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**ESTIMATION AND FORECAST OF WOOD DEMAND AND
SUPPLY IN TAMILANDU**

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Estimation and Forecast of Wood Demand and Supply in Tamilandu

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Preface

This 'wood Balance' study was undertaken by Madras School of Economics, Chennai at the request of State Forest Research Institute, Tamil Nadu. The project team would like to thank Thiru C.K. Sreedharan, I.F.S., then Principal Chief Conservator of Forests (PCCF), Tamil Nadu; Prof. M. Naganathan, then Vice-Chairman State Planning Commission (SPC) of Tamil Nadu; Thiru R.K. Ojha, I.F.S., then Chief Conservator of Forests (Research) for their support and encouragement. The authors would also like to thank K. Arulmozhi, then Principal Secretary/Member Secretary, SPC; Dr. G. Kumaravel, then Full Time Member, SPC; Thiru K. Lakshmikanthan Bharathi, then Member, SPC and Ms. Jayanthi Murali for their inputs during several meetings and discussions. Thiru V. Irulandi, I.F.S., Thiru Jainaluddin and other staff at SFRI have provided continuous support for the successful completion of the project work. Though the project was completed during 2008-09, the State Planning Commission gave its final approval in November 2010 and uploaded on its website in March 2012.

Numerous people have helped in gathering, collating and entering the vast amount of data that went into the preparation of this report. The project team would like to thank all of them, in particular District Forest Officers and Forest Rangers in collecting the primary survey data in eleven districts of Tamil Nadu, Thiru Kripananda Swamy of Chennai Port, Thiru Muthu of Tuticorin Port and Thiru K. Baskaran.

Mr. T.R. Prabhakaran and Ms. E. Kalaivani have worked as project associates at various stages of the work while Mr. S. Raju has been instrumental in analyzing the primary data. The authors would like place on record their deep appreciation for the dedicated contribution of all the project associates.

The project team would like to acknowledge support provided by the Director and Administrative Officer of MSE in facilitating smooth conduct of the project.

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EXECUTIVE SUMMARY

Wood balance study was last conducted for Tamil Nadu in the early 1980s – with exclusive focus on fuel-wood. The present study – in line with some of the best studies in the field such as the one conducted recently by Kerala Forest Research Institute – was carried out by Madras School of Economics at the request of State Forest Research Institute.

Envisaging that wood demand in the form of fuel-wood and timber would arise at the household, industrial and service sector levels, the study assessed the total wood demand in Tamil Nadu for the year 2008. A comprehensive primary survey was carried out with the help of the State Forest Department to assess the wood demand at various levels. The primary survey covered ten districts spread over the seven agro-climatic zones of Tamil Nadu. Given its diverse and intensive wood usage, Chennai has been separately surveyed. In all about 3500 households and 450 small-scale industrial units and service providers have been surveyed to assess fuel-wood and timber demand.

Overall wood demand in Tamil Nadu for the year 2008 is estimated as 28.5 million cu.m., with fuel-wood demand constituting about 82 percent of the total demand. Households contribute 77 percent of the total demand, followed by industrial sector (16 percent) and service sector (6.4 percent).

The timber supply is mainly through trees-outside-forests, followed by farm-forestry, imports and other sources (including transfers from other states). The main source for fuel-wood on the other hand is attributed as 'other sources' indicating that the supply chain of fuel-wood is fairly complex. Trees-outside-forests are estimated to contribute about 41 percent of the total fuel-wood supply.

Overall Demand for Wood in Tamil Nadu – 2008

(in million cu.m.)

Sector	Wood Demand		Total
	Fuel-wood	Timber	
Household	19.73 (84.5)	2.288 (44.6)	22.02 (77.3)
Industry	2.08 (8.9)	2.553 (49.7)	4.63 (16.3)
Services	1.54 (6.6)	0.292 (5.7)	1.83 (6.4)
Total	23.35 (100)	5.133 (100)	28.48 (100)

Note: The figures in brackets are percentages.

Overall Supply of Wood in Tamil Nadu – 2008

(in million cu.m.)

Supply Source	Fuel-wood	Timber	Total
Forests	0.42 (1.8)	0.07 (1.3)	0.49 (1.7)
Trees-outside-Forests	9.55 (40.9)	2.37 (46.2)	11.92 (41.8)
Farm-Forestry	0.89 (3.8)	1.13 (21.9)	2.02 (7.1)
Imports	0 (0)	0.97 (19.0)	0.97 (3.4)
Other Sources	12.49 (53.5)	0.59 (11.5)	13.08 (45.9)
Total	23.35 (100)	5.13 (100)	28.48 (100)

Note: The figures in brackets are percentages.

With regard to the supply-demand gap, the main cause of concern appears to be the high fuel-wood demand in Tamil Nadu. The study presents a few scenarios of future demand for fuel-wood (for the year 2013) and timber (for the years 2013 and 2018). The total demand for fuel-wood under various scenarios would vary between 15.17 to 23.22 million cu.m. by 2013. Household sector, which presently contributes to about 84.5 percent of the total fuel-wood demand, continues to dominate with its contribution ranging between 70 to 80 percent by 2013. The total demand for timber under various scenarios would vary between 5.4 to 6.5 million cu.m. by 2013 and between 5.7 and 7.7 million cu.m. by 2018.

The study further recommends action plan to be followed by the Forest Department. In case of fuel-wood, rapid urbanization and accelerated decrease in the per-capita fuel-wood consumption will enable the state to bridge the supply-demand gap in future. However, the evidence from the last decade has not been very encouraging with regard to decline in fuel-wood consumption due to lack of access to transition fuels such as kerosene. In addition, the study argues that fuel-wood shortage could be effectively addressed by utilizing significant amount of land under cultivable wasteland and fallow land categories.

Finances for cultivating bushy vegetation for fuel-wood purposes could be explored through the Clean Development Mechanism of the Kyoto Protocol due to carbon-neutral nature of fuel-wood. However, greenhouse gas contribution and health burden are likely to be high with fuel-wood given the inefficient combustion processes that marks the usage of these fuels. Hence an integrated effort involving the departments of environment, forests, and health is needed to ensure realization of

multiple goals of greenhouse gas reduction, reducing health burden and bridging the supply-demand gap of fuel-wood.

In case of timber, the economic viability of tree plantation should be highlighted by the Forest Department. For financing purposes the scope of using the Clean Development Mechanism should be widely publicized. The Department should thus adopt the role of facilitator of information and as knowledge source in its efforts to bridge the supply-demand gap. Public investment to encourage research on alternate materials instead of wood particularly in the construction and transportation sector should be a high priority.

