)other aspects such as land reforms and special area programs. The findings of the Commission and its recommendations are contained in a massive 15 volume report published in 1976 and summarized in an abridged report, which followed in 1977(see India. National Commission on Agriculture. 1976 and 1977). The material contained in the report is based on data already available through the Ministry of Agriculture and Irrigation as well as on information generated by the Commission itself. The report generally reflects the situation as of 1973-74.

4.1.2.1.1.1 Forestry Wing

Inspector General of Forests (Sharma 1978: 219)
(acts as ex-officio Additional Secretary to the Government of India in all forestry matters)

Various deputy and assistant inspectors are concerned with forests in general, wildlife, forest industries, and forest statistics, while technical officers are assigned responsibilities for forest planning and industry. The Division of Forestry and Wildlife, the director of which is also the Director of Wildlife Preservation, has particular responsibilities in the area of wildlife conservation; it is the agency responsible for the implementation of the CITES (Convention on International Trade in Endangered Species) Treaty, to which India is a signatory.

4.1.2.1.1.1.1 Central Board of Forestry (Sharma 1979: 219)

The CBF is composed of the ministers in charge of forests in the states and Union Territories, the Secretary to the Department of Agriculture and the Inspector General of Forests. Under the Chairmanship of the Minister of Agriculture and Irrigation, the board meets annually to consider policy and other forest related matters at the national level.

4.1.2.1.1.1.2 Indian Board for Wild Life

Established: 1952

An advisory body, the Indian Board for Wild Life meets once every quarter to consider and make suggestions concerning policy regarding wildlife and wildlife conservation. The Board has set up four wings for investigating problems of management of 1) zoos, 2) birds, 3) fisheries, and 4) flora. In 1970 the Board commissioned an expert committee to produce a report concerning national parks and wildlife sanctuaries and to develop a wildlife conservation policy for India (Indian Board for Wildlife 1970).

4.1.2.1.1.1.3 Forest Research Centre

4.1.2.1.1.1.4 Forest Research Institute and Colleges
Dehra Dun

The Institute and Colleges represent the main center for research in forests and forest products. There are four regional centers at Jabalpur, Coimbatore, Bangalore, and Burnihat. Research conducted by the institue has covered Eucalyptus hybrids and the introduction of tropical pines. The Institute has succeeded in producing Eucalpytus hybrids which are promising for large-scale plantations.

In the area of training, the Institute and Colleges serve as training centers for the South-East Asia Regions. During 1977, for example, there seven foreign students for officers' training and 23 students in the range officers' course (India. Dept. of Agriculture 1978:123).

4.1.2.1.1.1.5 Forest Research Laboratory

4.1.2.1.1.2 Division of Soil and Water Conservation
Etablished 1956

The division is involved in planning, coordinating, and monitoring the Central Sector Programme of Soil and Water Conservation on a national scale, including the arid and semiarid regions of the country.

Research programs have included pilot projects for developing integrated technology for ravine reclamation in Rajasthan, Gujarat, Madhya Pradesh, and Uttar Pradesh; soil conservation in the catchments of multipurpose river projects; collaboration in the planning processes of the Drought

Prone Area Programme implemented in the arid and semiarid regions of the country where research findings for integrated area development are being applied (Paylore 1977:58).

4.1.2.1.1.2.1 All-India Soil and Land Use Survey Organization (Paylore 1977:58)
New Delhi

Centered in New Delhi, the Organization has four Regional Centres (at Delhi, Calcutta, Nagpur, and Banagalore) and three sub-centres at Ahmedabad, Hyderabad, and Ranchi. The Organization has the strength of 80 sanctioned field parties with ancillary supervisory and ministerial staff (India. Dept. of Agriculture 1978:54).

The Organization conducts rapid reconnaissance surveys for identification of priority watersheds in the catchments of selected river valley projects and detailed soil surveys in priority watersheds in order to provide scientific data for planning and implementation of soil conservation works. During 1977, furthermore, detailed soil surveys were carried out in problem-prone areas such as the ravine lands of Kotah and Pukharayan (Uttar Pradesh) and salt-affected areas of Etah (Utter Pradesh) (India. Dept. of Agriculture 1978:53-54).

4.1.2.1.1.2.2 Soil Conservation, Research, Demonstration and Training Centre
Dehra Dun

Established in the 1950's by the central government Soil Conservation Board (an organization which has since been abolished) as one of a group of nine regional centers, the Centre at Dehra Dun (Uttar Pradesh) now has administrative responsibility for six additional centers: Kota (Rajasthan); Agra (Uttar Pradesh); Chandigarh; Ootacamund (Tamil Nadu); Bellary (Karnataka); Vasad (Gujarat). Among the research problems dealt with by the Dehra Dun Centre have been: erosion control in the Himalayas, stabilization of land slides, development of techniques for crop production, and establishment of pastures and forestry (India. NCA 1976:vol.5:270-71). In 1977 the Centre's work included continuation of its studies on soil and water losses; this involved collecting about 400 run-off samples from six gauging stations installed in an experimental watershed of the Center (India. Dept. of Agriculture 1978:54-55).

4.1.2.1.1.2.3 Central Soil Mechanics Research Station
New Delhi

4.1.2.1.1.3 Fisheries Wing

The wing is the main organization dealing with fisheries at the national level. Under the Wing are:

Deep Sea Fishing Organization
Bombay
-conducts offshore and deep sea exploratory surveys; has a number of substations all along the coast

Integrated Fishery Project (Indo-Norwegian Project)
Cochin
Established: 1957

The Project conducts exploratory survey work and is also engaged in the demonstration of modern fishery technology for the use of the industry by carrying out diversified fishing, processing, and marketing activities (NCST 1976:234)

Central Institute of Fisheries Education
Bombay
Established: 1961

Provides post-graduate education in fisheries mainly to District Fisheries Officers drawn from various State departments.

Inland Fisheries Training Center
Barackpore
Established: 1947

Provides training to middle-level fisheries executives--chiefly as nominated by State fisheries departments--in Inland Fisheries.

Central Inland Fisheries Research Institute
P.O. Barrackpore
West Bengal 743101

Established in 1947, the research conducted by the Institute includes: freshwater aquaculture; estuarine, riverine and lacustrine capture fisheries; brackish water fin and shellfish culture; frog farming; weed control; water pollution; economics of inland fisheries practices.

Regional Training Centers for Inland Fisheries Operations
Agra

Provides training for Inland Fisheries Operatives deputed by State governments.

Central Institute of Fisheries Operatives
Cochin, Madras
Training in manning deep sea fishing vessels.

Pelagic Fisheries Project

4.1.2.1.1.4 Directorate of Plant Protection, Quarantine and Storage

4.1.2.1.1.5 Agricultural Research and Education Wing

4.1.1.2.1.6 Food Wing

4.1.1.2.1.7 Rural Development Wing

National Institute of Community Development

4.1.2.1.1.8 Central Ground Water Board (CGWB)

The Board is responsible for coordinating at the national level the activities for the exploitation of groundwater resources, including exploration, assessment, development and scientific management of the resources. As recently reported, the CGWB was scheduled to survey the country's underground water potential over a five year period beginning in 1979 at an anticipated cost of $58 million.

During 1977-78 the activities of the CGWB including systematic hydrogeological surveys, deep groundwater exploration, short-term water supply investigations, and hydrogeological laboratory studies in various parts of the country. The CGWB also constructed tubewells on a deposit basis (India. Dept. of Agriculture. 1978:47-48).

Special groundwater investigations undertaken in recent years have included:

1) study of a pilot project on induced recharged in the Suhaon area of Ballia district in Uttar Pradesh;
2) detailed investigation on groundwater potential and preventive measures for salt water intrusion at Sriharikota, Nellore district in Andrha Pradesh;
3) micro-hydrogeological surveys for groundwater resoruces development in Monghyr district (Bihar) and Nadia and Murshidabad districts (West Bengal);
4) monitoring the extent, nature, and effects of surface and groundwater pollution from discharge of industrial wastes in the Damanganga and Kotar rivers in Daman and Gujarat.

Systematic hydrogeological surveys during 1977 (up to October) covered an area of 24,854 square kilometers. Within the same period reappraisal studies covered 41,949 square kilometers, ninety-six boreholes and fourteen deposit wells were drilled, and 57 short-term water supoply investigations were conducted (India. Dept. of Agriculture 1978: 48).

In addition to its research efforts, the GGWB provides in-service training for officers of Central and State governments in various aspects of hydrogeology and water-well drilling techniques.

4.1.2.1.2 Department of Irrigation

4.1.2.1.2.1 Central Board of Irrigation and Power

4.1.2.1.2.2 Central Water Commission

The Commission has conducted detailed studies on appraisal and promotion of irrigation facilities in drought-prone areas and has also worked with the Technical Advisory Committee on Agroclimatic study in the Meteorological Department.

Water Wing

The Ganga-Brahmaputra Water Study

4.1.2.1.2.4 Indus Waters Commission

4.1.2.1.2.5 Indo-Bangladesh Joint Rivers Commissions

4.1.2.1.2.6 Ganga Basin Organization

4.1.2.1.2.7 National Flood Commission
Established: July 1976

The Commission is to study, in depth, the flood problem and protection measures as undertaken since 1954 with a view to recommending a scientific comprehensive approach and high priority measures for both flood control and protection. The Commission was expected to submit its report within two years (Soil Conservation Digest, vol. 5, no. 1, 1977).

4.1.2.2 MINISTRY OF CHEMICALS AND FERTILIZERS

4.1.2.3 MINISTRY OF EDUCATION, SOCIAL WELFARE AND CULTURE

4.1.2.4 MINISTRY OF ENERGY

Central Electricity Authority

4.1.2.5 MINISTRY OF HEALTH AND FAMILY WELFARE

Department of Health

Department of Family Planning

Directorate-General of Health Services

All-India Institute of Hygiene and Public Health

Committee on Urban Wastes (see Varma 1978:26)
Has made recommendations for studies relating to the use of sewage for irrigation.

Central Public Health Engineering Organization

Set up to help state government in the preparation and execution of their water supply and sanitation schemes and for giving technical advice and guidance (Dal 1976:106).

4.1.2.6 MINISTRY OF INDUSTRIES

Department of Industrial Development

Department of Heavy Industry

Khadi and Village Industries Commission

Indian Institute of Handloom Technology

4.1.2.7 MINISTRY OF PETROLEUM

Oil and Natural Gas Commission (ONGC)

Among other things, the ONGC conducts geophysical exploration and bottom topographic surveys and surveys sea bottom sediment.

