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Forest Degradation in India: Extent and Determinants

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I

INTRODUCTION

Forest resources are among the most crucial links in the ecosystem. Apart from providing direct use values, forests provide numerous environmental benefits such as watershed protection, nutrient cycling, pollution control, micro-climatic regulation, carbon sequestration, etc. Degradation of these precious resources affects the economy and environment locally as well as globally. In fact, forest degradation could become a major constraint on future growth and development in most of the developing countries like India. The real costs of such degradation are increasingly felt in terms of declining productivities of interlinked natural resources such as land, water, grass lands, etc. Though the impacts, in terms of loss of production, are not realised at the macro level, the problem is of very serious concern at the regional level. In fact, it is observed that the annual depletion value of forests was 19.8 per cent of the estimated forestry value added in Maharashtra (1993-94) when direct use values are taken into account (Haripriya, 2000). The costs of degradation are mounting and would make a dent in the national income if these costs were taken into account, though no precise estimates are available at the all-India level. Unless effective measures are adopted to arrest degradation, achieving sustainable development would remain a distant dream. For, sustainable development requires keeping the natural capital (K_n) constant in the long run.

Depletion of forest resources can be viewed from two angles, i.e., quantitative and qualitative. Hitherto quantitative aspects in terms of forest cover, its distribution, demand and supply of forest products (Chandrakanth *et al.*, 1979; Kalla, 1988; Guleria, 1988; Raju *et al.*, 1988) were given priority over qualitative aspects by researchers as well as policy makers. As a result, recent years have shown an improvement in the area under forests, though contradictions still exist among different data sets (Table 1). On the other hand, little attention was paid to the qualitative side of the forests, which is mainly due to lack of data on degradation. Though it is heartening to note that the area under forests is increasing, one is not sure of the quality of the existing forest stock. For, ultimately it is the quality of

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forests that determine their actual value. Neglecting the qualitative side of forests may result in lower value addition to the national income. That is, the contribution of forests to the national economy will decline in per unit as well as absolute terms. Therefore, it is necessary to understand various aspects of forest degradation in order to formulate meaningful policies for checking degradation and improving the quality of forests in India. Further, while the area under forests is determined historically, quality of forests (degradation) depends on the day-to-day human use and misuse of forests.

On this backdrop this paper makes an attempt to examine the extent of forest degradation at the state level and identify the effects of local variables and suggest policies to check forest degradation. In the process some of the important hypotheses like poverty-degradation, development-degradation links are tested. This paper is organised as follows: the theoretical underpinnings of forest degradation in the context of sustainable development are discussed in Section II; data and approach are discussed in Section III. Section IV examines the trends in the area under forests, contribution of forests and extent of forest degradation across states; estimates of factors affecting forest degradation are presented in Section V, while some policy implications are discussed in the last section.

II

FOREST DEGRADATION AND SUSTAINABLE DEVELOPMENT: THEORETICAL BACKGROUND

Degradation is a dis-investment in the stock of forests if more value than replaced (by nature or man) is extracted from it. Perpetuation of this dis-investment would threaten the food security in the long run. This would happen due to the differences between the equilibrium and actual rate of extraction or the replacement (social) and actual costs of using forests. The anatomy of the linkages is as follows: increased population pressure enhances the demands on land, including forest lands. Marginal costs of extraction (production) or costs of replenishing (as land/forest is a renewable resource) increases as more is extracted in the absence of technological breakthrough (more output per unit of extraction). However, in actuality costs fall because of abundant labour in relation to land, availability of technologies (such as tractors) that reduce costs or if inputs are subsidised (cheap water, fertilisers, etc.). This widens the gap between social and actual costs, in the absence of well functioning markets (for forest products), setting the conditions for degradation.

Forest degradation is critically linked with sustainable development especially in agrarian economies like India. Often low household incomes are associated with low land productivities. There is growing literature associating increasing poverty and degradation of forest lands (quantitatively as well as qualitatively) called as the vicious circle of poverty and resource degradation (UNSO, 1994). This is attributed mainly to the population, agriculture, and environment nexus. In this regard, Boserup's theory of a positive relation between population pressure and technological innovation is unfound in many parts of the developing world. It was observed that increased population density without technological progress has led to shortened fallow periods, deforestation and soil degradation (Vosti, 1993 as cited in UNSO, 1994). On the contrary, appropriate institutional arrangements could halt or reduce degradation even under the conditions of increasing population pressure (Tiffen *et al.*, 1994).

Divergent views are held as far as the relationship between poverty and resource degradation, on the one hand and property rights and institutions in resource management, on the other. It is often argued that poor degrade the environment more due to their greater reliance on the natural system and also due to their high discount rates of future returns consequent upon the absence of alternative income sources. In a cross-country study, it was observed that industry-led nexus ('frontier' theory) results in deforestation in places with large forests and poverty nexus ('immeserisation' theory) leads to deforestation in regions with small forests (Rudel and Roper, 1997). Many observers challenge the argument of a high discount rate by the poor. Since poor depend heavily on a limited natural resource base they have greater motivation to conserve it (Jodha, 1986). It is further argued that a number of factors like the existing policy environment, institutional structure, literacy, market penetration, urbanisation, etc., influence the discounting of future significantly (Mertens *et al.*, 2000; Godoy *et al.*, 1997; Barbier and Burgess, 1996; Tiffen *et al.*, 1994; Leach and Mearns, 1991; Cline-Cole *et al.*, 1990; Anderson, 1990). A recent study (Reddy, 1999) of four states across India has rejected the hypothesis of a direct relationship between poverty and resource degradation (private as well as common lands). The study clearly showed that higher dependence does not necessarily mean higher use of resources. Poor households though depend more on common resources, use less of the resource in absolute terms and vice versa in the case of rich households. In fact, factors like access to markets and other resources like water influence the intensive use of crop lands while local institutions play an important role in sustainable management of common lands. For, marginal and small farmers use their land less intensively (less degrading) compared to big farmers, as the former do not have access to water (Reddy *et al.*, 1996).

Another common hypothesis or argument is that forest degradation (mainly deforestation) is linked with grazing. Often pasture formation and cattle ranches have been identified as major factors in deforestation in Latin America (Barbier and Burgess, 1996; Downing *et al.*, 1992 and Kaimowitz, 1996 as quoted in Walker *et al.*, 2000). However, it was observed in Kalahari that basic soil processes are relatively unaffected by grazing pressure (Dougill and Cox, 1995). Interestingly, poor regions are characterised by greater concentration of livestock coupled with poor quality forests. This could be attributed to the agro-climatic conditions of these regions rather than to poverty-degradation or grazing-degradation linkages. Therefore, the linkages are neither exclusive nor immutable. It is not necessarily true that agriculturally well-endowed regions will ameliorate the conditions of the poor faster. Similarly, it is not necessary that the poor continue to remain in less endowed regions without adopting any alternative livelihood strategies such as migration (UNSO, 1994). On the other hand, institutions play an important role in the success of sustainable land management practices.