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Chapter 1

INTRODUCTION

Context of the Study

As the economy of a country grows, the needs of its population also increase and diversify. Growing income of a large population would increase the wood demand significantly. The demand for wood at household level could transform from fuel needs to life-style based needs including construction and furniture needs. Further, the demand from industrial sector could also transform from traditional (e.g., paper and pulp) to modern forms (e.g., sports goods). The supply of wood could also transform from traditional sources, namely forests, to plantations and agro-forestry, and imports in an increasingly liberalized global economy. To clearly understand the existing and future gap between supply and demand for wood and to design pro-active intervention policies to reduce the gap, the wood-balance studies could be extremely useful. Absence of such studies could mislead the policy interventions.

Tamil Nadu (TN) with growing and vibrant economy fits the above description and presents a case for carrying out a detailed wood balance study. Given that there has not been a proper study of such kind in the past two decades further reinforces the need for the study. It is against this backdrop that the present study is undertaken by Madras School of Economics in June 2008. The study had the following main objectives:

- To assess current and future demand and supply of wood in Tamil Nadu in an attempt to identify the supply-demand gap and suggest options for policy intervention.
- To analyze changing structure of household fuel-mix in Tamil Nadu and assess the role of fuel-wood in the household fuel-mix.

The study depended on both secondary and primary sources of data for meeting these objectives and the report is structured as follows: The rest of this Chapter discusses the relevant literature on the wood balance studies in India. The second Chapter provides a brief overview of the wood situation in Tamil Nadu and the third Chapter outlines the approach and data sources. The fourth Chapter discusses the demand for fuel-wood and timber in the household, industrial and service sectors, along with the demand originating from exports. The fifth Chapter discusses the supply scenario of fuel-wood and timber in Tamil Nadu by focusing on forests, plantation and agro-forestry, and imports from other countries and other states of India. The sixth

Chapter then compares the supply and demand of wood in Tamil Nadu to assess the gap between the two at present and in future. Finally, the last Chapter concludes with policy recommendations.

Literature Review

A wood-balance study is aimed to assess quantities of wood supply, demand and the net balance of trade. Several such studies have been carried out in the past in several states in India as discussed below. Table 1 provides an overview of such studies. It may be noted that some of these studies have not been carried out with specific aim of assessing wood balance.

- a) Wood balance study of Andhra Pradesh (2001) – conducted by Institute of Wood Sciences and Technology, Bangalore during the year 2000, sponsored by Andhra Pradesh Forest Department, the main objectives of the study were to estimate the present and future consumption and possible sources of production of fuel-wood, timber, pulpwood, poles and bamboo.
- b) Gujarat wood balance study (1984) – carried out by Gujarat Forest Department to estimate the current consumption and supply of wood, mainly in the form of fuel-wood, poles and timber, from different sources and to make future projections.
- c) Wood balance study of Haryana (1988) – conducted by National Council of Applied Economic Research, New Delhi at the request of the Government of Haryana, for the reference year 1985-86.
- d) Demand and supply of fuel-wood in Karnataka (1993) – carried out by Indian Institute of Management, Bangalore, at the request of Karnataka Forest Department in 1986-87, mainly to assess the supply and demand balance of fuel-wood in Karnataka state and also to examine the influence of fuel-wood demand on deforestation.
- e) Wood balance study of Kerala (1990 and 2005) – carried out by the Kerala Forest Research Institute at the request of Kerala Forest Department. The first study published in 1990 was carried out during 1987-1989, while the second one published in 2005 was carried out in early 2000s. Besides demand and supply of wood in Kerala, the studies (especially the second one) also focused on fuel consumption pattern and contribution of fuel-wood in the fuel-mix in the household sector.

Table 1: State-level Studies on Wood Balance / Fuel-wood Assessment

State	Name of the agency/author	Year of the study	Remarks
Andhra Pradesh	IWST/ICFRE	2001	Wood Balance Study Based on primary data from a field survey in 2000
Gujarat	Forest Dept.	1985	Wood Balance Study Based on primary data from a field survey in 1984
Haryana	NCAER	1988	Wood Balance Study Based on primary data from a field survey in 1985.1986
Himachal Pradesh	HPU Shmla/ Singh et al.	1994	Wood Balance Study Based on primary data from a field survey of rural areas in 1989-1990
Jammu & Kashmir	DES	1987	Wood Balance Study Based on primary data from a field survey of rural areas in 1986
Karnataka	IIMB	1993	Fuel Wood Assessment Based on primary data from a field survey in 1986.1987
Kerala	KFRI	1989; 2005	Wood Balance Study Based on primary data from a field survey in 1987.1988 (1989 report); field survey in 2001 (2005 report)
Orissa	ORG	1989	Wood Balance Study Based on primary data from a field survey in 1989
Tamilnadu	Statistics Dept	1985	Fuel Wood Assessment – Rural Areas Based on primary data from a field survey of rural areas in 1984
West Bengal	Forest Dept	1987	Wood Balance Study Based on primary data from a field survey in 1984-1985

Source: Pandey (2002); various Forest Research Institute reports.

- f) Wood balance study of Orissa (2000) – conducted by Operations Research Group, Bhubaneswar, under the sponsorship of the Directorate of Social Forestry Project, Orissa Forest Department in 1989. The objective of the study was to estimate the current consumption and availability of fuel-wood and timber in different sectors of Orissa state and make projections for the year 2000, keeping in mind the

consumption trend and plantation, afforestation and regeneration programmes pursued in the state.

- g) Fuel-wood in rural households of Tamilnadu (1985) – carried out by the Department of Statistics, Tamilnadu at the request of the Social Forestry wing of the Tamilnadu Forest Department, with an objective to estimate the total consumption as well as patterns by fuel-wood type in the rural household sector of Tamilnadu through different sources, and to assess the extent of fuel-wood scarcity. The per-capita biofuel consumption by the rural households is estimated to vary between 148 to 422 kg across different districts of Tamil Nadu. Fuel-wood contributed to about 70 percent of the biofuel consumption in the state. Of the fuel-wood sourced from forests and other trees, largest proportion came from *Prosopis* species and the study estimated that most of it is freely collected. Besides *Prosopis*, *Acacia* and *Casuarina* also contributed to the fuel-wood in Tamil Nadu.

Barring few exceptions (for example, Wood Balance Study of Kerala, 2005), most of the wood balance studies have provided static picture of the supply-demand gap. However, for policy purposes it would be helpful if the analysis extends to include future supply-demand patterns also. Further, available evidence suggests that a large proportion of population, especially in rural areas, continues to depend on fuel-wood for cooking. Such dependence not only exasperates the supply demand gap in the overall wood scenario, but also poses significant indoor pollution and human health problems. Hence it is important to learn about the factors influencing the demand for fuel-wood and devise intervention strategies. The present study aims to address some of these issues by focusing on Tamil Nadu.