4.1.2.8 MINISTRY OF PLANNING

Department of Statistics

National Sample Survey Organisation

4.1.2.9 MINISTRY OF SCIENCE AND TECHNOLOGY

Established: 1971

The Department coordinates Science and Technology activity in the country, including planning and provision of grants to research institutions; holds ministerial responsibilities of such autonomous bodies as the Council of Scientific and Industrial Research (CSIR) and the National Research Developme Corporation (NRDC); and concerns itself with bilateral agreements on science and technology with other countries.

The DST has taken the lead in promoting indigenous technology and the adaptio of modern technologies through in-house research and development efforts in industry. As of the end of 1977 some 440 research and development establishments covering both the public and private sectors were registered with the DST.

Focused on the problems of small industries are seventeen state research development and design committees set up jointly by the DST and the Department of Industrial Development. These started functioning in 1973.

4.1.2.9.1 National Remote Sensing Agency (NRSA)

An autonomous body under DST the NRSA was set up for conducting surveys of various natural resources using satellite imagery, scanner data from aircraft, and serial photography. The laboratory is located at Hyderabad, and the Research Flight Facility with three aircraft and equipment is at Bangalore. The Indian Photo Interpretation Institute at Dehra Dun, formely part of the Survey of Indian, has come under the NRSA since July 1976.
The Fifth Plan allots Rs. 6.39 crores to the NRSA.

4.1.2.9.2 National Information System for Science and Technology (NISSAT)

NISSAT was set up by the DST with the broad objectives of interlinking and coordinating a large number of informatiopn sources, systems and services into an effective decentralized information network involving standardized and mutually compatible systems for collection, storage, processing, and dissemination of information. The Fifth Plan calls for the establishment of four sectoral information centers and six regional information centers.

The outlay for NISSAT under the fifth plan is Rs 1.60 crores.

4.1.2.9.3 National Committee on Science and Technology (NCST)

The NCST is the top body for advising the government on all matters relating to planning and promotion of science and technology.

The NCST prepared in 1973 the first Science and Technology Plan, which places emphasis on areas such as natural resources, fuel and power, oil and natural gas, petro-chemicals, fertilizers, groundwater, minerals, heavy engineering, and machine tools, mining, steel and metallurgy industry and utilization and recycling of wastes. (India, Min. of Information 1978: 76). The NCST was reponsible for a major survey of India marire resources, completed in 1975 (NCST 1975).

4.1.2.9.4 Council for Scientific and Industrial Research (CSIR)
(see 4.3.1.5 below)

4.1.2.9.5 National Research Development Corporation of India (NRDC)
New Delhi

Set up in 1953 to serve as a link between research and industry (India, Min. of Information 1978:78).

4.1.2.9.6 National Committee on Environmental Planning and Coordination (NCEPC)
See 4.1.11.

4.1.2.10 MINISTRY OF STEEL AND MINES

Indian Bureau of Mines

4.1.2.11 MINISTRY OF TOURISM AND CIVIL AVIATION

Indian Meteorological Department

Organized on an all-India basis in 1875, the Department now collects and process a variety of meteorological data from 1,163 observatories. In conjunction with the Indian Institute of Tropical Meteorology (IITM) at Pune, the Department conducts fundamental and applied research relating to weather forecasting, aviation climatology, agricultural meteorology, hydrology, space research, air pollution, seismology, radio meteorology, and instrumentation. IITM also conducts experiments in weather modification.

With regard to arid and desert area, the Meteorological Department is carrying out research on various aspects of desert meteorology with special reference to the Thar Desert. The Drought Research Unit of the Department conducts systematic studies on all climatic aspects of chronically drought prone areas of the country; these cover agro-climatology of drought, drought predictions, fluctuations in the aerial extent of drought, and snyoptic features associated with drought, dust storms, and rainfall trends (India. NCEPC 1977:51).

Marine meteorological activities include monitoring of temperature and salinity, compilation of wave and swell data, and air-sea interaction studies (NCST 1975).

4.1.2.12 MINISTRY OF WORKS AND HOUSING

National Water Supply and Sanitation Programme

Central Seismological Laboratory

4.1.2.13 MINISTRY OF ATOMIC ENERGY

Department of Atomic Energy

Atomic Minerals Division

The Division performs tracer studies for siltation in harbors, sea pollution, and offshore exploration of atomic minerals.

4.1.3 CENTRAL GOVERNMENT ORGANIZATIONS NOT AFFILIATED WITH MINISTRIES

4.1.3.1 CENTRAL BOARD FOR THE PREVENTION AND CONTROL OF WATER POLLUTION *

Established under the Water (Prevention and Control of Pollution) Act 1974 in September 1974, the Board functions as the Central Board at the National Level and as a State Board for the Union Territories. The Board works in cooperation with State Water Pollution Control Boards, 15 of which had been established as of early 1979.

The Board is essentially a policy-making body whose functional planning decisions are assisted by a Water Resources and Quality Control Committee, which is in turn assisted by two subcommittees: the Quality Advisory Committee and the Technical Services Advisory Committee.

The Board consists of a full time Chairman, five officials nominated by the Central Government as its representatives, five persons from the members of the State Water Pollution Control Boards as nominated by the Central Government, three non-official persons nominated by the Central Government to represent the interests of agriculture, fisheries, industry, trade or other interests, two persons representing government-owned, managed, or operated companies or coporations, and a full time member Secretary.

The stated objectives of the Board include: advising the central government on matters concerning the prevention and control of water pollution; providing technical assistance and guidance to State Boards; coordinating the activites of the State Boards and resolving disputes among them, training personnel in the water pollution control field, collecting and compiling data on water pollution and water pollution control measures, laying down standards for water quality of streams or wells; and planning a nation-wide

*The information presented here is taken from the the 1977-78 Annual Report of the Board (CBPCWP 1978).

program for the prevention, control and abatement or water pollution.

The Board's personnel as of March 31, 1978 totalled 55 persons, up 30 persons from the previous year. The Board's expenditures for 1977-78 came to Rs. 21,260,000, of which Rs. 5,980,000 was for administration. Funds acquired under the Water (Prevention and Control of Pollution) Cess Act, which became effective April 1, 1978, are expected to improved the Board's financial position. This Act provides for the levy and collection of a cess on water consumed by persons carrying on certain industries and by certain authorities, with the end of augmenting the resources both of the Central Board and of the State Boards for the Prevention and Control of Water Pollution.

In 1977-78 the Board was in the course of establishing a mobile laboratory and procuring the equipment necessary for its operation.

As reviewed in its 1977-78 Annual Report, the Board has experienced difficulties in carrying out its functions because of inadequate accomodations, which prohibit it from establishing a laboratory and setting up demonstrations plants (CBPCWP 1978:26).

Activites of the Board, as reported in its 1977-78 annual report (India CBPCWP 1978:8-14), include:

preparation of comprehensive industrial surveys

Four types of industries (ferilizers, man-made fibers, fermentation, and textiles) were initiated in 1977 with the object of compiling data on location, production, capacities, processes used, present status of pollution control measures, the manner of disposing of wastes, etc. Specialized committees were appointed for covering each of the four classes of industrial activity. The completed documents, scheduled for publication during 1978-79, would provide a basis for the development of realistic effluent standards.

Inter-state Yamuna River Project

The project, being carried out by the Central Board in collaboration with the State Boards of Haryana, Madhya Pradesh, and Uttar Pradesh, is designed to assess: the pollution potential in the Yamuna River basin arising from all types of human activities; its impact on the river water quality at various points; and the present status of water quality along the river. Sixteen monitoring points along the river from its origin to its confluence with the Ganges at Allahabad were monitored for characteristics such as BOD and ammonia content. The project report was scheduled for publication by September 1978.

classification and zoning of fresh and sea waters

This effort, scheduled for completed during 1978-79, involves the classification of waters by designated uses (from drinking water to irrigation and industrial water for fresh waters and from salts pans and water sport to navigation and controlled waste disposal for

sea water).

establishment of a grid for water quality monitoring

The three-level monitoring program, being developed in cooperation with State Boards, forsees the establishment of a total of 200 stations for monitoring at the global, national, and state levels.

preparation of a coastal pollution map of the country

Initiated in April 1977, this project has as its objectives the preparation of coastal pollution maps showing: significant pollution in both existing and potential fishing grounds; and existing waste discharges into coastal waters and the quantities of pollutants. These maps would then form the basis for recommendations for future siting of industries in coastal areas. The final report of this project was schedued for December 1978.

training programs, conferences, education

Four training programs sponsored by the Central Board and conducted in collaboration with various institutions involved 94 participants between December 1977 and April 1978. Areas covered were: water quality management; legal and economic aspects of water pollution; training in environmental pollution control; and aquatic ecology.

The Board also held various conferences and seminars, including a meeting in September 1977 of the Charmen and Member-Secretaries of the State Boards to review progress in the implementation of the Water Pollution Control Act of 1974.

Mass education efforts included participation in the Agri-Expo 1977 in New Delhi in November and December 1977, at which the Board exhibited a working model illustrating water pollution control and distributed a pamphlet describing the activities of the Central Board.

planning guides for industrial establishments

Initiated in September 1977, the object of this project is the development of guidelines for industrial locations so that compatible industries from the waste treatment point of view can be sited together and the development of procedures for sharing of waste treatment costs, etc. among such industries. The project is scheduled for completion in March 1979.

water quality criteria

This project is collecting information on water quality criteria around the world with the object of preparing Indian standards for receiving-water quality.

The Central and State Boards have evolved a permit system for various effluent sources such as industries.

4.1.3.2 Geological Survey of India
Calcutta

The geological survey is responsible for all investigations pertaining to geological sciences except for exploration and exploitation of oil and natural gas. The survey collects bottom sediment samples and investigates bottom topography for the exploration of mineral deposits (NCST 1975).

Arid land research is carried out by the Survey through its Quaternary Geology, Geomorphology, and Environmental Geology Division. Six specific arid zone projects cover: Sand Advance, Desert Evaluation, Lake Salinity, the Luni Basin, the Ghaggar Basin, and the Rann of Kutch (India. NCECP 1977:49). On the basis of extensive field studies, the Division produced the first Geohydrological Map of India in 1969.

4.1.3.3 Indian Standards Institute (ISI)

Through its appropriate committees, the ISI lays down quantified water pollution standards, some of which have already been adopted, others of which are being devloped.

4.2 STATE AND LOCAL GOVERNMENT FUNCTIONS

India is civided into 22 state and 9 Union territories, the latter of which are administered by the president through administrators.

The states and Unions territories are grouped into four zones, each with a zonal council: Northern, Western, Central, and Southern. For the Northeastern states there is a Council similar to a zonal council.