The relationship between development and degradation is yet another important but less explored proposition. This proposition is popularly known as the 'Environmental Kuznets Curve' (EKC), which portrays a bell shaped relationship between environmental degradation and per capita income. That is environmental degradation aggravates till a point of development (per capita income) after that it starts falling with increases in per capita income. Hitherto, the empirical work on EKC pertaining to deforestation vindicates the relationship (for a review and empirical support see Godoy *et al.*, 1997). However, these results are based on either cross-country analysis or pertain to African and Latin American countries. In the Indian context the EKC hypothesis needs to be tested.

III

DATA AND APPROACH

Multiple sources are available for information on various aspects of forests. Unfortunately, many of the sources are neither consistent nor comparable with other sources. These sources include Ministry of Environment and Forests, Ministry of Agriculture, Government of India, Centre for Monitoring Indian Economy (CMIE), Central Statistical Organisation (CSO), etc. All these sources are based on village records and other land use estimates. Of these sources, CMIE and Ministry of Environment and Forests data are comparable. Of late, the National Remote Sensing Agency (NRSA) started publishing data on forest cover and forest degradation. This data is more reliable as it is based on the data generated from satellite imageries using the remote sensing technique. The data are available for 442 districts for the year 1988-89 (NRSA, 1995). The NRSA provides data on total forest area, area under evergreen forests, deciduous forests, degraded forests, forest blanks, forest plantations and mangrove forests.[1] Total forest area given by NRSA compares well with the data from Ministry of Environment and Forests, as the Ministry is relying on NRSA data in recent years. On the other hand, the NRSA is the only source, which gives information under the heading of degraded forest. As per the NRSA, degraded forest or scrub is defined as the forest area with crown density of less than 20 per cent. To this we have added the component of forest blanks (crown density of less than 10 per cent) to arrive at the total degraded forest. Though the latest set of NRSA data (NRSA, 2000) provides data for all the districts in the country, it is not comparable with the earlier set due to three reasons: (a) it covers only one aspect of forests, i.e., under-utilised/degraded notified forest land, (b) the time span of the estimates is quite large, starting in 1986 and ending in 1999, to arrive at time specific estimates (different districts are covered in different years) and (c) scale of mapping also differs.

Alternatively, forest degradation is defined as the area with crown density of less than 40 per cent. The Ministry of Environment and Forests is providing the data for all the states in regular intervals of two years (State of the Forest Reports). These estimates are reliable as they are assessed by the NRSA. According to this, total forest area is grouped under three categories, namely, dense forests (crown density more than 40 per cent), open forest (crown density between 10 and 40 per cent) and mangroves. Forest area with less than 10 per cent crown density is included in the recorded forest.[2] The data on recorded forest are provided by the respective state forest departments and include dense forest cover, open forest and areas with less than 10 per cent crown density. For the purpose of our study, we define degraded forest as the forest area with less than 40 per cent crown density, i.e., recorded forest minus dense forest.

This data, however, is not comparable with the NRSA (1995) data on forest degradation (defined as forest area with less than 20 per cent crown density), which are available at the state as well as district level. The data on socio-economic and demographic variables are obtained from sources like CMIE (*Profiles of Districts, 1993*), *Statistical Abstracts of India*, *Livestock Census*, *Fertiliser Statistics*, etc. Based on these sources of data, an attempt is made here to identify the factors influencing forest degradation across States using the multiple regression technique. Details of the estimation procedure are discussed in the relevant section.

IV

EXTENT OF FOREST DEGRADATION

There have been significant changes in land utilisation in India between 1950-51 and 1998-99. However, most of these changes have taken place during the first two decades, i.e., 1950-51 to 1970-71. Land use pattern is more or less stable between 1980-81 and 1998-99. The substantial increases in the earlier decades in some of the components like the area under forests, net sown area are due to abolition of Zamindari system, reclamation of lands from one category to another and implementation of better reporting system. As mentioned earlier different sources give different estimates of area under forests in India (Table 1). Time-series data are provided by two sources, namely, CMIE and *Statistical Abstract of India* (SAI) from 1970-71 onwards, though with some gaps. The Ministry of Environment and Forests provides data every two years since 1989 and the latest being 1999. While the data from SAI show a slide in the area under forest between 1970-71 and 1990-91, the CMIE data reveals an increasing trend from 1950-51 till 1995-96. The reason for this discrepancy is that SAI was giving data on reported area rather than actual area during the early years (1970-71 and 1980-81). On the other hand, the Ministry's data between 1989 and 1999 give a stable picture of the area under forests around 64 million hectares. However, all these estimates seem to converge by the 1990s (Table 1). During the 1990s the area under forests ranged between 68 million hectares

(CMIE) and 64 million hectares (Ministry and SAI), whereas the satellite data from NRSA which is more reliable puts the figure at 65.71 million hectares for the year 1988-89, which is comparable with the Ministry's (FSI) data. For, FSI data are assessed by NRSA and hence we restrict our analysis to the Ministry's data that are available till 1999.

The area under forest cover accounted for about 19 per cent of the total geographical area of the country, which is well below the desired level of 33 per cent (Table 1). There is a marginal decline of 0.69 million hectares of forest area between 1988-99 and 1999. The proportion of forest area varied widely across states, reflecting serious ecological imbalances (Appendix Table 1). It varied from 2.18 per cent in Haryana to 87 per cent in Mizoram. Over the period, variations across the states have increased marginally. Apart from the quantity aspects, quality of forests is equally, if not more, important for sustaining the ecological balance as well as the local populations. Of the total forest area, dense forests with crown density of above 40 per cent accounted for 59.22 per cent while open forests with 10 to 40 per cent crown density occupied about 40 per cent. The share of mangroves is less than one per cent.

TABLE 1. AREA UNDER FORESTS IN INDIA

(million hectares)

Year (1)	CMIE* (2)	Ministry of Environment and Forests (GOI) (3)	*Statistical Abstract of India* (4)	National Remote Sensing Agency (5)
1950-51	46.87 (14.26)	-	-	-
1960-61	54.69 (16.64)	-	-	-
1970-71	66.38 (20.19)	-	74.86 (22.77)	-
1972-75	-	-	-	55.49 (16.88)
1980-81-82	67.34 (20.48)	-	73.67 (22.41)+	46.35 (14.10)@
1988-89	-	64.01 (19.47)	-	65.71 (19.99)
1990-91	67.99 (20.68)	63.92 (19.44)	63.92 (19.44)	-
1992-93	68.07 (20.71)	64.01 (19.47)	-	49.05 (14.90)#
1995-96	68.83 (20.94)	63.83 (19.41)	-	-
1996-97	-	63.34 (19.27)	-	-
1999	-	63.70 (19.38)	-	-

Notes: * All the figures except 1995-96 are three-year averages in the case of CMIE.
+ Pertains to the year 1980. @ Pertains to the year 1980-82.
# NRSA figures for 1980-82 and 1992-93 are as reported in *Facts and Figures 1999*, Forest Department, Government of India, New Delhi.
Figures in parentheses are percentages to the total geographical area.