Chapter 2

WOOD SITUATION IN TAMIL NADU

Tamil Nadu (TN, henceforth) is spread over 1,30,058 sq.km. area and accounts for about four percent of total area of India. The topography of TN broadly consists of coastal plains in the east, uplands and hills in the western part, with plains accounting for more than half of the state's area. Study of the land-use classification in TN over years reveals that agriculture and forests account for more than 50 percent of land use, with agricultural land registering a decline from 61 percent in 1970s to about 46 percent in 2002-03, and that under forests showing almost stable percentage of the total area. However, it may be noted that while the area officially recorded as forests may not have changed, the actual tree cover could have changed in the state over the years. Such changes in tree cover will have significant implications for the wood supply in the state.

Within the state, Dharmapuri district ranks first with a forest cover of 3.66 lakh hectares (about 17 percent of total forest area of the state). This is followed by Erode district with a forest cover about 2.28 lakh hectares. The districts Dharmapuri, Erode, Vellore, Coimbatore, Thiruvannamalai, The Nilgiris, Dindigul, Salem, Tirunelveli and Theni account for almost 80 percent of the total forest area in TN.

Forest Area

For administrative purposes, forest area is divided into reserve forests, protected forests and unclassified forest area. The Forest Department has exclusive control on the reserve forests and it is also responsible for its management. The protected forests are managed by the Forest Department, but could be accessed by the people, especially for gathering produce of trees. The unclassified forest area, while very small in area, provides further access to the produce from the trees on the land. However, in most cases these are totally barren and unproductive lands and hence may not provide much scope for collection of forest produce, including wood. Table 2 provides district-wise forest area under these three categories in Tamil Nadu.

Following Supreme Court ban on felling of trees in 1996, Tamil Nadu was among the first states in the country to strictly implement the order. In principle only dead or wind fallen trees are sent to the forest depots and sold in public auction. Further, the teak trees cultivated along the canal banks in Thanjavur district, after they attain age of

30 years, are extracted and sold in auction. Similarly, the industries using pulpwood receive pulpwood from the plantations raised in Kodaikanal and Nilgiris plantations.

Table 2: District-wise Forest Area by Ownership Status

(in Sq. Km.)

Sl. No.	District Name	Reserve Forest	Protected Forest	Unclassified Forest	Total Forest
1	Chennai	120.2	21.1	0.7	142.0
2	Nagapattinam	130.3	5.8	13.3	149.4
3	Kancheepuram	128.1	23.1	0.8	152.0
4	Tiruvallur	140.2	24.0	0.8	165.0
5	Tiruvarur	153.1	6.4	13.4	172.9
6	Ramanathapuram	125.1	15.1	34.4	174.6
7	Cuddalore	155.5	6.2	13.2	174.8
8	Thanjavur	168.3	7.1	12.2	187.6
9	Perambalur	170.5	7.0	13.7	191.2
10	Tiruchirapalli	172.5	6.2	15.2	193.9
11	Thoothukudi	145.8	21.1	29.1	196.0
12	Pudukottai	178.2	7.2	12.7	198.1
13	Sivaganga	180.0	24.1	37.6	241.7
14	Virudhunagar	200.1	27.4	32.7	260.2
15	Kanyakumari	409.1	4.1	25.2	438.3
16	Karur	583.0	102.1	0.0	685.2
17	Theni	324.2	270.1	93.5	687.8
18	Dindigul	630.1	135.2	0.1	765.3
19	Madurai	420.5	310.1	104.5	835.1
20	Namakkal	920.2	6.1	3.6	929.8
21	Villupuram	980.1	175.0	148.4	1303.5
22	Tirunelveli	1205.7	234.9	26.3	1466.8
23	The Nilgiris	1368.1	55.1	82.2	1505.4
24	Erode	1520.5	8.5	5.4	1534.4
25	Krishnagiri	1187.1	213.0	160.2	1560.3
26	Vellore	1460.3	28.1	78.1	1566.5
27	Salem	1433.3	192.5	9.1	1634.8
28	Coimbatore	1557.5	40.1	70.6	1668.1
29	Tiruvannamalai	1640.3	24.4	83.1	1747.8
30	Dharmapuri	1569.2	250.1	186.4	2005.6
	Total	19376.8	2250.9	1306.1	22933.8

Source: Joseph (2006).

Fuel-wood collection however could be taking place from all forest areas, even though there is no clear evidence about the same. This could be due to the fact that, the

rural population still depends to a large extent on fuel-wood for cooking. Besides income and access to alternative fuels, one of the main factors influencing the household's choice of fuel-wood for cooking is proximity to the forest land.

Forest Cover

Forest cover, on the other hand provides a different classification of forests. Forest Survey of India distinguishes forests as dense, moderately dense, and open forests depending on the crown cover. Forest Survey of India provides periodically district-wise forest cover in all states of India, including Tamil Nadu. The assessment is available for the years 1997, 2001, 2003 and 2005. Since the district classification has changed in 2001 in Tamil Nadu, for consistency the assessment from 2001 to 2005 is used here to analyse the changing pattern of forest cover across the districts of Tamil Nadu.

Based on the total forest cover area (averaged over the three years mentioned above), districts are classified into three categories: below the state average, close to state average and above the state average. Table 3 shows the district-wise percentage area (as percentage of total geographic area of the district) under dense and open forest categories over the three assessment years. Figures 1, 2 and 3 show the changing trends of forest cover under dense and open forest categories across the three district classifications.

Access to forests for collection of forest produce to some extent depends on the nature of forest – dense or open. Keeping this in mind, the selection of districts for primary survey (described below in section 3) is based on the forest cover and the changing trend of forest cover.

Table 3: District-wise Forest Cover in Tamil Nadu

(in percentage of district geographic area)