Within states the principal subdivision is, for most states, the district, headed by a district collector. In large urban centers, there are local self-governing bodies known as corporations; smaller cities and towns are headed by municipal committees or boards. Corporations have relatively more autonomy than municipal bodies, which are closely controlled by appointed executive officers. Municipal functions include roads, water supply, drainage, public health, education, and parks (Turian 1978:638).

Rural areas have a three tier system of panchayati raj at the village, block, and district level. The village panchayats, elected directly by the villagers, are responsible for agricultural production, rural production, rural industries, medical relief, grazing grounds, village roads, irrigation tanks, wells, and sanitation. These panchayats have their own powers of taxation. As of 1974, there were 219,896 panchayats covering 412.8 million people. The block panchayats or panchayat samiti, chosen from among the members of panchayats in 100-village development blocks, coordinate the work of panchayats and are responsible for local projects. There were 2,863 of these panchayat samiti in 1974. At the top of the rural local government organization is the zilla parishad, consisting of the presidents of the panchayat samitis, the the members of the state legislature and Union parliament respresenting the area, and district officers (Turian 1978:638).

Under the Indian constitution, the following matters are delegated exclusively to the State Governments:

--forests
--preservation of water quality
--solid waste disposal
--land use
--industries, in general
--public health and sanitation
--agriculture, including protection against pests, plant diseases.

water

In the states, the Irrigation Department and the State Ground Water Board are the organizations that deal with water for irrigation purposes. Water supply is basically the concern of municipal officials. As of late 1978 there were 15 state Boards for the Prevention and Control of Water Pollution (see 4.1.3.1).

forests

State Forest Departments through their Chief Conservator of Forests are responsible for regulating the exploitation of forest resources. In some areas, Forest Corporations bear this responsibility.

The Forest Department in each State is headed by a Chief Conservator of Forests assisted by various levels of Conservators of Forests, usually charged with forest management within specific areas or circles. Divisional Forest Areas are in charge of forest divisions and Range Officers, assisted by deputies and Forest Guards are assigned specific beats (Sharma 1978: 220).

wildlife

Wildlife in most states is the responsibility of the Forest Department. A few states such as Uttar Pradesh, West Bengal, Karnataka, Rajasthan, Madhya Pradesh, Orissa, Jammu and Kashmir, and Gujarat have State level officers to head the wildlife organization. These states also have a few Deputy and Assistant Conservators of Forests and protective staff to deal with wildlife sanctuaries. Most state have no administrative organization to implement the provisions of the wild birds and animals protection Acts in non-forest areas (NCA 1976:vol.9:319-320).

soil

Soil conservation activities in the states are carried out as one of the activities either of the Agriculture Department or the Forest Department. According to the report of the National Commission on Agriculture, however, the capabilities of soil conservation officials within these departments are limited. The Commission reported, for example, that with the exception of the the state of Uttar Pradesh, there was no specialist staff either at the State or divisional level able to make proper assessments of soil and moisture conservation measures or help farmers solve problems of soil deterioration and water waste. Furthermore, most states were found

to lack the planning body to collect and compile data on the problems, achievements and benefits of soils conservation (India. NCA 1976: vol. 5:266-67.

In most states there are Soil Conservation Boards, modelled after the now defunct Central Soils Conservation Board. These boards attempt to avert soils problems by coordinating the activities of all departments directly or indirectly involved in the conservation and management of soils and water resources within the States; representatives from these departments constitute the boards' membership (India. NCA 1976: vol. 5:267).

air quality

The Motor Vehicle Departments of state governments are responsible for the control of air pollution from vehicle exhaust emissions.

solid waste disposal

Solid waste disposal is the responsibility of municipal authorities, corporations, and other local bodies. Their functions are governed by appropriate municipal legislation, usually under the State Municipal acts.

fisheries

Each of the State governments has a directorate of fisheries responsible for the development of marine as well as of inland fisheries and the promotion of the fishing industry. The directorates are headed by Directors of Fisheries assisted by specialists at the headquarters and by field staffs in the districts. Fishermen training centers and staff training centers are also run by State Fisheries directorates for the purpose of providing training to personnel up to a certain level (NCSt 1975: 234).

4.3 MAJOR RESEARCH INSTITUTES

By a recent count there are more than 129 national laboratories for scientific research as well as a network of more than 200 other laboratories and research institutions. Under the University Grants Commission, a Scientific Research Council has been established to promote research in the Universities. Government allocations for scientific research increased about a hundred fold between 1950-51 and 1976-77. Under the Fifth Plan (ended in 1978), about RS. 1,570 crores were projected for scientific research.

Indian science policy, as adopted by a parliamentary resolution as early as March 1958, is guided by objectives which include, among others, securing for the people of the country the benefits from the acquisition of scientific knowledge and its application. Among the aims set forth in the resolution are the encouragement of individual initiative for the acquisition of scientific knowledge and the fostering of programs to train scientific and technical personnel to meet the needs of fields such as science and education, agriculture, industry and defense. (Indin, Min. of

Information 1978: 75).

4.3.1 Research organizations under the Ministry of Science and Technology

The Department of Science and Technology under the Ministry has administratalve responsibility for:

4.3.1.1 Survey of India
Dehra Dun

Geodetic and Geophysical Surveys
Include tidal observations and geomagnetic measurements.

4.3.1.2 National Atlas Organization
Calcutta

The Organization has published a detailed forest atlas of India with the technical support of the Forest Research Institute at Dehra Dun and with assistances from the Ministry of Agriculture and Irrigation, the Central Forestry Commission, the State Forest Departments, the Indian Board of Wildlife, and wildlife wardens throughout the country. The atlas indicates forest distribution, forest types, locations of wildlife and wetlands, and locations of economic activities. Maps covering annual rainfall, annual temperature, soils, and rock types are also included (Das Gupta 1976).

4.3.1.2 Natural History Museum
New Delhi

4.3.1.3 Botanical Survey of India,
Calcutta (with four main centers in Calcutta)
Indian Botanical Garden
Central National Herbarium
Industrial Section of the Indian Museum
Central Botanical Laboratory
There are seven regional centers: Allahabad, Coimbatore, Dehra Dun, Jodphur, Pune, Port Blair, and Shillong.

Among other things the Botanical Survey is working on a detailed inventory of the flora of the desert regions of India (India. NCEPC 1977:51).

4.3.1.4 Zoological Survey of India
Calcutta

With headquarters in Calcutta, the Zoological Survey, established in 1916, has regional stations at Dehra Dun, Jabalpur, Jodhpur, Madras, Patna, Port Blair, Pune, Shillong, and Solan.

From its base in Jodhpur the Desert Regional Station conducts field studies within both Rajasthan and Gujarat relating, which include an extensive and intensive faunistic survey of the area, with particular reference to desert fauna, wildlife, and fossils of the region. Particular focus is on insects, lizards, snakes, and bats (Paylore 1977:60). The staff of the Jodphur station consists of 4 chief scientists, 3 scientific assistants, 8 technical

personnel, 6 ministerial personnel, and 11 supporting staff (Paylore 1977:61).

The Survey's publications include: Records, Memoirs, Occasional Publications, Fauna of India, and the Bibliography of Indian Zoology.

Independent institutions receiving research assistance from DST:
Indian Association for the Cultivation of Science, Calcutta
Bose Institute, Calcutta
Raman Research Institute, Bangalore
Birbal Sahni Institute for Palaeobotany, Lucknow
Wadia Institute of Himalayan Geology, Dehra Dun
Maharashtra Association for the Cultivation of Science, Bombay
Padmaja Naidu Himalayan National Zoological Park, Darjeeling

Grants to: Indian National Science Academy, New Delhi
Indian National Science Congress Association, Calcutta

4.3.1.5 Council of Scientific and Industrial Research (CSIR)

With a network of laboratories and research institutions the CSIR is a major instrument of scientific and industrial research under State sponsorship. It supports research in universities and other centers of learning.

National laboratories functioning under CSIR fall into six discipline groups:

Physical and Earth Sciences
Chemical Sciences
Biological Sciences
Engineering Sciences
Information Sciences
Fiber Technology

4.3.1.5.1 National Environmental Engineering Research Institute (NEERI) Nagpur

Formerly the Central Public Health Engineering Research Institute, NEERI maintains fields centers are at Ahmedabad, Calcutta, Delhi, Hyderabad, Jaipur, Kanpur, and Madras.

The Institute carries out research in sanitation, disposal of sewage and industrial wastes, industrial hygiene, and pollution. Furthermore, under World Health Organization (WHO) sponsorship, NEERI has carried out pilot studies on the need for preventive maintenance of water distribution systems with particular emphasis on the prevention of waste (Varma 1978:25).

The Institute has recommended reuse of water for cotton textile mills and chemical and pharmaceutical industries to conserve regular water supplies (Varma 1978:26).

4.3.1.5.2 National Institute of Oceanography
Dona Paula
Caranzalem PO, PIN 403301
Goa

The Divisions located at the institute's headquarters in Goa cover: physical oceanography (including coastal oceanography and coastal zone management), geological oceanography (including surveys for minerals and oil), chemical oceangraphy (including desalination technology and the chemical aspects of pollution), and biological oceanography (including ecology of estuaries, mangroves, coastal aquaculture, and protection of the environment)

The Regional Centre at Cochin specializes in biogeography, ecology and systematics of zooplankton, and coastal oceanography. The Regional Centr at Bombay studies ecology, coastal aquaculture, and pollution, and conducts hydrographic surveys.

4.3.1.5.3 National Geophysical Research Institute
Hyderabad

4.3.1.5.4 National Chemical Laboratory
Pune

Performs research on desalinization

4.3.1.5.5 Central Salt and Marine Chemicals Research Institute
Bhavnagar, Gujarat

The Institute has developed the necessary technology in desalination of salt water, and several pilot plants/service plants are in fact in operation with capacities varying from 80 to 30,000 liters per day. Technologies employed include: solar distillation, flash distillation, electrodialysis, freezing, processes, and reverse osmosis (Varma 1978: 25). The Institute also works on deriving salt and other chemicals from seawater, the use of seaweed for cattle feed, and the use of seawater in irrigation.

4.3.1.5.6 Central Food Technological Research Institute
Mysore

Includes fisheries research.

4.3.1.5.7 National Botanical Gardens
Lucknow

4.3.1.5.8 Industrial Toxicology Research Centre
P.O. Box 80
Lucknow

The Centre studies the harmful effects of substances encountered in industry, agriculture, and mines. It performs experimental field investigations on environmental problems such as hazards due to industrial

dusts, radioactivity, X-ray radiation, and pollution of water and food resources.