As far as the changes in different components of forest area is concerned, only marginal changes are observed between 1989 and 1999 at the all-India level (Table 2). This indicates stability in the quantitative and qualitative aspects of forests in

India. The area under recorded forests has increased by 0.10 per cent while the area under forest cover has declined by 0.05 per cent at the all-India level. There are variations across states regarding the quantity and quality of forests. Between 1989 and 1999, 12 out of the 25 states have recorded increase in the area under forests, forest cover as well as recorded, while 13 states have recorded a decline in the area under forest cover whereas 8 states have recorded a decline in the recorded forest area (Table 2). The area under dense forests has gone up in 17 states while it has declined in 8 states. On the other hand, the area under open forests has declined in 16 states and increased in 9 states. The decline in dense forest and open forest is reflected in the decline in forest cover. Recorded forest, which includes forest cover plus the area with less the 10 per cent crown density, has increased.

TABLE 2. CHANGES IN AREA UNDER FORESTS ACROSS STATES (COMPOUND GROWTH RATES BETWEEN 1989 AND 1999)

(per cent per year)

State (1)	Area under forest cover (2)	Area under recorded forest (3)	Area under dense forest (4)	Area under open forest (5)
Andhra Pradesh	-0.7965	0.0067	-0.5396	-1.1143
Arunachal Pradesh	0.0122	0.0000	0.6241	-2.6385
Assam	-0.9490	0.0000	-0.7728	-0.2144
Bihar	-0.1721	-0.0014	-0.1034	-0.2407
Goa	-0.3835	3.0643	0.2033	-2.4602
Gujarat	1.0579	0.3233	2.0307	-0.8575
Haryana	5.5254	-0.0714	13.1958	1.7494
Himachal Pradesh	-0.2227	5.2010	2.5354	-4.4972
Jammu and Kashmir	0.0083	-0.3452	0.1787	-0.1870
Karnataka	0.1137	0.0207	0.0335	0.3758
Kerala	0.1701	-0.0009	0.1399	0.3060
Madhya Pradesh	-0.1027	-0.0592	-1.1306	1.8642
Maharashtra	0.5780	-0.0333	0.1653	1.1661
Manipur	-0.2837	-0.0007	1.6095	-1.1294
Meghalaya	-0.0364	1.0976	5.6276	-2.3093
Mizoram	0.0877	0.0000	-0.2527	0.1783
Nagaland	-0.1346	0.0046	1.0402	-0.7410
Orissa	-0.0221	-0.4054	-0.5535	0.6809
Punjab	1.9765	0.3442	18.2148	-1.7148
Rajasthan	0.6770	0.1749	4.0322	-0.5104
Sikkim	-0.0192	0.0000	-0.1968	0.5599
Tamil Nadu	-0.3655	0.1376	-1.1888	0.6017
Tripura	0.7621	0.0207	6.2600	-1.5485
Uttar Pradesh	0.0507	0.0766	0.1187	-0.0878
West Bengal	-0.0382	0.0000	0.6782	-0.9950
Union Territories	-0.0548	0.1371	0.0000	-1.8825
All-India	-0.0459	0.0973	-0.0039	-0.0936

In order to arrive at the area under degraded forests (open forest + area with less than 10 per cent crown density), we have deducted the area under dense forest from the area under recorded forests. At the all-India level, the area under recorded forest is about 76 million hectares accounting for 23 per cent of the total geographical area. The impact of the declining quality will be more revealing if we look at the actual degradation data in absolute terms. The estimates put the extent of degradation at 38 million hectares accounting for about 50 per cent of the recorded forest area in the country (Table 3). The extent of degradation varies across states, viz., 10.8 per cent in Sikkim to 86 per cent in Rajasthan. There appears to be some problem in the case of Arunachal Pradesh where the extent of area under degraded forests is negative. The incidence of degradation is on the higher side in the northeastern states, which may

TABLE 3. EXTENT OF DEGRADED FORESTS ACROSS STATES

(million hectares between 1989 and 1999)