District	Dense Forest			Open Forest		
	2001	2003	2005	2001	2003	2005
Districts with below state average forest cover						
Thanjavur	1.4	1.8	1.8	0.7	2.0	2.2
Chennai	0.7	2.1	2.1	2.8	2.1	2.1
Pudukkottai	2.1	1.7	2.1	2.7	3.4	3.1
Kancheepuram	6.6	2.4	2.4	2.3	6.1	6.1
Ramanathapuram	3.8	2.4	2.4	1.3	3.2	3.2
Perambalur	4.3	3.6	3.8	2.6	3.8	4.3
Sivaganga	8.7	4.1	4.4	3.1	7.6	7.3
Virudhunagar	4.9	4.5	4.5	2.4	3.2	3.1
Cuddalore	6.2	5.0	4.8	4.5	6.7	6.7
Tiruchirapalli	6.1	4.9	5.1	2.2	3.8	4.5
Madurai	6.5	5.3	5.3	5.6	7.1	7.4
Districts with close to state average forest cover						
Villupuram	9.1	6.4	6.4	6.1	8.3	8.0
Namakkal	10.1	9.8	9.8	5.1	6.4	6.1
Tiruvannamalai	13.8	10.4	10.5	5.4	10.9	12.0
Salem	10.6	11.4	11.4	10.4	10.3	10.5
Tirunelveli	11.4	11.0	12.5	4.0	5.1	4.3
Districts with above state average forest cover						
Vellore	16.2	12.7	12.8	7.8	15.1	15.5
Dharampuri	11.3	12.9	12.9	16.7	17.8	17.8
Dindigul	13.1	13.0	15.6	7.8	9.7	7.1
Coimbatore	14.4	16.6	16.6	9.6	7.6	7.6
Theni	13.0	17.9	17.8	13.2	12.2	13.1
Erode	13.6	18.9	18.9	12.6	8.3	8.3
Kanniyakumari	21.6	19.7	27.3	8.4	12.1	12.2
The Nilgiris	41.9	50.3	50.3	37.5	31.0	31.0
Average of the Districts						
All Districts	9.6	9.2	9.6	6.9	8.2	8.2

Source: FSI (2001, 2003, 2005).

Figure 1: Trends in Forest Cover – Districts with below State Average Forest Cover

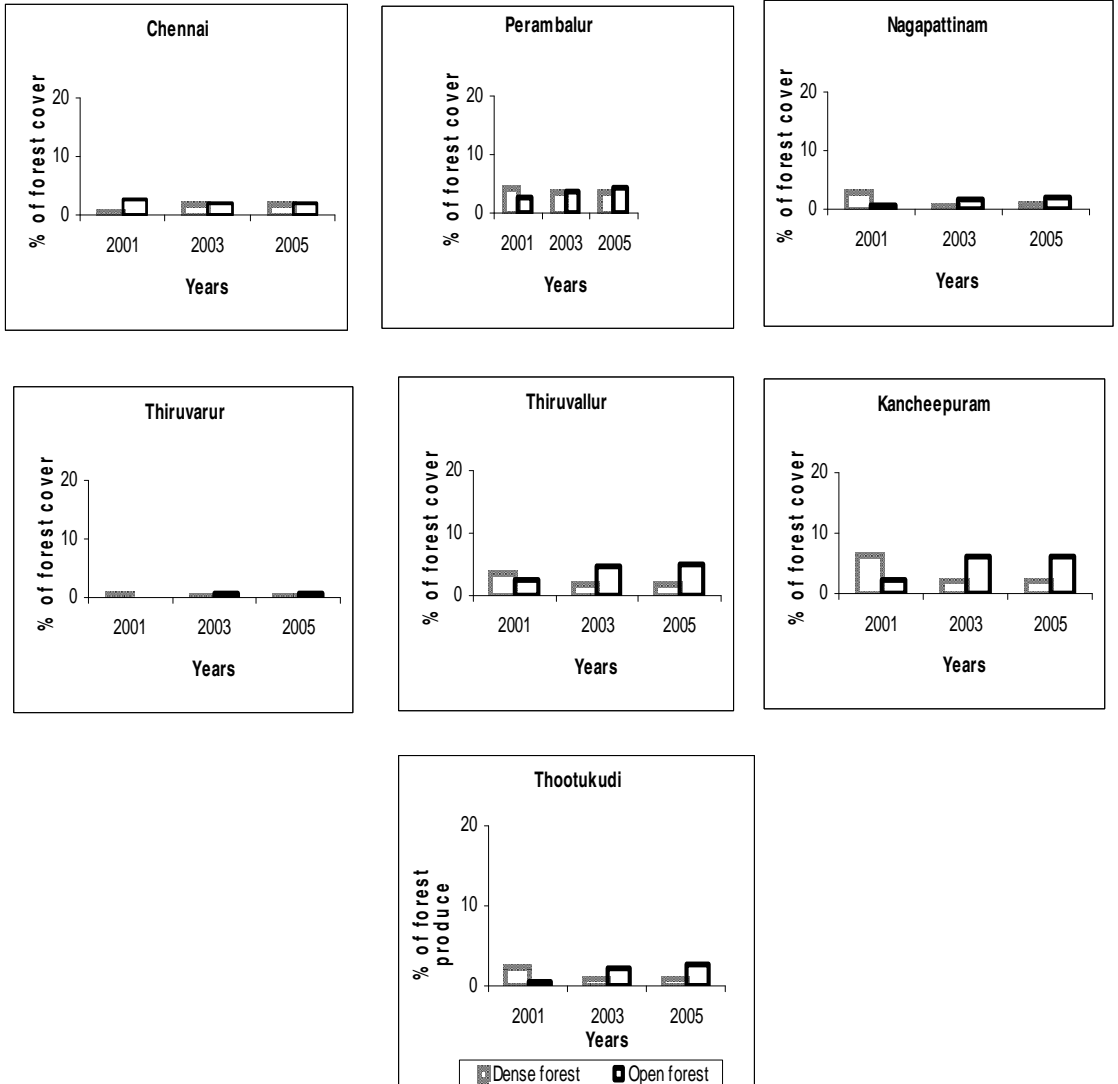


Figure 1: Trends in Forest Cover – Districts with below State Average Forest Cover (contd.)

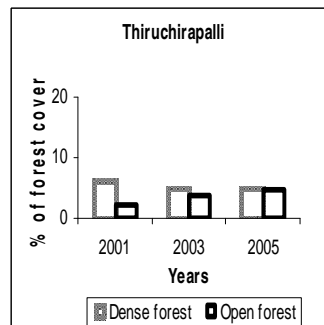
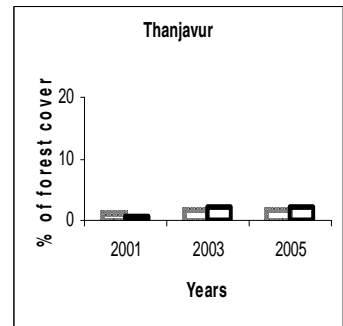
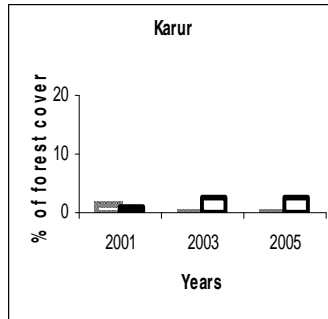
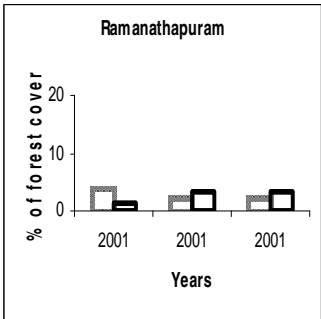
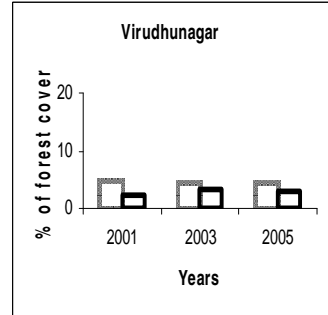
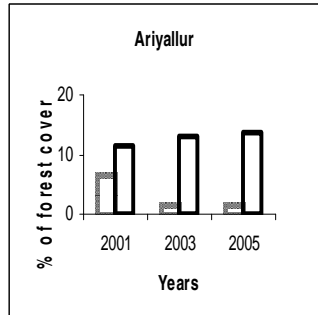
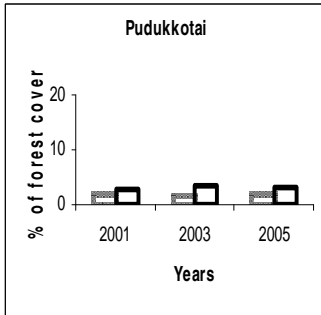