As recently reported, a National Pollution Study Centre near Lucknow is being set up under the direction of the Industrial Toxicology Research Centre at the cost of one million dollars. It is expected that within five years the center will have a range of facilities to test

under natural conditions the effects of toxic and persistent chemicals on animals, insects, plants, aquatic systems, soil, and bacteria. (WER, May 7, 1979:8).

4.3.1.5.9 Indian National Scientific Documentation Centre
New Delhi

4.3.2 Indian Council of Agricultural Research
New Delhi
Established: 1929

The ICAR is the national body for coordinating research, education, and extension education in the fields of agriculture, animal husbandry, and fisheries sciences.

The Department of Agricultural Research and Education in the Union Ministry of Agriculture and Irrigation provides administrative support to ICAR and coordinates the work of central and state agencies.

The ICAR functions through a network of 30 well equipped and well-staffed research institutes, a Directorate of All-India Soil and Land Use Survey, 21 agricultural universities, 51 all-Indian co-ordinated projects and a few other institutions.

The ICAR offers fellowships and scholarships to attract good students into agriculture.

An important project presently in progress under the ICAR is the All-India Co-ordinated Project in Dry Land Agriculture, which involves 23 research centers in an effort to produce new technology to improve agriculture production in rain-fed areas (India. Min. of Information 1978:90).

Its various institutes throughout the country are carry out research related to irrigated agriculture. The ICAR is coordinating research on water management, soil salinity and cropping patterns on an all-India basis. The extensive studies carried out by ICAR as well as by Agricultural Universities and a numerous research stations "have not only revolutionized irrigated agriculture in the country but have also helped considerably in the efficient and economic use of water by evolving sound soil and water management practices" (Varma 1978: 34). This research, as described by Varma 1978 includes water use efficiency studies relating to water application methods; irrigation scheduling; reducing percolation losses in rice; selection of suitable crops; drainage studies; and increased efficiency in water conveyance and and distribution.

4.3.2.1 Central Arid Zone Research Institute (CAZRI)
Jodhpur

Established: 1959

Functioning as one of the institutes under the ICAR, CAZRI is engaged in investigations and pilot experiments on various aspects of arid zone problems.

Functioning units of CAZRI are the Basic Resources Survey Division; the Plant Studies Division, which concentrates on the improvement of plant resources of arid and semi-arid areas; the Division of Animal Studies, with specialization in the improvement of animal products and the control of desert rodents; the Division of Soil-Water-Plant Relationships, which studies the principles of soil-water-plant relationships as a basis for improving production under desert conditions; the Division of Economics and Extension, which conducts socio-economic surveys and assesses factors such as nomadic human resources; the Division of Extension and Training; and the Division of Wind Power and Solar Energy Utilization (India. NCEPC 1977:47-48).

CAZRI has Central Research Farms at Jodhpur and Pali, and afforestation and experimental units at Kailana, Bikaner, and Jaisalmer, and twelve range management sub-stations totalling 1030 hectares located in seven districts (under different agroclimatic conditions) of Western Rajasthan.

The Institute has extensive laboratory space, including separate laboratories and equipment for each of the chief scientists in the fields of soil science, plant physiology, geomorphology, hydrology, geology, cartography, analytical and organic chemistry, silviculture, agronomy, agrostology, horticulture, animal ecology, and animal nutrition and physiology. Equipment includes a spectrophotometer, a nitrogen analyzer, a refrigerating centrifuge, cold and warm temperature-controlled germination chambers, and geophysical instruments for seismic surveys of groundwater (Paylore 1977:49).

CAZRI has a library of 10,000 volumes, receives 330 periodical publications, and has a herbarium of desert flora.

As of 1976 CAZRI staff consisted of 94 scientists, 24 research fellows, 132 field and technical personnel, and 72 administrative personnel. (Paylore 1977:48).

CAZRI's budget for 1976-77 was Rs. 8,431,000. The Institute has received fellowship grants under the UNESCO Major project for Arid Lands Research and also receives Colombo Plan aid from Australia (Paylore 1977:48).

4.3.2.2 Central Soil Salinity Research Institute

The Institute conducts research on various problems associated with the incidence and control of salinity under various land use conditions in the arid and semi-arid zones (India. NCEPC 1977:49)

4.3.2.3 Central Sheep and Wool Research Institute and similar Institutes

The Institute carries out pilot studies with demonstration units for

extension work on various aspects of improvement and promotion of livestock breeding, production of wool, and management of grasslands. Also under the ICAR are the Indian Grassland and Fodder Research Institute, the India Veterinary Research Institute, and the National Dairy Research Institute, all of which conduct research relating to grassland, fodder, and dairy development (India. NCEPC 1977:49).

4.3.3 Other government-affiliated research centers

See the following sections above:

4.1.2.1.1.1.4:	Forest Research Institute and Colleges
4.1.2.1.1.2.2:	Soil Conservation Research, Demonstration, and Training Centre
4.1.2.1.1.3	Central Inland Fisheries Research Institute
4.1.2.1.1.8	Central Ground Water Board
4.1.2.9.1	National Remote Sensing Agency
4.1.2.11	Indian Meteorological Department
4.1.3.1	Central Board for the Prevention and Control of Water Pollution
4.1.3.2	Geological Survey of India

4.4 Higher Education

According to the 1977-78 edition of the Indian reference manual, India had 105 universities, 9 institutes of National importance, and 10 institutions deemed to be Universities. These Universities, most of which have been established since Indian independence in 1947, were set up under laws passed either by the central parliament or by state legislatures. Most of the universities have large numbers of affiliated undergraduate colleges: Calcutta University has 218, Madras University 157, and Gujarat Unviversity for 136. The most prestigious universities are reported to be Calcutta, Bombay, Madras, and Delhi.

The University Grants Commission, established in 1953, promotes and coordinates university education and also determined and maintains standards of teaching, examination and reserach in the universities. It is authorized to enquire into the financial needs of the universities and to make grants to them (India. Ministry of Information 1978:53).

4.4.1 Scientific and technical education

Technical education is provided by state vocational and technical schools at the secondary and higher secondary levels. Such training includes: agriculture, engineering, forestry, medicine, animal husbandry, and primary school teacher training (Indian. Ministry of Information 1978:53).

Five university level national institutes provide facilities for high levels of education and research in engineering and technology. These institutes, all of which are called Indian Institute of Technology and which are located at Kanpur, Bombay, Bharagpur, Madras, and New Delhi, admit some 7,200 students annually to undergraduate courses. In addition, the Indian Institute of Science at Bangalore admits some 2,00 students each year to post-graduate studies and some 1,500 research scholars, and some 60 other engineering colleges and university departments offer facilities for post-graduate courses and research, admitting about 2,500 students annually (India. Ministry of Information 1978: 53).

A scheme for rural education was initiated in 1956 with the aim of providing post-secondary education to rural youth and inspiring them with a spirit of service to the community and sympathy for the rural way of life. It was also intended to prepared them for careers in the rural development programs of both state and central governments. To advise the central government on the development of rural higher education, the National Council for Rural Higher Education was set up. As of 1977-78 10 rural institutes were functioning: Coimbatore and Gandhigram in Tamil Nadu; Udaipur in Rajasthan; Birouli in Bihar; Bichpuri in Uttar Pradesh; Amravati, Gargoti and Wardha in Maharashtra, Taranur in Kerala, and Indore in Madhya Pradesh. Most are affiliated to state universities (India. Ministry of Information 1978:56).

4.4.1 Selected educational institutions with programs in or interests relating to natural resources and environment

Most Indian Universities have programs in sciences, including zoology and botany, as well as in other fields of interest for environmental and natural resources development. The scope of this report does not permit

of a detailed account of these activities. The following list mentions educational and quasi-education institutions whose activities or curricula are directed toward education or training in environmental matters. These names have been derived from Quigg 1973, USAID/New Delhi 1979, Tryzna and Coan 1976, and other sources. This list is in no way to be considered exhaustive.

All-India Institute of Hygiene and Public Health (Tryzna and Coan 1976)
110 Chittaranjan Avenue
Calcutta

Established: 1932

Trains public health doctors, engineers, nurses, etc. Major areas of course work include environmental health (medical and engineering), water treatment and supply, and waste treatment and disposal. Students are given the opportunity to survey urban and rural problems in field centers covering large populations (Quigg 1973:49).

Centre for Environmental Planning and Technology (CEPT) (USAID/New Delhi 1979:16)
University Road
Navrangpura, Ahmedabad

The Centre was established to provide an integrated approach to training, education, and research in architecture, environmental planning, and technology. The Centre has two schools, the School of Planning and the School of Architecture, whose faculties work together to develop an interactive and comprehensive education and research program. CEPT has provided consultancy service for, among other, the Hyderabad Urban Development Authority and the government of Gujarat to prepare and integrated environmental improvement plan for the tribal areas in the Panchmahalas district.

Indian Institute of Tropical Meteorology (ELC 1978)
Hamburg House
Ganeshkind Road
Poona 5

The Institute offers research work for doctoral candidates. This involves areas such as short-range and medium-range prediction, general circulation of the atmosphere, climatology, cloud seeding, and air pollution (Quigg 1973:50).

Indian Institute of Management (IIMA)
Vastrapur
Ahemedabad

The Institute specialized in applied education with the primary objective of improving management practices. It engages in research and education on the management of agriculture and conducts programs in rural development, training for rural and agricultural development, and agriculture and forestry management (USAID/New Delhi 1979:21).

Indian Institute of Technology (Tryzna and Coan 1976)
Kanpur
Uttar Pradesh

Sanitary and environmental engineering research. The civil engineering department offers a program focusing on water and wastewater treatment, design and operation, industrial water and waste treatment, environmental sanitation, air pollution, biochemistry, and microbiology. Research is also conducted in most of these fields. This program was established in 1966 (Quigg 1973:50).

Jadavapur University
Department of Environmental Research
Calcutta 700 032

University of Jodhpur
Centre of Desert Studies
Jodhpur, Rajasthan

Kerala, University
Ecology Inland Water Course
Beach Road
Trivandrum 7, Kerala

National Council of Educational Research and Training
N.I.E. Buildings, Mehrauli Rd.
New Delhi

As reported in 1973, curriculum was being developed with the aim of including the concepts of environmental conservation in biology, social sciences, physics, chemistry and geography courses. Students are to be teachers already in training (Quigg 1973: 51).

School of Environmental Sciences
Jawaharlal Nehru University
New Delhi

The school engages in education and research to: train skilled manpower for state and central government; provide environmental education for teachers in state schools and training for technical staff of industries; and to offer consultation in the design of development projects (USAID/New Delhi 1979:38).