State (1)	1989 (2)	1991 (3)	1993 (4)	1995 (5)	1997 (6)	1999 (7)	CGR* (8)
Andhra Pradesh	3.8 (59.9)	3.9 (60.7)	3.9 (60.8)	3.9 (61.1)	4.1(63.9)	4.0 (62.1)	0.36
Arunachal Pradesh	-0.3 (-5.3)	-0.3 (-5.8)	-0.3 (-0.8)	-0.3 (-5.1)	-0.3(-5.07)	-0.6(-12.1)	-8.57
Assam	1.5 (48.9)	1.5 (48.4)	1.45(47.9)	1.5 (48.9)	1.5 (49.4)	1.6 (52.7)	0.75
Bihar	1.6 (54.1)	1.6 (54.5)	1.6 (54.9)	1.6 (54.4)	1.6 (54.5)	1.6 (54.6)	0.08
Goa	0.008(7.4)	0.03(20.7)	0.04(30.2)	0.05(30.1)	0.04(30.1)	0.04(30.1)	18.59
Gujarat	1.4 (72.0)	1.3 (67.9)	1.3 (67.5)	1.3 (67.2)	1.3 (67.3)	1.3 (66.8)	-0.41
Haryana	1.6 (92.3)	0.1 (80.5)	0.1 (80.3)	0.1 (77.9)	0.1 (77.9)	0.1 (73.2)	-2.37
Himachal Pradesh	1.4 (66.7)	2.9 (76.3)	2.6 (72.9)	2.6 (73.0)	2.6 (73.0)	2.6 (74.2)	6.33
Jammu and Kashmir	1.01(48.2)	0.9 (45.5)	0.9 (45.7)	0.9 (45.4)	0.9 (45.4)	0.9 (45.4)	-0.94
Karnataka	1.4 (36.0)	1.4 (35.7)	1.4 (35.8)	1.4 (35.8)	1.4 (35.8)	1.4 (35.9)	-0.002
Kerala	0.3 (26.0)	0.3 (24.9)	0.3 (24.9)	0.3 (24.7)	0.3 (24.7)	0.3 (24.9)	-0.41
Madhya Pradesh	6.4 (41.2)	6.0 (38.6)	5.9 (38.2)	5.9 (38.4)	7.2 (46.4)	7.3 (47.2)	1.31
Maharashtra	3.8 (59.1)	3.8 (59.0)	3.8 (59.9)	3.8(59.89)	4.0 (63.0)	3.7 (58.3)	-0.17
Manipur	1.0 (66.6)	1.0 (64.9)	1.0 (65.0)	1.0 (64.9)	1.0 (67.4)	0.9 (60.8)	-0.90
Meghalaya	0.5 (59.7)	0.6 (65.2)	0.6 (65.2)	0.5 (57.4)	0.5 (57.4)	0.4 (37.6)	-3.48
Mizoram	1.2 (75.6)	1.2 (73.1)	1.0 (70.3)	1.2 (73.1)	1.2 (72.7)	1.2 (76.2)	0.08
Nagaland	0.4 (46.3)	0.5 (59.1)	0.5 (59.6)	0.5 (59.6)	0.5 (59.6)	0.3 (40.5)	-1.33
Orissa	3.2 (53.7)	3.2 (54.1)	3.0 (52.5)	3.0 (52.5)	3.1 (54.4)	3.1 (54.4)	-0.28
Punjab	0.3 (96.5)	0.2 (83.1)	0.2 (83.4)	0.2 (83.4)	0.2 (82.4)	0.2 (82.2)	-1.26
Rajasthan	2.8 (90.7)	2.9 (90.4)	2.8 (88.7)	2.8 (88.4)	2.8 (88.4)	2.7 (86.4)	-0.30
Sikkim	0.02 (9.1)	0.02 (9.3)	0.03(12.2)	0.02 (8.5)	0.02 (8.6)	0.03(10.8)	1.80
Tamil Nadu	1.3 (56.3)	1.3 (56.8)	1.3 (58.2)	1.3 (58.4)	1.4 (61.7)	1.4 (61.7)	1.07
Tripura	0.5 (80.7)	0.4 (71.0)	0.4 (71.1)	0.4 (71.1)	0.4 (71.1)	0.4 (64.6)	-2.18
Uttar Pradesh	2.9 (55.9)	2.9 (56.0)	1.8 (44.1)	2.9 (55.5)	2.9 (55.6)	2.9 (55.7)	0.04
West Bengal	0.9 (71.9)	0.8 (70.3)	0.9 (71.7)	0.8 (70.8)	0.8 (70.1)	0.8 (70.0)	-0.28
Union Territories	0.08 (9.7)	0.07 (9.5)	0.07 (9.5)	0.07 (9.9)	0.08(10.2)	0.08(10.9)	1.34
All-India	38.8 (50.2)	38.5 (50.0)	36.7 (48.8)	37.9 (49.6)	39.8(52.0)	38.8(50.7)	0.20

Source: Forest Survey of India, Ministry of Environment and Forests, Government of India, New Delhi.
Note: Figures in parentheses indicate percentages to area under recorded forests.
* Compound growth rate per cent per year.

be due to the practice of *jhum* (shifting) cultivation. However, these states are not exceptions. Degradation is equally bad in states like Rajasthan, Haryana, Bihar, Tamil Nadu, Andhra Pradesh, Gujarat, etc. In a majority of the cases the incidence of degradation seems to be higher in the states where the proportion of deciduous forests is more and forest plantations are low (Appendix Table 2).

In terms of changes in the area under degraded forests, there is a marginal increase at the all-India level between 1989 and 1999. However, 15 states have recorded negative growth rates while 10 states recorded an increase in the area under degraded forests. Based on the changes in the area under forests, dense forests and degraded forests during the last decade, the states can be categorised as best performers and worst performers. The states that have shown an increase in the area under dense forest along with a decline in the area under degraded forests are termed as best performers and those states recording negative growth in the area under dense forests along with an increase in the area under degraded forests are termed as worst performers. Accordingly, 13 states (Arunachal Pradesh, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Nagaland, Rajasthan, Punjab and West Bengal) turned out to be best performers while 7 states (Andhra Pradesh, Assam, Bihar, Madhya Pradesh, Mizoram, Sikkim and Tamil Nadu) turned out to be worst performers (Table 4). And the remaining 5 states fall in between (average performers).

TABLE 4. NUMBER OF STATES SHOWING INCREASE/DECLINE IN DEGRADED FOREST AREA (1989-1999)

Particulars (1)	Total forest cover (2)	Total recorded forest (3)	Dense forest (4)	Degraded forest (5)
I. States showing increase	12 (Arunachal Pradesh; Gujarat; Haryana; Jammu and Kashmir; Karnataka; Kerala; Maharashtra; Mizoram; Punjab; Rajasthan; Tripura and Uttar Pradesh).	12 (Andhra Pradesh; Goa; Himachal Pradesh; Karnataka; Meghalaya; Nagaland; Punjab; Rajasthan; Tamil Nadu; Tripura and Uttar Pradesh).	17 (Arunachal Pradesh; Goa; Gujarat; Haryana; Himachal Pradesh; Jammu and Kashmir; Kerala; Karnataka; Maharashtra; Manipur; Meghalaya; Nagaland; Rajasthan; Punjab; Tripura; Uttar Pradesh and West Bengal).	10 (Andhra Pradesh; Assam; Bihar; Goa; Himachal Pradesh; Madhya Pradesh; Mizoram; Sikkim; Uttar Pradesh and Tamil Nadu).
II. States showing decline	13 (Andhra Pradesh; Assam; Bihar; Goa; Himachal Pradesh; Nagaland; Madhya Pradesh; Manipur; Meghalaya; Nagaland; Orissa; Sikkim; Tamil Nadu and West Bengal).	8 (Bihar; Haryana; Jammu and Kashmir; Kerala; Madhya Pradesh; Maharashtra; Manipur and Orissa)	8 (Andhra Pradesh; Assam; Bihar; Madhya Pradesh; Mizoram; Orissa; Sikkim and Tamil Nadu).	15 (Arunachal Pradesh; Gujarat; Haryana; Jammu and Kashmir; Karnataka; Kerala; Maharashtra; Manipur; Meghalaya; Nagaland; Orissa; Punjab; Rajasthan; Tripura and West Bengal).

The impact of forest degradation on the economy is conspicuous in its declining contribution to gross state domestic product (GSDP) (Table 5). Between the years 1980-81 and 1996-97 the contribution of forestry and logging to GSDP has gone down in absolute as well as relative terms. The annual decline in the value of forest and logging is 6 per cent, whereas its share in GSDP has been halved in sixteen years. The declining variations across states may be viewed from a negative angle. That is, the incidence of degradation is spreading to more states, which is reflected in the forest revenues. Besides, continuation of the declining trend during 1990s suggests further intensification of degradation process.