Figure 2: Trends in Forest Cover – Districts with close to State Average Forest Cover

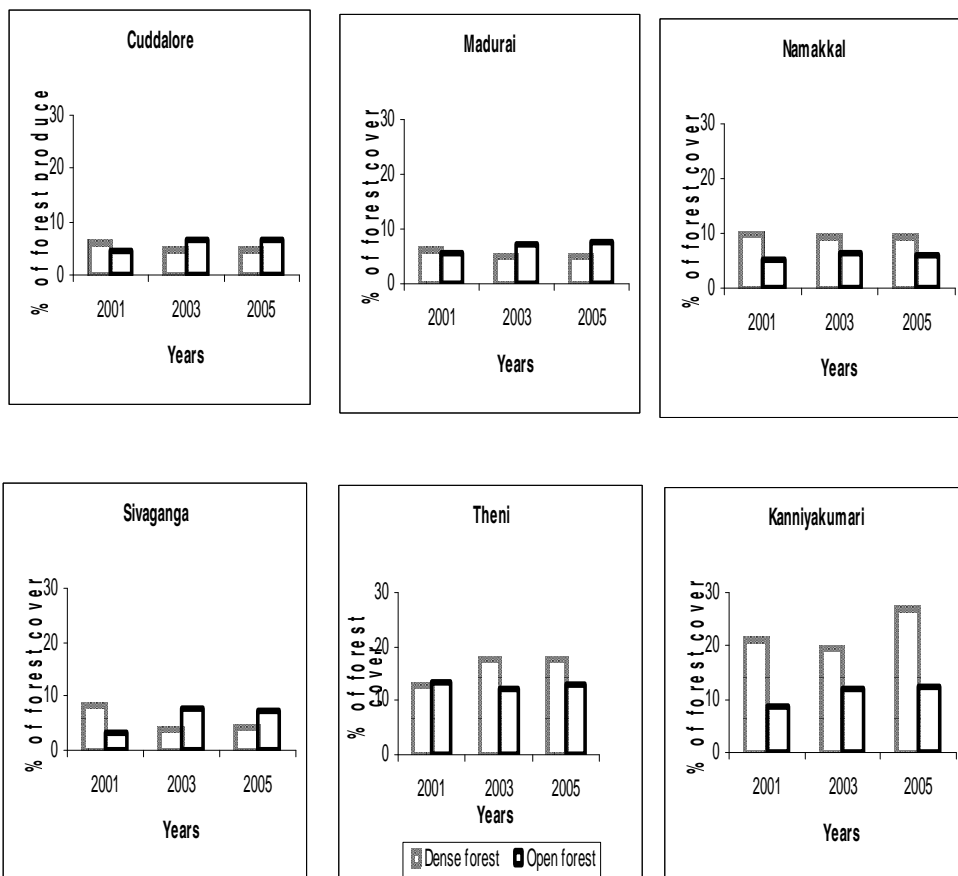
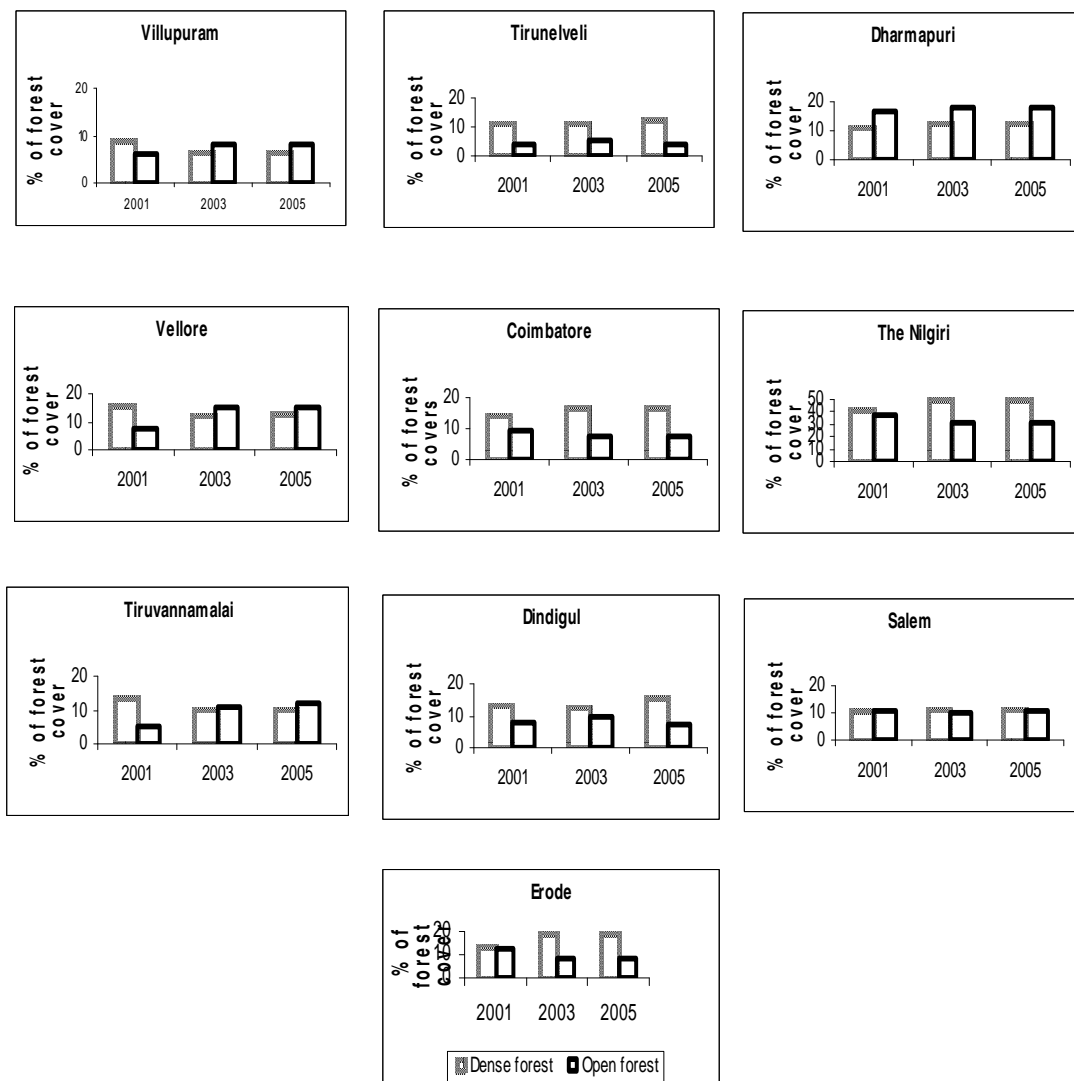