School of Planning and Architecture
Indraprastha Estate
New Delhi 110 002

Areas of interest are: urban parks and gardens, landscape design, and environmental assessment.

4.5 NON-GOVERNMENTAL ORGANIZATIONS

There are a large number of non-government organizations in India which take an interest in environmental matters. The list below is derived mainly from a list of organizations participating in in World Environment Day Ceremonies in 1978 (ELC 1978). Further information on these organizations and their activities was available for only a few groups. Groups are listed in alphabetical order. Some of these organizations might appropriately appear under research institutes as well.

Action for Food Production (AFPRO) (USAID/New Delhi 1979:10)
Community Centre
Safdarjung Development Area
New Delhi-110016

AFPRO is a non-profit, joint-service agency established to coordinate, support, evaluate and give technical advice to food production projects of church-related and secular voluntary agencies working in India. The organization has five departments: water resources development, agriculture, livestock, finance, and technical information service.

All-India Animal Welfare Association (ELC 1978)
16 Dadsbhoy Manzil
Congress House
Bombay 400 004

All-India Institute of Medical Sciences
Ansari Rd.
New Delhi 110 016

Among pertinent areas covered by the instiute are environmental health and noise monitoring.

Andrha Pradesh Natural History Society (ELC 1978)
Dept. of Zoology
Andrha University
Visakhapatnam (A.P.)

Appropriate Technology Development Association
P.O. Box 311
Ghandi Bhawan
Lucknow 22 6001

Aravaly Geographers (ELC 1978)
Dept. of Geography
SBSH New Campus
University of Udaipur
Udaipur 313 001

Assam Valley Wildlife Society (ELC 1978)
c/o Pertabghur Tea Estate
Darrang 784 175

Association of Soil and Water Conservationists and Trainees
Dehra Dun

Publishes the Soil Conservation Digest.

Auroville Centre for Environmental Studies (ELC 1978)
Pondicherry 2

Beauty Without Cruelty (ELC 1978)
4 Prince of Wales Drive
Wanowrie
Poona 411 001

Bihar Natural History Society (ELC 1978)
Biological Park
Near Raj Bhavan Patna 1

Birdwatchers Society (ELC 1978)
Ismail Yusuf College
Jogeshwari
Bombay 400 060

Bombay Civic Trust
Jehangir Art Gallery, 1st Floor
Mahatma Ghandi Road
Bombay 23

A member of the Trust is on the Board of Directors of the Environmental Liaison Centre in Nairobi.

Bombay Environmental Action Group (ELC 1978)
c/o Department of Botany
Institute of Science
Bombay 400 032

Bombay Natural History Society (ELC 1978)
Hornbill House
Shahid Bhagat Singh Road
Bombay 400 023

The Society is a member of the IUCN.
Founded in 1883, the Bombay Natural History Society has been an active force in the field of wildlife conservation in India. In recent years its activities have included conferences with state legislators to discuss important issues involving wildlife and the environment. It has also published significant books pertaining to wildlife; these include the numerous editions of The Book of Indian Birds and M. Krishnan's survey of India's wildlife between 1959 and 1970 (Krishnan 1975).

Bose Institute (ELC 1978)
93/1 Acharya Prafulla
Chandra Road
Calcutta 700009

Founded in 1917, the Institute performs research in biology, cytogenetics,

mutation, physiological genetics, biochemistry, chemistry of plant products, radiation, and nuclear physics.

Calcutta Metropolitan Planning Organization (ELC 1978)
18 Rabindra Street
Calcutta 700 001

The Organization is engaged in regional and city planning.

Community Science Center (ELC 1978)
Gujarat University Campus
Navrangpura, Ahmedabad 9

Darjeeling Natural History Society (ELC 1978)
Darjeeling
West Bengal

Delhi Birdwatchers Society (ELC 1978)
3-A Tis January Marg
New Delhi 110 011

Environmental Awareness Association (ELC 1978)
Dept. of Botany, SBSH
Udaipur 313 001

Ethology Society (ELC 1978)
c/o Zoology Department
Madras, Christian College
Tambaram
Tamil Nadu

Family Planning Association of India
1 Jeevan Udyog, Dadabhai Naoroji Road
Bombay 400 001

The Association published Planned Parenthood Monthly.

Family Planning Research Academy (ELC 1978)
A-19 Empire Mahal
Dadar T.T.
Bombay 14

Friends of Indian Wildlife (ELC 1978)
1906 Dr. H.C. Sen Road
Fountain
New Delhi 110 006

Friends of the Trees (ELC 1978)

Organizations with this name are found in New Delhi, Cutrorim Gon, Cochin, Bangalore, Punalur, Rajkiot, Secunderabad, Bombay, Delhi, Amravati, and Ahmedabad.

Friends of Wild Animals and Birds (ELC 1978)
c/o Mr. P.V. Panat
Janki Nivas 35 Gokhale Road North
Dadar
Bombay 400 028

Gandhi Peace Foundation (ELC 1978)
221/3 Deendayal Upadhiaya Marg
New Delhi 110002

Gorakhpur Environmental Action Group (ELC 1978)
Dep. of Botany
University of Gorakhpur
Gorakhpur 273 001 (U.P.)

Green Canopy (ELC 1978)
Malakpet
Hyderabad (A.P.)

High Range Game Preservation Association (ELC 1978)
Nettigudi Estate
Munnar P.O. 685612

Horticultural Society of Saurashtra (ELC 1978)
5 College Wadi
Rajkot 360 001

Indian Association for the Cultivation of Science (ELC 1978)
Jadavpur
Calcutta 700 032

Indian Association for Water Pollution Control (ELC 1978)
c/o Central Public Health Research Institute (NEERI)
Nehru Marg
Nagpur 3

The objective of the Association is the advancement of fundamental knowledge and practical know-how in water pollution research and control.

Indian Council of Ecological Research (ELC 1978)
c/o Botanical Survey of India
14 Madan Street
Calcutta 700 013

Indian Environment Society (ELC 1978)
c/o Mr. Desh Bandhu
Department of Botany
Swami Shraddhandand College
University of New Delhi
Alipur
Delhi 110 036

The Society appears to be one or the more active non-government en-

vironmental groups in India. Among other things, the Society, in cooperation with the Center for Education in International Management and the United Nations Environment Programme (UNEP) organized a series of seminars on Enviornmental Management Education, held in Darjeeling, Udaipur, and New Delhi during the first half of 1978. Papers presented at these meetings covered topics such as envioronmenta impact assessment, marine pollution, wildlife conservation, nature conservation, and problems in urban air pollution control (Bandhu, Bhardwaj and Bhat 1978).

Since 1978 the Society has been publishing a periodical entitled Huntin In the Sun. Scheduled to appear three time a year, the publication aim to stimulate and excite interest in the environment among the general public. Also designed to promote environmental awareness in India was the establishment of a Youth Division of the Society in 1977.

Indian Human Ecology Council
8 Darya Ganj
New Delhi 1100002

Indian National Science Academy (ELC 1978)
Bahadur Shah Zafar Marg
New Delhi 110 001

Indian Society of Naturalists (INSONA) (ELC 1978)
Oza Building
Salatwada
Baroda 90 001

Indian Society of Naturalists (ELC 1978)
c/o Maharaja Fatesingh Zoo Trust
Indumati Mahal
Jawaharlal Nehru Marg
Baroda 390-001

Indian Youth Organization for Environmental Studies and Conservation (ELC 1978)
Nizamuddin West
New Delhi 110 013

Indian Youth Population Coalition (ELC 1978)
33-B, First Cross Street
Shastri Nagar
Madras 600 020

Indore Eco Society
Botany Department
P.M.B. Gujarati College
Indore, M.P. 452 001

Institute of Development Studies (I.D.S.)
Manasa Gangoiri
Mysore 570 006

Conducts environmental studies.

Institute of Science (ELC 1978)
15 Madame Cama Road
Bombay 400 032

Affiliated with the University of Bombay, the Institute has since 1971 offered a four-month interdisciplinary program, focusing on water pollution control. A Bachelor of Sciences is required for admission (Quigg 1973:50).

Institute of Town Planners India (Tryna and Coan 1976)
4-A Ring Road, Indraprastha Estate
New Delhi 1

City and regional planning.

The Institution of Engineers (ELC 1978)
Environmental Engineering Division
8 Gokhale Road
Calcutta 700 020

Established: 1920 (Institution of Engineers)

The Environmental Engineering Division of the Institution of Engineers publishes the Environmental Engineering Division section of the Journal of the Institution of Engineers, one recent issue of which contained articles dealing better rural sanitation, expansion of urban water supply sytems, and environmental pollution in Kashmir (Journal of the Institution of Engineers, vol. 59, pt. EN 1, October 1978).

The Institution of Public Health Engineers (ELC 1978)
24, Netaji Subhas Road
Calcutta 700 001

International Commission on Irrigation and Drainage (ELC 1978)
48 Nayaya Marg
Chanakyapuri
New Delhi 110 021

International Society for Tropical Ecology
Department of Botany
Banaras Hindu University
Varanasi 221005

Khadi and Village Industries Commission (ELC 1978)
Gramodaya 3, Irla Road
Vila Parle (West)
Bombay 400 056

Local Action Group for Environmental Education (ELC 1978)
c/o Vikram A. Sarabhai
Community Science Center
Navrangpura, Ahmedabad 380009

Mahashastra Association for the Cultivation of Science (ELC)
Servants of India Society Bldg.
Agarkar Road
Poona 411 004

Mining, Geological, and Metallurgical Institute (Tryzna and Coan 1976)
29 Jawaharlal Nehru Road
Calcutta 16

Moradabad Environmental Action Group (ELC 1978)
c/o Department of Botany
Hindu College
Moradabad 244 001

National Council of University Students of India (ELC 1978)
F-13 South Extension Part I
New Delhi 110 049

National Environmental Association (ELC 1978)
206 Ashok Nagar
Udaipur 313 001

Nature Conservation Society (ELC 1978)
Daltonganj
Palamau
Bihar

Nilgiri Wildlife Association (ELC 1978)
49 Richmond Road
Bangalore 560 025

Public Service Engineers' Union (ELC 1978)
532/3 Galle Road
Kollupitiya

RUCTA Jt. Secretary (ELC 1978)
(Environmental Studies Campaign)
Derashri Shikshak Sadan
University Campus
Udaipur 302 004

Saharanpur Environmental Group (ELC 1978)
c/o Department of Botany
M.S. College
Saharanpur 247001

Science Club
c/o Mr. Bir Sarkar
10 Wood Street
Calcutta 700 016

Seva Mandir (K. Saint) (ELC 1978)
Fatehpura
Udaipur 313 001

Society for Clean Environment (SOCLEEN)
"Garden Resort"
606, Sion-Trombay Road
Chembur, Bombay 400 071

The Society publishes Scavenger, a journal featuring articles on pollution and resource problems. It also participates in meetings dealing with pollution control and was instrumental in organizing, in conjunction with the Indian Association for Radiation Protection and the Environmental Mutagen Society of India, a one-day topical meeting in Bombay in June 1976 entitled "Protection from Modern Industrial and Environmental Risks: Lessons from Nuclear Industry" (Scavenger, vol. 6, no. 2, April 1976, p. 29).