TABLE 5. CONTRIBUTION OF FORESTRY AND LOGGING TO GROSS DOMESTIC PRODUCT

(million rupees in constant prices)
(average of three years)

Item (1)	1980-81 (2)	1990-91 (3)	1996-97 (4)
1. Value of forestry and logging	24,095.4	21,409.8	19,822.1
2. As per cent in GSDP	2.17	1.31	1.01
3. Coefficient of variation (in per cent) (across states)	139	120	120
4. Compound growth rate (per cent) (1980-81 to 1996-97)	-	-	-6.02

Source: EPW Research Foundation (1999), *National Accounts Statistics in India 1950-51 to 1996-97*, Third Edition, Mumbai.

Joint Forest Management and Forest Degradation

At this juncture it would be interesting to look at the role of Joint Forest Management (JFM) in improving the conditions of forests in India. JFM was formally introduced in India through a resolution in 1990 to address the problems and constraints of government management of forests (for details, see Saxena, 1999). According to the JFM resolution, the rights of the protecting communities over forest lands are specified. The communities are given rights to collect grasses, lops and tops of branches, non-timber forest produce and a portion of proceeds from the sale of trees when they mature. The share of the community varies from 20 to 100 per cent across the states (Saxena, 1999). Under JFM more than 33,000 committees were formed spreading over 17 states in the country covering about 81,000 square kilometres (sq.km) of forest area accounting for 20 per cent of the total forest cover (Table 6). The extent of coverage of forest area under JFM ranges from 0.2 per cent in Kerala to 95.7 per cent in Haryana. The high proportion of coverage in Haryana is due to marginal area under forest (604 sq. km). The next highest coverage is in Uttara Pradesh (53.8 per cent). JFM is expected to have discerning impact on degraded forests, since JFM is mainly focused on degraded forests to the neglect of dense forests (Saxena and Sarin, 1999). Interestingly, none of the states with better coverage under JFM (above all-India coverage) such as Uttar Pradesh, Andhra Pradesh, Bihar, Madhya Pradesh and Orissa are among the best performers in terms of increasing dense forest area and checking degradation. On the contrary, states like Andhra Pradesh, Bihar and Madhya Pradesh are among the worst performers. This indicates a weak link between JFM and improving the forest conditions. We have also examined the relationship between JFM coverage and the extent of forest degradation by estimating a regression equation. But the coefficient of JFM (per cent of forest area covered under JFM) did not turn out significant though it has a positive sign.[3] This may be due to the limited spread of JFM across the states. Further, there is need to critically evaluate the JFM programme in terms of its impact rather than romanticising the concept. In this context, the following observation on JFM is very apt: "....much of the effort of the *'sympathisers'* of the JFM to date has concentrated on promoting the principles of JFM to the government, NGOs, and local communities. Such promotion may be valuable in the early phases of a programme, but there are potential problems in sustaining it for too long. The nature of promotion results in too much emphasis on positive aspects of the programme and too little critical analysis. At the outset it is important to be able to persuade key actors of the merits of JFM, but it eventually becomes important to temper this with critical appraisal, long-term strategies, and the building of capacity to implement such policies" (Saxena, 1999, p. 25).

TABLE 6. AREA COVERED UNDER JOINT FOREST MANAGEMENT (JFM) ACROSS THE STATES IN INDIA (1999)

	State (1)	Forest cover (sq. km) (2)	Area under JFM (sq. km) (3)	JFM area as per cent of forest cover (4)
1.	Andhra Pradesh	43,290	15,243	35.2
2.	Bihar	26,524	7,192	27.1
3.	Gujarat	12,578	692	05.5
4.	Haryana	604	578	97.5
5.	Himachal Pradesh	12,521	60	0.5
6.	Jammu and Kashmir	20,440	141	0.7
7.	Karnataka	32,403	814	2.5
8.	Kerala	10,334	20	0.2
9.	Madhya Pradesh	1,31,195	38,468	29.3
10.	Orissa	46,941	11,098	23.6
11.	Rajasthan	13,353	1,857	13.9
12.	Tamil Nadu	17,064	458	2.7
13.	Uttar Pradesh	33,994	4,493	53.8
14.	Total	4,09,590	81,303	19.8

Source: Saxena (1999).

V

DETERMINANTS OF FOREST DEGRADATION

Forest degradation is closely liked with human activities and hence can be checked to a large extent provided these linkages are clearly understood. In order to understand the reasons for forest degradation, an attempt is made here to examine the relationship between the extent of forest degradation, on the one hand and socio-economic, demographic, technological, institutional and climatic factors, on the other. This would help us not only in understanding the causes of degradation but also helps us in formulating policies to check degradation in future. For this purpose we have estimated the regression functions across states for the years 1993 and 1999. Here the analysis is limited to the states where the area under forests is above 10 per cent. We have also estimated the functions at the district level using the NRSA data. Though the data sets are not comparable, the latter provides the picture at a disaggregated level. We have tried the linear as well as log-linear estimates, but found that the linear specifications are better in terms of explaining the variations. The following specification is adopted for the purpose:

$$FD_i = f\text{ (Economic, Demographic, Technological, Climatic, Institutional, Social and Market Factors)} + U_i$$

where FD_i is the extent of forest degradation in i-th state or district.

Economic factors include level of poverty, per capita income, area under irrigation, cropping intensity, land productivity, and availability of livestock. Demographic factors include population density and land-man ratio. Technological factors include availability of tractors. Climatic factors include average rainfall. Institutional factors include farm size and availability of institutional credit. Social factors include proportion of scheduled tribe population and literacy level in the rural areas. Rural literacy is also taken as a social development indicator.

Though there are no studies so far on the relationships between the extent of forest degradation and other factors in the Indian context, some of the studies pertaining to Latin America and Africa (Godoy *et al.*, 1997; Rudel and Roper, 1997) help us in formulating the hypotheses theoretically. As mentioned earlier, the literature on the linkages between poverty and forest degradation is rather controversial, though the evidence is more in favor of a weak relationship between these two. Therefore, we expect a non-significant (positive or negative) relationship between poverty and forest degradation. Other economic factors like per capita domestic product, cropping intensity and land productivity are closely linked with irrigation and development. Therefore, the presence of irrigation may have negative or positive impact on degradation. The availability of irrigation leads to concentration of efforts in irrigated and more fertile lands and hence there will be less pressure on forests. On the other hand, high profitability of irrigated farming may prompt farmers to encroach forest lands. The expected impact of these factors could be mixed, whereas the availability of livestock is associated with less irrigated regions. The availability of livestock in the region will be less degrading when compared to tractor. For, tractors make it easier and, perhaps, are economical to cultivate forest lands. On the other hand, livestock grazing may result in degradation of forest lands, though literature is not in favour of this argument.