Figure 3. Trends in Forest Cover – Districts with above State Average Forest Cover



Forest Output

As mentioned above felling of trees not in private land is not permitted in Tamil Nadu since 1996. However, wherever timber could be extracted from wind-fallen or dead trees, it is transferred to the government depots for auction. Similarly, there are other dedicated forest areas for producing other major forest products. Table 4 provides an overview of the major forest produce in Tamil Nadu as per official statistics for the years 2000-01 to 2006-07, and figure 4 shows the changing trend in the production of each product graphically. With the exception of fuel-wood (and Babul), all other forest produce show declining trend in the recent years. The trend over the previous decade is further erratic indicating the fluctuating nature of the primary source of wood in Tamil Nadu which needs to be contrasted against the steadily increasing demand for wood.

Table 4: Outturn of Forest Produce in Tamil Nadu: 2000 to 2006

Major Forest Produce	Unit	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Timber	M.T.	194.258	1497.602	3906.884	6033.92	7421.24	7748.877	6410.749
Teak Poles	Nos.		2174	5042	32	1769.87	9488	
Pulpwood	M.T.	6560	3595.787	1782.87	15797	100020.1	93393.59	29593.13
Fuel-wood	M.T.	45176	11925.225	16845.08	31011.27	17057.46	20548.53	63104.5
Sandalwood (Heartwood)	M.T.	1477	920	1225	210.5	344.078	332.336	616.025
Sandalwood (Sapwood)	M.T.	51	325	726.325	311	91.9	94.3	96.99
Wattle Bark	M.T.	463	247.012	664.878	2500	4847.143	3439.15	445.732
Babul	M.T.		107434.6	98172.59	93591.13	89331.12	48148.97	80029.44

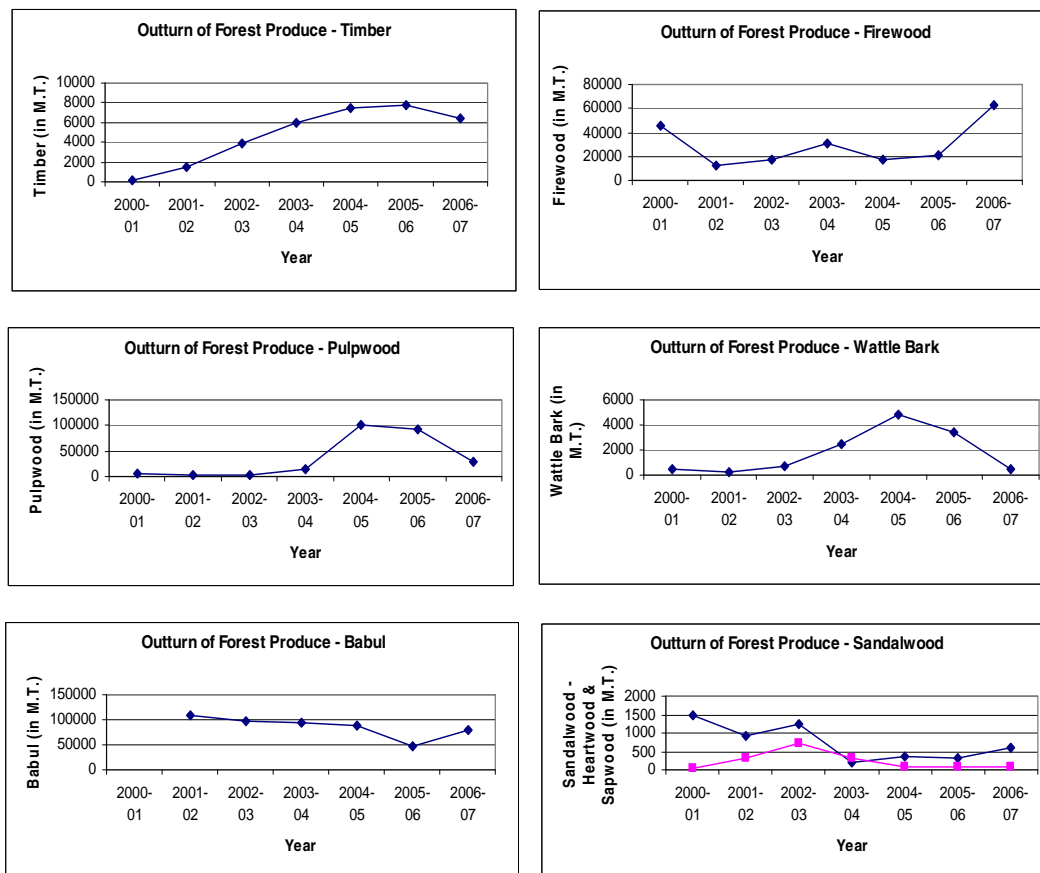
M.T. – metric tones; Nos. - numbers

Source: Various issues of Statistical Handbook of Tamil Nadu.

Demand for wood arises in the form of fuel-wood and timber. The per capita consumption of fuel-wood in rural Tamil Nadu was estimated as 172 and 166 kg, respectively in rural and urban areas in 1978-79 by a national level study published by NCAER in 1985. Percentage contribution of fuel-wood and chips in the household fuel expenditure was estimated as 91.3 and 42.9 percent in rural and urban areas, respectively in 1993-94. This estimate is based on NSSO household level data (NSSO, 1997). In 1999-2000, the corresponding figures were reported as 85.9 and 23.3 percent (NSSO, 2001).

In a state level study of household fuelwood consumption, the statistics department of the Tamil Nadu government estimated the per-capita annual consumption of biofuels to vary between 148 and 422 kg across different districts. In the average annual per-capita bio-fuel consumption in the state (of 271 kg), fuelwood was estimated to contribute about 70 percent (cited in Pandey, 2002).