Society of Clean Cities (Tryzna and Coan 1976)
Raj Bhavan
Bombay 200 035

Society of Indian Foresters (Tryzna and Coan 1976)
P.O. New Forest
Dehra Dun

Professional organization.

Soil Conservation Society of India (Tryzna and Coan 1976)
Hazaribagh

Publishes the Journal of Soil and Water Conservation in India.

Udaipur Environmental Group (ELC 1978)
c/o Dep. of Zoology
University of Udaipur
Udaipur 313 001

UE Group (ELC 1978)
E 15, University Block
Shastri Marg
Ashkor Nagar
Udaipur 313 001

Wild Life Preservation Society of India (Tryzna and Coan 1976)
6 Astley Hall
Dehra Dun
Uttar Pradesh

The Society is a member of the IUCN.

Wildlife Conservation Society (Tryzna and Coan 1976)
Savinaya Society
Behind Patel Park
Bhavnagar 364 001

The Society's goal is "educating the public about the importance of preservation of nature and natural resources, including wildlife."

World Wildlife Fund- India (ELC 1978)
Great Western Building
1st Floor
Opp. Lion Gate Clock Tower
S. Baghat Singh Road
Bombay 400 023

The Fund is affiliated with the World Wildlife Fund and is a member of the I.C

Youth and Biosphere (ELC 1978)
Block C, University Campus
Ujjain 456010

Youth and Family Planning Programme Council (ELC 1978)
P.O. Box 3850
New Delhi 110049

5.0 LEGISLATION PERTAINING TO ENVIRONMENT AND NATURAL RESOURCES

India has a federal system of governmnment in under which legislative powers are divided among the 22 constituent states and the central (union government in New Delhi. Legislative power reserved exclusively for the federal government are those relating to fields such as defense, foreign affairs, and currency. Those shared by the state and federal governments include economic and social planning, and labor and price control; in these areas central government legislation prevails if conflicts should arise. Legislative powers reserved to the states cover many areas relatec to environmental and natural resources: agriculture, irrigation, public health, and local government. The constitution provides, however, that the central parliment may legislate with respect to any subject either during emergencies or when the subject assumes national importance. Furthe if a state law is inconsistent with a federal law, the federal law is to prevail and the state law, at least as regards the point of inconsisten is declared void. The States are: Andhra Pradesh, Assam, Bihar, Gujarat, Jammu and Kashmir, Kerala, Machya Pradesh, Maharashtra, Mysore, Nagaland, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal. There are in addition 9 union territories administered by the central government.

Article 48A, the Directive Principles of Constitution, provides that the "State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country" (Hassan 1978:6).

5.1 General Environmental Legislation

Environmental Impact Analysis

There is no statute prescribing Environmental Impact Analysis; the Indian government has stated, however, that in the absence of such a statute, they carry out such analysis as a "policy" matter, without, however, further elaborating on the specific features of that policy or how intensely it is applied (Hassan 1978: 15).

5.2 Water Legislation

Under the Indian Constitution (1949) the States have the exclusive powers to both make and enforce laws covering surface water and groundwater. With regard to inter-state waters, however, the federal government is empowered to make regulations covering regulation and development of inter-state rivers and river valleys, if such regulation is declared to be in the public interest. Although all major Indian rivers are also interstate rivers and thus subject to central government control, the River Boards Act 1956 (see below) is the only piece of legislation in which the federal government has exercised this power (Varma 1978:28).

There is presently no Indian legislation dealing with water resources in a comprehensive fashion, but a Water Resources Act, modelled after the U.S. Water Resources Planning Act of 1965 is reported to be under consideration. Under this Act, water would be declared as a national asset and a organization to deal with its development in an integrated and comprehensive manner would be established. Organizations set up under the law would include a policy-making National Water Resources

Council and River Basin Commissions with responsibility for integrated river basin developments (Chaturvedi 1976:70).

5.2.1 Central Government legislation

5.2.1.1 March 23, 1974 Water (Prevention and Control of Pollution) Act, no. 6. (Lucknow Law Times, vol. 15, 1974)

The act sets up the comprehensive administrataive and legal framework for the control of water pollution in certain specified Indian states and territories which adopt this act by resolution. Chapter I sets commencement dates and defines relevant terms. Chapters II and III provide for the establishment of a Central Board as well as of state and joint water pollution prevention and control boards and set forth membership requirements, internal proceedings, and rules of order for these boards. Chapter IV delineates the powers and functions of boards in relation to each other and central and state governments. Enforcement and legal mechanisms for pollution control described in Chapter V include powers to obetain information, insepction and monitoring, prohibition of discharges, court actions, and appeals. Chapter VI provides for board financing and for reprots applicable to administering the Act. Chapter VII lists penalties, and Chapter VIII contains miscellaneous provisions.

State board functions include the establishment of water quality standards, the development of state wide comprehensive programs for the prevention of water pollution and the adoption of such remedial measures as are necessary to prevent, control or abate water pollution. Central Board functions include the coordination of state board activities, the compilation of technical and statistical material on water pollution, the establishment of pollution abatement standards in cooperation with the states, and the technical assistance to the state boards. Pollution control measures include the establishment of control areas and the regulation of discharges. Final considerations deal with penal sanctions and the powers of the local and central authorities. (See IDHL, vol. 26,no. 1 (1975)).

As of 1978 the Act had been adopted by thirteen of the 22 Indian states, which had accordingly set up State Boards. The Central Board had also been established (Varma 1978:28).

Implementation of the law is the responsibility of the Central Water Pollution Control Board and Boards established by the individual states.

Assistance in evolving quality standards under the act has come from the Indian Standards Institution (Hassan 1978:21).

According to a 1978 review of the enforcement situation, implementation of the act has been impeded by insufficient resources, including lack of laboratories, manpower, and funds (Hassan 1978:21).

5.2.1.2 Water (Prevention and Control of Pollution) Rules 1975

5.2.1.3 Water (Prevention and Control of Pollution) Amendment Act, 1978

5.2.1.4 Water (Prevention and Control of Pollution) Cess Act, 1977 no. 36

This law provides for the levying and collection of a cess on water consumed by certain industrial enterprises and by local authorities. The tax is designed to increase the revenues and resources of the Central Board and the State Boards for the Prevention and Control of Water Pollution set up under the 1974 law. The law requires that the rate of the cess be determined on the basis of the nature of the pollutants produced by the industry (Bandhu and Bhardwaj 1978:197).

5.2.1.5 The River Boards Act 1956

The act empowers the central government, in consultation with the State Governments, to constitute River Boards for the regulation and development of inter-state rivers.

5.2.2 State government water legislation

About 75 state irrigation statutes cover various aspects of irrigation management and administration such as supply of irrigation waters, flood control, construction of field channels on the irrigation system, drainage and prevention of waterlogging, requisition of labor in emergencies, protection of irrigation works, and the role or irrigation panchayats (councils) and other similar institutions in the administration of irrigation systems. The acts vary quite widely because of varying conditions (rainfall, soils, topographic features, agricultural practices, etc.) in different parts of the country (Varma 1978:28).

Under the Mysore (Karnataka) Irrigation Act, for example, the State Government must grant approval for the construction, control, or maintenance of irrigation works. The state government is to control the construction of wells in any area, and irrigation officers are to decide in the public interest where irrigation channels are to be constructed and what the most suitable alignment for such channels is to be. Also included are provisions for regulating the supply of water from irrigation works, cultivation on irrigated lands, and the cropping pattern in the irrigated area. Under this law, permission to use irrigation waters is initially granted for a period not to exceed six years, after which permanent access to irrigation waters can be obtained. The state government is also empowered to assume control of private irrigation works for the purpose of maintenance and to levy a cess on the land benefited by the irrigation works it maintains. Provision for the protection of irrigation works, include specific prohibitions against mining and the excavation of wells in the vicinity of irrigation works (Varma 1978: 28).

The legislative situation tends to be further complicated by the existence in most states of a large number of laws covering various aspects of irrigation management and administration. The central government Irrigation Commission had made several recommendations aimed at simplifying the legislative situation. These include: the consolidation of state irrigation laws into a single law uniformly applicable to all regions of the State and the issuance of central government laws to serve as a framework for more uniform state laws. A Model Irrigation Bill has, in fact, been prepared and is being circulated among state governments, who are encouraged

to adopt the bill with changes that may be necessary to meet peculiar local circumstances (Varma 1978: 28).

Groundwater, the ownership of which remains undefined under present state legislative provisions, is now considered to belong the owner of the land*. In order to extend the regulation over groundwater necessary for its inclusion in overall water use plans, the central government, through a working group consisting of Central and State representastives, has prepared for circulation to the states a Model Bill on Ground Water that provides for the establishment within each state of a Ground Water Authority to: regulate the extraction and/or use of groundwater in any form in the certain areas; grant permits to extract and use groundwater in certain areas; register existing users; grant license for sinking wells; and make decisions on the cancellation of permits or licenses. Penalties for offenses against the law are also stipulated (Varma 1978: 28).

5.2.2.1 Individual state legislation (selected examples)

The [State of] Maharastra Water Pollution Prevention Act, May 1970

The Jammu and Kashmir State Canal and Drainage Act 1963

Regulates use and control of water for irrigation and other purposes from all rivers, streams, lakes and natural collections of standing water.

West Bengal Notification No. 7. Regulations. Control of Water Pollution. 1957.

This notice prohibits discharge of any matter likely to cause pollution into waters controlled by the Damodar Valley Corporation. Impeding the flow of water so as to aggravate pollution problems is also prohibited. (See Calcutta Gazette, February 20, 1958, part I, pages 490-492).

Northern India Canal and Drainage Act 13 of 1873 and Punjab State Tubewell Act 1954.

The Madras River Conservancy Act No. 6, 1884.

The Bombay Irrigation Act No. 7, 1879.

The Hyderabad Irrigation Act No. 24, 1960.