Population density and land-man ratio represent the demographic factors that are associated with economic development. It is usually expected that population density to be higher and land-man ratio to be lower in the developed regions. In the absence of any *a priori* knowledge in this regard, we intend to test the hypothesis whether demographic pressure leads to forest degradation or not. The nature of technique deployed determines the impact of technological factors. For instance, tractorisation may lead to extensive cultivation practices due to its cost effectiveness as well as time saving nature. Therefore, it is pertinent to test the impact of tractor on forest degradation. Climatic factors, represented by rainfall, indicate the drought-proneness of the region. A strong inverse relationship between rainfall and forest degradation suggests that degradation as a natural phenomenon. Therefore, it needs to be explored whether high rainfall regions are characterised by less degradation of forests. Institutional factors like availability of institutional credit may result in less forest degradation. For, the availability of subsidised credit would result in intensive cultivation practices. It was observed in Latin America that households with loans to repay often resort to off-farm employment and so have less time to clear and cultivate in the forest (Godoy *et al.*, 1997). Forest degradation is likely to be more in the event of small size farms as they are always on the look out for expanding their land base. Besides, small farm families may also depend more on forests to complement their farm incomes. However, this depends on the relative economics of wage labour vis-a-vis forest collection as well as availability of free labour at the household level.

Forest degradation is often linked with the concentration of tribal populations. As in the case of poverty, we expect a weak link between forest degradation and concentration of tribal populations. Education is expected to lower degradation. Higher literacy levels are associated with the adoption of modern farm technologies and out-migration and hence lower pressure on forests. In a household level study it was observed that households with more education clear the forest less as they seem to reap higher crop yields, earn higher income, have fewer children, etc. (Godoy *et al.*, 1997). On the other hand, market penetration is expected to increase degradation. Markets facilitate the interaction of demand and supply and help in realising the economic value of forest products (Reddy, 1999). Therefore, access to markets results in degradation of forests.

Measurement of Variables

Given the above specification, dependent and independent variables are measured in the following manner:

FD_i = Proportion of forest area degraded to the total forest area of the state/ district.

Economic factors: (i) Percentage of gross irrigated area, (ii) Cropping intensity in percentage, (iii) Land productivity in kilograms per hectare (all crops), (iv) Availability of total livestock as well as draught power per hectare, (v) Per capita state domestic product total and from agriculture in rupees per person, (vi) Relative development index at the state and district levels in relation to all-India (India = 100), (vii) proportion of people living below poverty line.

Demographic factors: (i) Population density as number of people per sq. km, (ii) man-land ratio is measured as number of rural population per hectare of net sown area.

Technological Factors: (i) Availability of tractors per thousand hectares

Institutional Factors: (i) Availability of institutional credit per hectare, and (ii) Average farm size in hectares.

Climatic Factors: (i) Average rainfall in millimetres.

Social Factors/ Indicators: (i) Proportion of tribal population to the total population, (ii) Proportion of literate population to total population.

Market Factors: Since it is difficult to measure market penetration, we have used two proxies, namely, (i) urbanisation (percentage of population living in the urban areas) and (ii) road length (number of kilometres of road length per 100 sq. km.

Though all these variables are included in the preliminary analysis, only a few of them find place in the final analysis. In order to eliminate less important variables and avoid multicollinearity problems, we have used the correlation matrices. For checking multicollinearity problem, we have adopted the statistical criteria: if the simple correlation coefficient of two independent variables is greater than the value of multiple 'R', then one of the two correlated variables has to be dropped (Klein, 1962, pp. 64 and 101). However, as long as the multicollinearity between the two variables is not too severe to vitiate the results by affecting the signs of the coefficients, no great caution need be exercised in this regard. Based on the correlation matrices, we have selected the variables for incorporating in the final specifications. A number of permutations and combinations of the selected variables are tried in order to select the good fit in terms of explanatory power and significance of the variables for the final analysis.

Results and Discussion

Analysis was carried out at the state and district levels. The district level analysis was based on the data provided by NRSA covering all the 442 districts in the country.

However, after filtering the data for a comparable data set at the district level, we are left with 360 districts across all the states in country. Though the number of permutations and combinations are run, here we are discussing only the relevant and important specifications due to paucity of space. At the district level, the explanatory power of the specifications is low,[4] though the number of variables turned out significant. The explanatory power of the specifications is reasonably good at the state level, explaining above 30 per cent of the variations (Tables 7 and 7A).

TABLE 7. FACTORS INFLUENCING FOREST DEGRADATION AT THE STATE LEVEL, 1993 AND 1999 (REGRESSION ESTIMATES)

Independent variable	1993	1999	
		Specification I	Specification II
(1)	(2)	(3)	(4)
State level			
1. Intercept	33.97069* (2.62)	52.67738* (3.88)	34.29347* (4.22)
2. Urbanisation	1.119178** (2.18)	1.045375** (2.10)	-
3. Livestock/1000 ha	0.007107*** (1.86)	-	0.008203** (2.04)
4. Relative development index	-0.254281** (-2.04)	-	-
5. Per capita Income	-	-0.003659***(1.99)	-
R^2	0.34	0.24	0.19
N	20	20	20

Note: Figures in parentheses are 't' values. *, ** and *** indicate levels of significance at less than 1, 5 and 10 per cent respectively.

TABLE 7A. FACTORS INFLUENCING FOREST DEGRADATION AT THE DISTRICT LEVEL, 1988-89 (REGRESSION ESTIMATES)

Independent variable	Specification I	Specification II
(1)	(2)	(3)
District level		
1. Intercept	68.645* (5.44)	62.961* (4.61)
2. Per cent irrigation	-	0.290* (1.83)
3. Farm size	-	-
4. Urbanisation	0.739* (2.56)	0.677* (2.40)
5. Length of roads	0.47 (0.54)	-
6. Institutional credit	0.0003 (0.09)	-
7. Rural literacy	-0.869* (3.18)	-0.792* (3.22)
R^2	0.04	0.05
N	360	360

Note: Figures in parentheses are 't' values. *, ** and *** indicate levels of significance at less than 1, 5 and 10 per cent respectively.

All the selected variables at the state level have theoretically expected signs. The estimates are consistent and robust across specifications and between the state and district levels. Three variables turned out significant during 1993 and 1999. While urbanisation and livestock turned out significant in both the years, relative development index turned out significant during 1993 and per capita income turned out significant during 1999. Urbanisation and livestock have a positive impact on forest degradation. This indicates that market penetration enhances the pressure on forests and hence degradation. The positive impact of livestock concentration may be due to the grazing practices. Both the development indicators, namely, relative development index and per capita income have a negative impact on forest degradation indicating that forest degradation is not associated with general economic development.