Figure 4: Trends in Outturn of Forest Produce in Tamil Nadu



Besides the household sector, wood is primarily used for industrial purposes. Two main forest produce are used by industry as raw material in Tamil Nadu. These include pulpwood and wattle bark. The statistical handbook of the Tamil Nadu government provides details about the industries using the forest products every year; however it remained more or less same over the years. Table 5 provides the information from the latest statistical hand book (2006-07).

The two major mills using pulpwood in Tamil Nadu, M/s Seshasayee Papers and Board Limited and M/s Tamil Nadu Newsprint and Papers Limited, obtain pulpwood from TAF CORN – Tamil Nadu Forest Plantation Corporation Limited. TAF CORN manage a 45000 hectare estate of Eucalyptus tereticornis and Eucalyptus camadulensis. TAF CORN

supplies its two customers approximately 100,000 tons per annum. The TAF CORN estate is managed on a seven year rotation – producing on average 10 tons per hectare.

Table 5: Industries Using Forest Produce in Tamil Nadu

Product	No. of Units	Name of the Industry	Remarks
Paper and Board	2	M/s. Seshasayee Paper and Board Ltd.	Pulpwood supplied till 2006-07, but not allotted in 2006-07
		M/s. Tamilnadu Newsprint & Papers Ltd	Continues to get pulpwood; 63559 MT pulpwood allotted in 2006-07
Rayon and staple fibre	-	-	Not allotted in the recent years
Tanning	6	New Wattle Bark Company, Mettupalayam	Use Wattle Bark for tanning purpose; the list has not changed over the years
		Siva Tan, Erode	
		St. Joseph's Euc. Oil Company, Ooty	
		M. Razak Rawther sons, Dindigul	
		Tan Extract chemicals, Komarapalayam	
		Hariharan Timber and Fuel-wood Department, Coonor	

Source: Various issues of Statistical Handbook of Tamil Nadu

Forest Management

Owing to increasing population and raising demands, wood consumption from forests has increased over years leading to formulation of strategies to encourage planting of timber species in private lands. Similar efforts are also on by the Forest Department to meet the increasing fuel-wood demands. Some of the schemes of TN Forest Department in this regard include:

Production Forestry: To meet the requirement of timber and forest produce by the local people, large scale planting of primary and secondary timber species on forest lands, poramboke lands and canal bunds, as well as encouraging planting of timber species by public in private lands.

Extension Forestry: Forest extension activities are undertaken in all districts through Forest Extension Centres. Such centres aim at disseminating tree growing knowledge to farmers with a concept of 'forests to farm lands'.

Community Forestry: To increase the green cover in the state, this scheme plants trees in private and community lands. Individual and/or institutional landowners having interest in growing trees will be targeted under this scheme.

Besides these several other programs targeting specific species are also initiated in the state. *Jatropha curcas* project, for instance, aims at raising *jatropha curcas* demonstration plants in 115 joint forest management committee villages covering 460 ha. over a period of three years 2004-05 to 2006-07.

Several corporations in the state help in commercial sale of the forest output. Some of these corporations are: (a) Tamilnadu Forest Plantation Corporation – to raise, maintain and harvest pulpwood and cashew to meet the needs of industries and to supply fuel-wood to meet the fuel-wood needs of the public; (b) Arasu Rubber Corporation Limited, Nagercoil – to plant, maintain and harvest rubber plantation in land taken on lease from the Forest Department in Kanyakumari district, to meet the rubber industry demands.

Over the years several initiatives have also been taken by the state government to boost the forest area and forest cover. Joseph (2006) provides an overview (shown in Table 6) of the forest management over the past 100 years. Forest management acquires significance in Tamil Nadu due to several factors including, below the norm forest area, growing demand and declining resource base. The management options explored over the years changed significantly in content as well as style.

More recent prescriptions for forest management revolve around multiple objectives of environmental protection, resource utilization in line with the National Forest Policy, and ensuring regional/national security. Consideration of Joint Forest Management as an option appears to provide a welcome change from top-down management style. As against the traditional approach wherein human dependence on forests is systemically overlooked, Joint Forest Management accepts upfront the need for coexistence of human-beings in the forest eco-systems. More than anything else, perhaps this consideration has ushered a sea change in forest development in the state.

Tamil Nadu Afforestation Project (TAP) Phase I was launched in 1997 to protect, conserve and manage the biodiversity. Using Joint Forest Management as tool for afforestation, between 1997 and 2004, TAP has facilitated about 1367 village forest councils to be formed with over 4.66 lakh people as active members in the co-management of the forests. Besides restoring degraded forest land in over 4800 sq.km. through planting of fifty local varieties of trees, the project also emphasized on watershed development. In view of the success in Phase I, the second phase has been launched from 2005-06. During the second phase, the project aims to develop over 1775 sq.km. of degraded (or degrading) forests in the state. Poverty alleviation has also been included as objective of the TAP Phase II making the whole exercise people oriented.

Table 6: Forest Management Strategies in Tamil Nadu over past 100 years

Period	Polices and objectives	Management Implication
Before independence	Protection from people and management for yield	Survey, revenue earning timber extraction.
1948-60	To increase forest area	Creation of administrative structures and preparation of working plan.
1960-73	Aforestation and plantation programme	Creation of afforestation and plantation divisions, planning and evaluation cells. Less emphasis on protection.
1974-80	Establishment of forest corporations	Clear felling of natural forests and conversion to commercial plantation Clonal Forestry (Tea, Coffee, Rubber, Eucalyptus etc)
1976-90	Emphasis on social Forestry	Dependence on foreign aid – interaction with people and institutions of NGO. Creation of Social Forestry plantations and institutions.
1990-to date	J.F.M Approach	JFM strategy VFC formation, peoples participation NAP- Programme, P.As and Protected area network.

Source: Joseph (2006)

Besides protecting and developing existing forests, the Forest Department has also been working on forestry extension. The overall aim of the forestry extension is to increase the forest cover to one-third of the total geographical area envisaged in the National Forestry Policy. Various schemes that are included under the forestry extension include, agro-forestry model plots, tank foreshore plantations, raising teak on padugais, and raising jatrophas curas.

Chapter 3

APPROACH AND DATA SOURCES

The following schematic diagram (Figure 5) explains the conceptual approach adopted in this study for assessing the wood demand and supply in Tamil Nadu. The demand for wood is assessed at four main levels: household, industry, service sectors and exports.