5.2.3 Water standards

Several water standards have been fixed by the Indian Standards Institute, which has been publishing such standards since the mid-1960's. These standards prescribe tolerance limits to guide the Central and State Government Water Pollution Control Boards and other authorities in setting up rules on the discharge of effluents (Bandhu and Bhardwaj 1979:198; see also Saxena 1976:7-15).

ISI:3307-1965 and 1974 give the tolerance limits for industrial effluents

*For a recent discussion of problems of groundwater rights and use of groundwater for irrigation, see Veeman 1978.

discharged on land for irrigation purposes.

ISI:7796-1963 and 1974 prescribe the tolerance for inland surface water, rivers, streams, lakes, and reservoirs, including rivers (liable to low seasonal flows) used for raw water for public water supply, bathing, fish culture, and irrigation purposes.

Other standards published by the Indian Standards Institute cover: tolerance limits for inland surface waters subject to pollution; methods of sampling and testing for industrial effluents; tolerance limits for various types of industrial effluents discharged into inland surface waters; tolerance limits for industrial effluents discharged into public sewers; tolerance limits for sewage effluents discharged into inland surface waters; and guides for treatment of effluents of the sugar cane industry, the pulp, paper and board industry, the tanning industry, and the electroplating industry. Standards are constantly being examined for revision and some already exist in revised form. Other standards are circulated in draft form (methods of sampling for industrial effluents), while standards for effluents from industrial operations not already covered are in preparation (Saxena 1976:12-14). Standards applying to sewage treatment and community sanitation have also been published by the Indian Standards Institute (Saxena 1976:14-15).

5.3 FOREST LEGISLATION

5.3.1 Central government legislation

5.3.1.1 The Indian Forest Act No. 16, 1927: An Act to consolidate the law relating to forests, the transit of forest-produce, and the duty leviable on timber and other forest-produce*

This Act is central government legislation taken over from the British at the time of independence in 1947. It represents a consolidation of the Indian Forest Act 1878 and its amending acts. As noted below it is supplemented and amended by state legislation and by specific regulations. India is said to be contemplating revisions in order to keep abreast of recent developments (Hassan 1978).

Chapter II provides for the declaration of government forest or waste-land areas as reserved forests and makes provisions for dealing with activities already being carried on within such areas and for preventing the initiation of new activities. These activities include shifting cultivation within forest areas, which the State government may either permit or prohibit either in whole or in part. Shifting cultivation "shall in all cases be deemed a privilege subject to control, restriction and abolition by the State Government." For the most part these forest were to be reserved for the public benefit and private rights held in the forests were to be settled, transferred or commuted (NCA 1976, vol. 9:350).

Acts prohibited in reserved forests include: making fresh clearings where such a right was not already held; setting fires or creating the danger of a forest fire; trespassing or pasturing domestic animals; quarrying; felling, girdling, lopping, tapping or burning trees or stripping bark; and hunting, shooting, fishing, etc. in contravention

of state rules. Most of these acts may be allowed under permits issued by the Forest Officer.

Chapter III, Of Village Forests, permits the state government to assign any village-community the rights of Government to or over any land which has been constituted a reserved forest; these are to be called village forests. Conditions may be stated in rules government these forests.

Chapter IV, Of Protected Forests, allows the state government to declare government-owned forest or wasteland as protected forest. The government is to record and regulate private activities within these forests, but they are generally open to private use for grazing, wood gathering, and other activities. The state government is empowered, however, to suspend the rights over any portion of one of these forests, provided that these rights can be exercised elsewhere. Further any trees or classes or trees can be declared as reserved, and some specified acts, including quarrying of stone, burning of lime or charcoal, the removal of any forest produce, and the clearing of forest may be prohibited.

Penalties for offenses in protected forests apply to contraventions of the provisions of state notifications dealing with reserved trees and prohibited acts and to causing fires within the forests.

Chapter V, which deals with forest land or wasteland not belong to the government empowers the state government to regulate or prohibit "in any forest of waste-land" 1) clearing land for cultivation; 2) pasturing of cattle; 3) the firing or clearing of the vegetation, when it appears that this prohibition is necessary for a) protection against storms, winds, etc.; b) soil conservation on the ridges and slopes and in the valleys and hilly tracts; c) the maintenance of water-supply in springs, rivers, and tanks; d) the protection of roads, bridges, railways, and other lines of communication; e) the preservation of public health. Furthermore, such forest may be placed under a the control of a forest officer or acquired by the government if this is felt to be the better alternative.

Chapters VI through VII deal with the regulation of forest production. Chapter titles are : Of the Duty on Timber and Forest Produce; Of the Control of Timber and other Forest Produce in Transit; and Of the Collection of Drift and Stranded Timber. Chapter IX lists penalties and Procedures, Chapter X states penalties for grazing domestic animals in reserved forests or in portions of protected forest closed to grazing, Chapter XI deals with forest officers, Chapter XII deals with the issuance of subsidiary rules by state governments, and Chapter XIII contains miscellaneous provisions.

5.3.2 State legislation

Prior to the formulation of the National Forest Policy in 1952, some of the states came under the provisions of the Indian Forest Act, other states had forest regulations with the force of law, and some states had no forest law at all. In pursuance of the National Forest Policy, some of the States enacted their own full scale forest Acts, and some extended the provisions of the Indian Forest Act to their own territories,

making various amendments to adapt the law their own situation. The National Agricultural Commission, which compared the Indian Forest Law as amended by the states and the State Forest Acts, found that the basic provisions are the same but that some of the State Acts take account of present day problems and make specific provisions for their solution. The Orissa Forest Act 1972, for example, allow no claims for shifting cultivation in any forest land designated as "reserved" (NCA 1976, vol. 9:359-363).

5.3.2.1 Individual state legislation (this is not an exhaustive list)

Act No. 1 of 1967. The Andhra Pradesh Forest Act, 1967.

Consolidates and amends the law relating to forest production and management.

Mysore (Karnataka) Forest Act 1963 and rules (1969)

Orissa Forest Act 1972

Act No. 4 of 1962. The Kerala Forest Act.

The Madhya Pradesh Forests (hunting, shooting, fishing poisoning water, and setting traps or snares in reserved or protected forests) Rules 1963.

The Forest (Hunting, Shooting, Fishing and Water Poisoning) Rules, 1957. Under the Rajasthan Forest Act, 1953.

5.3.3 Additional legislation bearing on forests

The Cattle Tresspass Act 1871

The Land Acquisition Act 1894

5.3.4 Problems with existing forest legislation

As reviewed by the National Commission of Agriculture in 1976, forest legislation in general suffered from several weaknesses, among them incompatibility of legislation among the states. The Commission stressed that rational forest development requires an effective all-India Act which would leave states free to make subsidiary rules and regulation to deal with any special situations. It also strongly urged that such an act contain stringent preventive and punitive measures to ensure that when a resource is allocated for development it is not wasted. With regard to deforestation, the Commission advised that provisions should be made that no deforestation be permitted without the approval of the State legislature and that where some diversion of forest land is considered unavoidable provisions should be made to bring some other areas under forests (NCA 1977:464-65).

5.4 SOILS

There is no central government legislation relating to soil conservation, but most of the States, acting on directives issued by the central government, have enacted legislation for conservation of both soil and water resources. A major problem with this state legislation is a lack of uniformity of the provisions from state to state, a problem which is most acute when neighboring states have different provisions applying to the same watershed. This is a factor which severely severely limits the effectiveness of soil conservation measures (India. NCA 1976: vol. 5:269).

As noted above (5.3.1.1) Chapter V of the Indian Forest Act 1927 provides for regulate private forest land for the purpose of soil and water conservation.

The Kerala Land Conservation Act No. 8, 1959

The Hyderbad Land Improvement Act 19. 1953.

Madya Pradesh Act No. 10 of 1958.
Provides for the extension of the Madhya Pradesh Land Improvement Scheme Act 1957 to Union Territory of Manipur.

Act No. 4, to amend the Travancore-Cochin Land Conservation Act. 1951. 1956.

The Travancore-Cochin Irrigation Act. 1956.

5.5 WILDLIFE

5.5.1 Central government legislaiton

5.5.1.1 The Wildlife (Protection) Act, no. 53, 1972

The act establishes a comprehensive federal regulation which is supported by state agencies. The law identifies national parks, sanctuaries/reserves, reserved forests, protected species, and regulates the sale, transport or trade in protected animals (Hassan 1978:35). No parts of this law affect the hunting rights conferred on certain tribal groups (scheduled tribes) of the Anadman and Nicobar Islands.

Chapter I, Preliminary, defines terms and states the circumstances under which the act extends to states

Chapter II empowers 1)the central government to appoint a Director of Wild Life Preservation and assistant directors and 2) each state government to appoint a Chief Wild Life Warden and other Wild Life Wardens and officers. State governments are to appoint Wild Life Advisory Boards consisting of, among other persons: the minister in charge of forests; two members of the state legislature; the Chief Conservator of Forests; the Chief Wild Life Warden; and not more than 15 other officials interested in the protection of wildlife. The duty of these boards is to advise the state government: in the selection of areas to be declared as sanctuaries, National Parks, game reserves, etc.; in the formulation of

the policy in granting licenses and permits under the act; in any matter relating to the amendment of schedules; and in any other matter relating to wildlife protection.

Chapter III lays down rules for the hunting of wild animals. Five Schedules (lists) are established: animals on Schedule I may not be hunted at all (see section 2.6.4 above); animals on Schedules II (Special Game), III (Big Game), and IV (Small Game) may be hunted only under, and in accordance with, the conditions specified in a license; to be issued by the Chief Wild Life Warden of the state or other authorized official. Schedule V contains those animals designated as vermin, for which no restrictions apply (common crow, common fox, fruit bats, jackal, mice, rats, voles). The central government is empowered to add animals to the schedules or transfer animals from one schedule to another; the state governments may add any Schedule II, III, IV or V animals to Schedule I, and may transfer animals from any schedule, except Schedule I and Schedule II, part II, to any other schedule.

Holders of licenses are, among other things, to keep a record of their kills or captures. Quite apart from the provisions otherwise stated Schedule I animals may be hunted if declared by the Chief Wild Life Warden to be dangerous to human life or to be disabled or diseased beyond recovery; Schedule II, III, and IV animals may be killed for the same reasons as well as if they have become a danger to property, including standing crops. Wounding or killing an animal in self-defense is no offense; animals thus destroyed become property of the state. Special permits may be issued for animals captured for educational, scientific, or collection purposes. Hunting of young females of wild animals is prohibited. The State government is to declared closed seasons. Hunting of certain types is prohibited (e.g., with airplanes, with fires or artifical lights, with explosives or chemicals).