At the district level also, market factors like urbanisation and road length turned out significant. These two variables have a positive impact on degradation emphasising the state level results. For, the demand for forest products will rise with the process of urbanisation. Irrigation is also positively associated with forest degradation. This could be due to the reason that irrigation enhances the productivity and profitability of land and hence the demand for land (pressure on forests) will be more in the irrigated regions. It is interesting to note that as far as land degradation is concerned irrigated regions have low incidence (Reddy and Behera, 2000). This indicates that as long as extensive cultivation (encroachment of forests and commons) is economical, the farmers try to safeguard their capital stock. In fact, it was observed in Latin America that the farmers clear forests while they keep their own lands as fallows (Godoy *et al.*, 1997). But, if irrigation is a proxy for economic development, its positive impact on degradation goes against the state level findings where economic development is associated with low incidence of degradation.

Rural literacy and institutional credit have revealed negative impact on forest degradation. Literacy and institutional credit turned out to be important policy variables for checking forest degradation. Rural literacy not only improves the awareness of the farmers towards environment but also opens up non-farm income avenues, which will reduce their dependence on common resources like forests. Education also helps in faster adoption of new technologies that enhance agricultural productivity. However, this has to be complemented by the availability of capital. Therefore, the availability of institutional credit would further strengthen the productive potential of agriculture.

VI

IMPLICATIONS FOR POLICY

Forest degradation in India is more of qualitative nature than quantitative in recent years. The area under forests has stabilised, thanks to the success of Joint Forest Management (JFM) programme, but much below the desired level. On the other hand, the extent of forest degradation accounts for half of the forest area. Qualitative decline in forests is reflected in the declining value addition of the forest sector to the economy. While the policies like JFM are effective in stabilising the area under forests, they could not make a dent in checking degradation. Now it is time to formulate policies to check degradation.

Hitherto, policy initiatives in this regard have been of control and command nature, i.e., reserve forests, notified forests, etc. Often these measures make forests privy to certain sections while excluding all others. Even democratic initiatives like

JFM may exclude outsiders and itinerants. Exclusive reliance on coercive policies may not be feasible, especially in the areas with large forests (Rudel and Roper, 1997). Therefore, policies that reduce the desire to depend on forests would be more appropriate and effective. Our analysis brings out clearly that forest degradation is associated with indicators related to development such as relative development index, per capita income, urbanisation, etc. Further, there is some evidence to argue that development checks degradation as hypothesised in the case of 'Environmental Kuznets Curve'.

Our results provide some new directions for policies towards checking forest degradation. Public investment in education, research and extension would go a long way in addressing resource conservation. Apart from being an effective check on forest degradation, level of literacy is directly associated with gross domestic product, indirectly with poverty, population growth, health, etc. After fifty years of planning, enormous funding and promises, total literacy, especially in the rural areas, remains to be a distant dream. Along with low levels of rural literacy, disparities across regions, genders, social groups, etc., are of serious concern. Rural literacy reduces pressure on forests through enhancing farm productivity and diverting the excess rural energies away from forests and other commons. Similarly, strengthening the institutional credit system in the rural areas would further enhance conservation and production to rural people (farm production) and environment (forest production).

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NOTES

1. Forest is defined as an area (within the notified forest boundary) bearing an association predominantly of trees and other vegetation types capable of producing timber and other forest produce. Evergreen forest is described, as a forest comprising thick and dense canopy of all trees, which predominantly remain green throughout the year. It includes both coniferous and tropical broad-leafed evergreen trees. Deciduous forest is described as a forest predominantly comprising deciduous species and where the trees shed their leaves once in a year. Degraded forest is described as a forest where the vegetative (crown) density is less than 40 per cent of the canopy cover. It is the result of both biotic and abiotic influences. Forest blank is described as openings amidst forests without any tree cover. It includes openings of assorted size and shapes as seen on the imagery. Forest plantations are described as an area of trees of species of forestry importance raised on notified forest lands. It includes eucalyptus, casuarina, bamboo, etc. Mangrove is described as a dense thicket or woody aquatic vegetation or forest cover occurring in tidal waters, near estuaries and along the confluence of delta in coastal areas. It includes species of the genera Rhizophora and Avicennia.

2. Thanks are due to C. Siva Sankar Reddy, Chief Conservator of Forests, Andhra Pradesh Forest Department, Government of Andhra Pradesh, for clarifying our confusion in this regard.

3. The estimated equation is: Per cent of area under degraded forest =

$$53.15709^{*} + 0.172498\%\ \text{JFM}.\ R^2 = 0.09;\ N=13.$$

't' values = (8.87) (1.02)

The coefficient did not turn out significant even after dropping the states with low forest cover (less than 10 per cent).

4. We have also estimated the equations by dividing the districts into two groups: one with higher than 20 per cent of the geographical area under forests and the other lower than 20 per cent area under forests. But this neither helped in increasing the explanatory power of the equations nor improved the significance of the independent variables. On the contrary, the number of significant variables has come down.

APPENDIX 1

PROPORTION OF AREA UNDER FOREST COVER, DENSE FORESTS AND OPEN FORESTS ACROSS STATES (1989-99)

State	1989			1991			1993		
	%FA	%DF	%OF	%FA	%DF	%OF	%FA	%DF	%OF
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	17.31	53.30	45.86	17.19	52.90	46.26	17.18	52.92	46.28
Arunachal Pradesh	82.27	78.93	21.07	82.10	79.33	20.67	81.99	79.39	20.61
Assam	33.19	60.20	35.96	31.55	64.01	35.99	31.25	65.28	34.72
Bihar	15.49	49.80	50.20	15.34	49.82	50.18	15.29	49.54	50.46
Goa	34.12	75.00	24.77	33.90	79.36	20.24	32.70	79.79	19.97
Gujarat	05.95	45.06	51.41	06.07	52.27	44.39	06.14	52.32	44.20
Haryana	01.27	23.09	76.91	01.16	64.13	35.87	01.16	64.13	35.87
Himachal Pradesh	24.03	53.08	46.92	21.16	75.65	24.35	22.46	76.51	23.49
Jammu and Kashmir	09.19	53.00	47.00	09.03	54.75	45.25	09.20	53.58	46.42
Karnataka	16.74	77.10	22.90	16.79	77.19	22.81	16.86	76.84	23.16
Kerala	26.11	81.90	18.10	26.48	81.82	18.81	26.60	81.47	18.53
Madhya Pradesh	30.08	68.66	31.34	30.62	70.25	29.75	30.53	70.56	29.44
Maharashtra	14.32	59.41	40.33	14.31	59.42	40.32	14.25	58.55	41.10
Manipur	79.99	28.29	71.71	79.21	30.02	69.98	78.92	30.12	69.88
Meghalaya	69.76	21.84	78.16	70.78	20.82	79.18	70.31	20.96	79.04
Mizoram	86.19	21.36	78.64	89.43	22.70	77.30	88.69	22.67	77.33
Nagaland	86.85	32.27	67.73	86.38	24.66	75.34	86.54	24.30	75.70
Orissa	30.26	58.47	41.12	30.32	57.94	41.65	30.28	57.59	42.00
Punjab	02.31	08.35	91.65	02.67	35.82	64.18	02.67	35.82	64.18
Rajasthan	03.79	22.38	77.62	03.75	23.58	76.42	03.83	27.34	72.66
Sikkim	42.79	77.14	22.86	42.74	79.23	20.77	43.95	76.79	23.21
Tamil Nadu	13.62	55.09	44.65	13.62	55.08	44.65	13.63	53.15	46.73
Tripura	50.81	22.80	77.20	52.78	32.97	67.03	52.81	32.85	67.15
Uttar Pradesh	11.50	66.87	33.13	11.42	67.39	32.61	11.54	67.62	32.38
West Bengal	09.55	39.70	35.18	09.03	42.18	31.38	09.22	41.07	33.04
Union Territory	72.08	84.98	02.65	71.52	85.88	01.78	72.36	85.78	01.93
All-India	19.47	58.97	40.21	19.44	60.23	39.10	19.47	60.24	39.10
C. V.	85.52	44.29	49.26	86.37	37.44	50.12	86.05	37.10	49.33

(*Contd.*)

APPENDIX 1 (*Concld.*)

State	1995			1997			1999		
	%FA	%DF	%OF	%FA	%DF	%OF	%FA	%DF	%OF
(1)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Andhra Pradesh	17.13	52.70	46.49	15.74	53.24	45.87	16.08	54.69	44.41
Arunachal Pradesh	81.94	78.95	21.05	81.92	78.94	21.06	82.21	83.89	16.11
Assam	30.68	65.23	34.77	30.37	65.26	34.74	30.20	61.28	38.72
Bihar	15.28	50.24	49.76	15.25	50.14	49.86	15.23	50.14	49.86
Goa	32.77	79.60	20.16	33.82	79.47	20.13	33.79	79.54	20.06
Gujarat	06.28	51.70	42.71	06.42	50.38	41.74	06.61	49.60	42.45
Haryana	01.36	61.36	38.64	01.37	61.26	38.74	02.18	46.58	53.42
Himachal Pradesh	22.45	76.51	23.49	22.49	76.35	23.65	23.50	69.71	30.29
Jammu and Kashmir	09.19	53.93	46.07	09.20	53.91	46.09	09.20	53.91	46.09
Karnataka	16.88	76.77	23.23	16.89	76.70	23.29	16.93	76.48	23.51
Kerala	26.60	81.80	18.20	26.59	81.81	18.19	26.56	81.65	18.35
Madhya Pradesh	30.48	70.40	29.60	29.59	63.07	36.93	29.73	61.91	38.09
Maharashtra	14.25	58.56	41.09	15.00	51.19	48.54	15.17	57.02	42.75
Manipur	78.64	30.29	69.71	78.01	28.34	71.66	77.86	34.15	65.85
Meghalaya	70.06	25.74	74.26	69.81	25.83	74.17	69.70	37.90	62.10
Mizoram	88.12	23.05	76.95	89.06	23.16	76.84	86.99	20.65	79.35
Nagaland	86.20	24.40	75.60	85.78	24.52	75.48	85.43	36.27	63.73
Orissa	30.25	57.66	41.92	30.15	55.60	43.95	30.21	55.44	44.11
Punjab	02.66	35.84	64.16	02.75	36.84	63.16	02.80	36.61	63.39
Rajasthan	03.88	27.74	72.26	03.90	27.63	72.37	04.05	31.06	68.94
Sikkim	44.07	77.52	22.48	44.10	77.44	22.56	43.94	75.79	24.21
Tamil Nadu	13.66	53.01	46.87	13.12	50.84	49.03	13.13	50.70	49.17
Tripura	52.81	32.85	67.15	52.89	32.80	67.20	54.79	38.78	61.22
Uttar Pradesh	11.54	67.58	32.42	11.55	67.54	32.46	11.55	67.33	32.67
West Bengal	09.32	41.84	32.55	09.41	42.60	31.97	09.42	42.63	31.95
Union Territory	72.29	85.39	02.31	82.47	85.41	02.25	82.37	85.44	02.20
All-India	19.46	60.31	38.98	19.27	57.98	41.26	19.38	59.22	40.02
C. V.	85.89	35.44	47.85	86.83	36.46	47.72	86.10	29.78	46.36

Source: State of Forest Reports, Ministry of Environment and Forests, Government of India, New Delhi (various issues).

Notes: % FA= Proportion of forest area to total geographical area; % DA= Proportion of dense forest area (> 40 per cent crown density) to total forest area; % OF = Proportion of open forest area (10 - 40 per cent crown density) to total forest area.

C. V. = Coefficient of variation in percentage.

APPENDIX 2

CLASSIFICATION OF FOREST AREA ACROSS STATES, 1988-89 (NRSA)

State (1)	Per cent of evergreen forests (2)	Per cent of deciduous forests (3)	Per cent of forest plantation (4)	Total forest area (ha) (5)
Andhra Pradesh	0.009	58.268	3.258	60,37,324
Arunachal Pradesh	83.452	0.353	0.373	69,35,087
Assam	56.732	26.282	4.603	17,26,387
Bihar	1.088	41.786	3.248	26,67,876
Goa	37.678	56.933	3.068	2,10,886
Gujarat	0.000	39.233	0.000	11,21,768
Haryana	0.000	36.458	0.000	68,234
Himachal Pradesh	87.476	0.000	0.290	14,64,494
Jammu and Kashmir	71.71	1.940	0.33	13,06,461
Karnataka	44.868	24.613	4.861	33,27,727
Kerala	29.576	43.289	17.499	9,49,681
Madhya Pradesh	0.000	84.119	0.405	1,42,54,034
Maharashtra	2.531	54.279	0.558	52,96,196
Manipur	4.149	77.405	0.000	14,14,078
Meghalaya	26.926	56.198	0.000	14,24,983
Mizoram	20.910	0.000	0.000	20,07,956
Nagaland	17.716	33.310	0.082	11,42,184
Orissa	0.000	83.725	0.846	45,95,295
Punjab	0.000	57.802	3.244	1,83,900
Rajasthan	0.000	45.552	0.541	22,53,718
Sikkim	77.428	0.000	0.000	2,80,456
Tamil Nadu	9.103	28.739	9.097	16,13,828
Tripura	1.970	34.063	1.937	3,80,652
Uttar Pradesh	46.564	35.208	1.526	34,84,012
West Bengal	1.536	36.200	2.269	8,08,107
Union Territories	0.000	83.220	2.231	7,55,491

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