Chapter IV provides for the delcaration by state governments of sanctuaries, national parks, game reserves, and closed areas:

Sanctuaries are to be declared by State governments in areas deemed worthy of protection. Entry into these areas is restricted, although traditional rights, including residence, within areas declared as sanctuaries may be retained; provisions are made for the government to acquire land within these areas. Permits may be obtained for entry into sanctuaries for scientific purposes, photography, tourism, or transaction of business with persons living within the sanctuary. Hunting is generally prohibted within a sanctuary but may be allowed under special conditions under permit issued by the Chief Wild Life Warden, the State official who exercised general control over the sacnturies.

National parks are declared by the State government for areas considered in need of protection because of their ecological, faunal, floral, or geomorphological importance, and their boundaries, once established, may not be altered without a resolution passed by the state legislature (this does not, however, apply to sanctuaries). Provisions for the government to acquire land or to deal with rights already held within areas declared to be national parks are laid down. "No person shall destroy, exploit or remove any wild life from a National Park or destroy or damage the habitat of any wild animal or deprive any wild animal of

its habitat...except under and in accordance with a permit granted by the Chief Wild Life Warden and no such permit shall be granted unless the State Government, being satisfied that such [an act]...is necessary for the improvement and better management of wild life therein, authorises the issue of such permit." No grazing of domestic animals is permitted.

Game reserves: The state government may declare any area as a game reserve; hunting within such areas requires a license issued by the Chief Wild Life Warden.

Closed areas: The state government may declare any area closed to hunting for a specific period state in a notification.

Chapter V, Trade or Commerce in Wild Animals, Animal Articles, and Trophies, declares all wild animals and all parts of wild animals hunted contrary to the provisions of the act to be state government property, which may not be held, sold, destroyed or damaged. Persons are to declare wild animals or wild animals products in their possession. The sale or transfer of certain wild animals or wild animal products is regulated, and a license is required for dealing in trophy and animal articles. No captive animal may not be purchased, receive, or acquired without a license. Provisions of this chapter apply across the board to schedule I animals and varying to Schedule II, III, and IV animals; they do not apply to those animals defined as vermin.

Chapter VI describes the powers of enforcement personnel and lists penalties. The stiffest penalties are for offences involving animals on Schedule I and Part II of schedule II or for offenses involving hunting in sanctuaries or National Parks; these are no less than six months but up to six years imprisonment and a fine of not less than 500 rupees (as of 1974) for a first offense and no less than one year imprisonment and a fine of not less than 1,000 rupees for a second offense.

5.5.1.1.1 Orders under Wildlife Protection Act 1972

The India government, acting under this legislation, issued in January 1978 an order banning trade in most wildlife for which there are overseas markets; this order has been subsequently strengthened to further limit trade in live wild animals, which is now restricted to 21 species of birds and a single mammal--the striped squirrel Trade in wildlife products is also severely restricted (IUCN Bulletin, vol. 10, no.8/9, 1979: 71).

5.5.1.2 CITES (Convention on Trade in Endangered Species)

India is a signatory of the CITES treaty. Implementation is in the hands of the Divison of Forests and Wildlife of the Department of Agriculture.

5.5.2 State government legislation

As of April 1975 the central government Wildlife Act had been adopted by all states except Assam, Nagaland, and Jammu and Kashmir.

5.6 FISHERIES AND FISH

5.6.1 The Indian Fisheries Act 1897

Prohibits the destruction of fish by explosives in inland waters and on the coasts. Penalty: up to two months in prison or a fine or up to Rs. 200.

Prohibits fishing with poisons, lime, or other noxious materials. Penalty: up to two months in prison or a fine or up to Rs. 200.

State governments may make certain rules covering selected streams or other waters that are the property of the state as well as other streams or waters, with the consent of their owners. These rules may prohibit or regulate: the use of fixed engines for the capture or fish; the construction of weirs; the use of nets with a mesh below a minimum size; the capture or sale of all or any kinds of fish during any closed season. They may also also prohibit all fishing in any specified waters for a period not exceeding two years.

5.7 COASTS AND BEACHES

Act, no. 80 of 1976: The Territorial Waters, Continental Shelf, Exclusive Economic Zone, and other Maritime Zones Act 1976

Territorial waters extend twelve nautical miles off the coastline; the contiguous zone extends 12 nautical miles beyond the line of territorial waters; the continental shelf "comprises the seabed and subsoil of the submarine areas that extend beyond the limit of its territorial waters up to ...two hundred nautical miles from the coast"; the exclusive economic zone extends two hundred miles from the coast. Any area of the exclusive zone may be declared a designated area with which the central government has: 1) sovereign rights for the purpose of exploration, exploitation, conservation, and management of the natural resources, both living and non-living; 2) exclusive rights and jurisdiction for the construction, maintenance or operation of artificial islands, off-shore terminals and other structures, etc. necessary for the economic exploitation of the zone; 3) exclusive jurisdiction to authorize, regulate and control scientific research; 4) exclusive jurisdication to preserve and protect the marine environment and to prevent and control marine pollution; 5) such other rights as are recognized by international law (Hassan 1978:32).

5.7.1 Marine Pollution

India has adopted no legislation implementing the International Convention on Prevention of Pollution of the Sea by Oil 1954, and has seemingly taken no action relating to the 1969 Internaltonal Convention of Civil Liability for Oil Pollution Damage, the 1969 International Convention Relating to Intervention on the High seas in Cases of Oil Pollution Casualities, or the 1971 International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage (Hassan 1978:23-25).

The Indian Merchant Shipping Act, 1958

Controls marine pollution and prohibits discharges on the high seas (Hassan 1978:25).

5.7.2 Coastal zone management

Such legislative coverage as there is is provided by individual coastal states of the federation; India is said to be now feeling the need for a national policy (Hassan 1978:32).

5.8 MINERALS LEGISLATION

The Mines Act 1952

The Mines and Minerals (Regulation and Development) Act 1957

Mineral Concessions Rules 1960

Petroleum Concessions Rules 1949

Coal Mines Regulations 1957

Metalliferous Mines Regulations 1961

5.9 AIR AND THE ATMOSPHERE

5.9.1 Central government legislation

According to a recent review of legislation in Asian countries, the laws of India are almost "oblivious to industrial pollution"

(Hassan 1978: 26), although the "nuisance" provisions of general laws may be applicable to air pollution control. Some Indian states have Smoke Nuisances Acts. There appears to be no law specifically providing for the protection of the atmosphere from chemicals and other industrial discharges (Bandhu and Bhardwaj 1979:198).

Although no such law has been put into effect, there are reports that the Ministry of Works and Housing had referred to an expert committee the preparation of an air pollution control bill, a draft of which already in existence as of 1976 (Saxena 1976:9).

Indian Motor Vehicles Act (1939)

Section 70 confers legal powers to the State governments to make rules regarding emissions of smoke, visible vapor, sparks, ashes, grit or oil and the noise caused by vehicles. No regulations appear to have been made (Hassan 1978:28)

Smoke Nuisances Act of 1908 (Bandhu and Bhardwaj 1979:198)

5.9.2 Standards

The Indian Standards Institute has prepared a number of of standards on methods of sampling and measurement of air and air pollutants, and work has been taken up on emission standards. It is not clear under what legislation or under what circumstances these standards would be applied.

Standards, some of which were issued as early as 1968, cover methods for measurement of air pollution from dustfall, sulfur dioxide, radioactivity, suspended matter, hydrogen sulfide, oxidants, polynuclear aromatic hydrocarbons, and mass concentrations of particulate matter. Draft standards covering smoke emission levels from diesel vehicles and pollution from inorganic fluorides were in circulation as of 1976, while preliminary draft standards were in preparation for measurement of lead in air and preliminary work was being conducted on the preparation of standards for emission from industrial plants, including phosphatic fertilizer plants, nitrogenous fertilizer plants, petroleum refineries, petro-chemical operations, and synthetic fiber plants (Saxena 1976:11-12).

5.10 LAND USE AND LAND REFORM

Land Use

According to a 1978 review of Indian environmental legislation, India has a federal land use law for Federal Territories and various Planning Acts for the States (Hassan 1978: 18).

Land reform

The Indian government has adopted a national policy on tenancy reforms aimed at conferment of ownership rights on cultivating tenants, and legislative provisions have been made in most of the states to conform to this policy. Major features of thie program embodied in this legislation have been: abolition of intermediary tenures; tenancy rights; fixing of ceiling on land holdings; and consolidation of holdings (NCA 1977: 679).

5.10 HAZARDOUS SUBSTANCES, PESTICIDES, ATOMIC ENERGY

HEALTH LEGISLATION (including hazardous substances and pesticides)

Drugs (First Amendment) Rules, 1964. Lays down standards for insecticides and disinfectants.

The Insecticides Act, no. 46, of 1968 to control poisonous substances, including insecticides

Regulates the import, manufacture, sale, transport, distribution and use of insecticides with a view to preventing risk to human beings of animals and matters connected therewith.

The Central Government is authorized to appoint a Central Insecticides Board to advise on technical matters related to control of pesticide use. A registration committee, whose members other than the chairman are appointed by the government from among members of the board, is responsible for licensing pesticides for manufacture and import after testing them for safety and effectiveness. The government is also authorized to appoint insecticide inspectors with powers of entry and may make regulations on packaging, labeling, manufacture, import, distribution, transport, storage and use of pesticides, as well as other regulations to implement this act. State governments may make additional regulations

which are not in conflict with this act. It is probibited to manufacture or sell any pesticide without a license issued by an officer appointed by the central government. Pesticides controlled by the act are listed in the schedule.

The law is primarily health and safety oriented and takes no significant consideration of environmental hazards (Hassan 1978:39

The Atomic Energy Act 1962, no. 33 to provide for control over radioactive substances or radiation generating p ants.

The Prevention of Food Adulteration Act 1954

The Act provides certain controls over toxic substances; it is primarily health and safety-oriented, rather than directed towards environmental mental hazards (Hassan 1978:39)

The Factories Act 1948

The Act provides certain controls over toxic substances--primarily health and safety oriented rather than considering environmental hazards (Hassan 1978:39).

Fertilizer (Control)(Amendment) Order, 1961
-modifies superphosphate standards.

5.12 SOLID WASTE MANAGEMENT

Solid waste management is generally the reponsibility of local bodies and municipalities and is covered by local legislation in India (Hassan 1978:31).

5.13 Monuments and cultural matters

5.13.1 Antiquities and Art Treasures Act 1972

Ancient Monument and Archaeological Sites and Remains Act 1958 (from Hassan 1978:43).

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