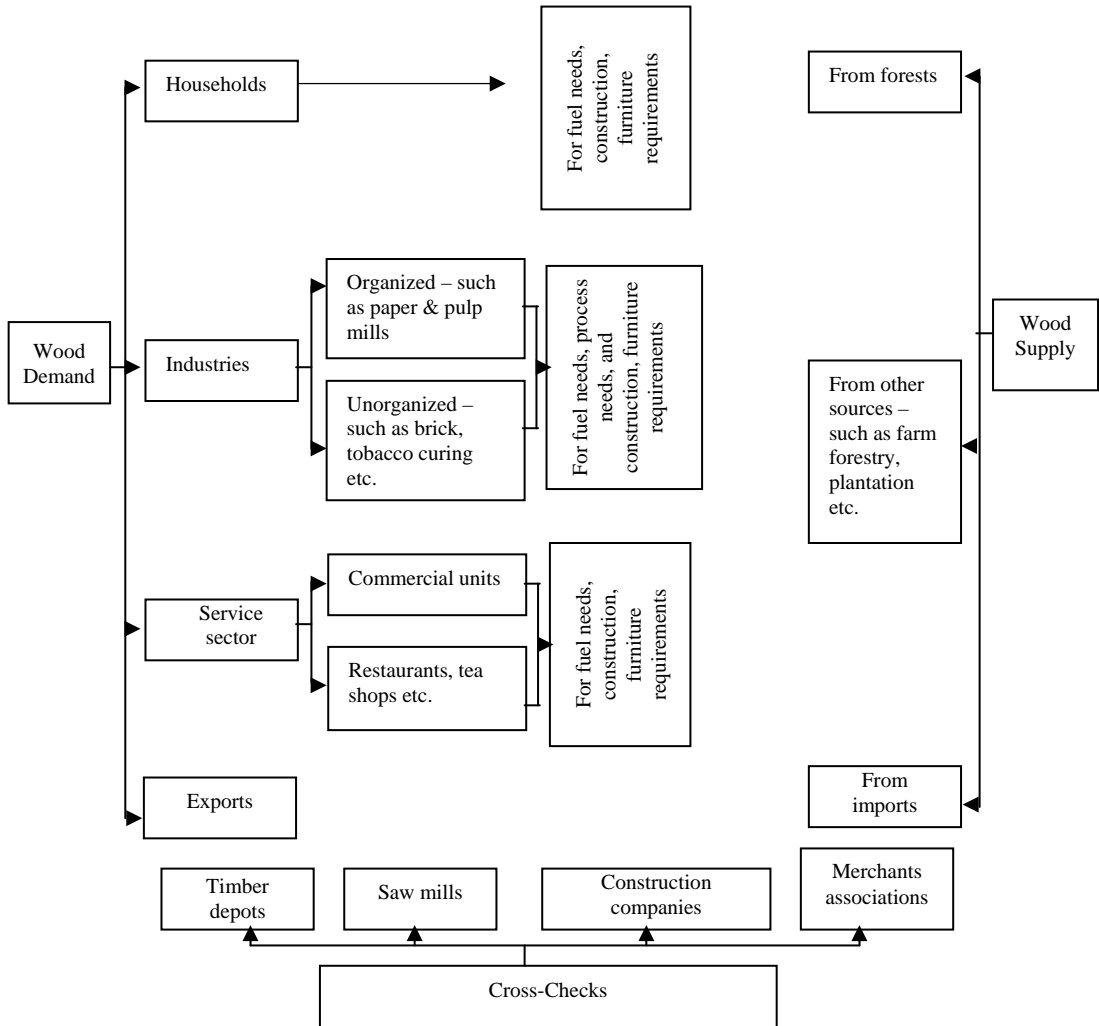
The household demand for wood is divided into two main components – demand for fuel wood and demand for timber used for construction purposes, furniture needs and for manufacturing agricultural implements. The households also demand a small, but not negligible, amount of wood for rituals. The industry sector is divided into organized and unorganized sectors, both needing wood as fuel, and for construction and furniture purposes. Further there are specific needs of wood by certain industries such as paper mills. The service sector covers commercial establishments, restaurants and tea shops and demand for wood arises from fuel needs as well as for construction and furniture needs.

From end-use perspective, wood consumption is divided into two main categories: fuel-wood and timber. The fuel-wood is demanded by households for cooking (and possibly heating) purposes, industries for heating purposes, and commercial establishments such as restaurants and tea shops for cooking purposes. Timber is demanded for construction purposes, furniture needs and for manufacturing implements. Timber and other forms of wood are also needed for several industrial end-uses including, paper and pulp; plywood and veneer; fiber board, particle board, and chip board; match industry; sports goods; railway sleepers, and packaging. Inter-state movements and imports constitute the final segment of wood demand estimation.

Wood is supplied through three main sources: forests, plantation and farm forestry, and imports. The supply from forests is fairly negligible in recent years due to the Supreme Court ban on felling of trees. However, fuel wood is believed to be extracted from the forests often through illegal means. Hence the official statistics may not reflect the ground reality. The data on imports could be fairly reliable but it would be difficult to trace the exact movement of the imported wood for various end-uses. Finally, the wood available from non-forest sources including the farm forestry would be widely dispersed and hence getting an accurate estimate could be difficult. Overall, the estimates for supply of wood would in general be less reliable than the demand estimates.

While matching the demand and supply of wood, cross-checks are essential due to the possible biases in the estimation of demand and supply. The cross-checks can be achieved through assessment of transaction of wood taking place through timber depots and saw mills. Similarly, the construction companies could also be tapped for getting an accurate picture of the timber demand emanating from the construction needs. All the estimations are done for the year 2008.

Figure 5: Conceptual Framework of the Study



The methodology adopted involved collection, collation and compilation of information from various secondary and primary sources, and econometric modeling for identifying the factors influencing the wood consumption, especially fuel-wood. Besides

assembling vast amount of secondary data painstakingly from diverse and dispersed sources, the study conducted an extensive primary survey of households, industries, and service provider (such as restaurants and tea-shops). Following sub-section describes the sample details along with the sampling methodology adopted in this study.

Primary Survey Details

An extensive primary survey was carried out to assess the wood demand in the household, (small scale) industry, and service sectors with the help of the officials of the Forest Department of Tamil Nadu. Based on several criteria including, area under forest cover, literacy levels, population density, consumption of fuel wood, eleven districts spread over seven agro-climatic zones¹ of Tamil Nadu were selected for primary survey. Within each district two taluks were selected based on similar criteria specified above and from each taluk, villages and towns were selected based on population characteristics. A sample of 400 households was selected from the districts Cudallore, Villupuram, Ariyalur, Coimbatore, Theni, Dharmapuri, Salem, Dindigul, and Ramanathapuram; whereas a sample of 200 households was selected from The Nilgiris and Kanniyakumari districts. From each district sample households were selected by dividing the sample between the rural and urban areas as per the prevailing district level rural-urban population distribution. Table 7 shows the villages/towns surveyed and the sample size in each of the village/town covered in the primary survey². The households in each village were selected randomly while ensuring that at least 20 percent of the sample included richer households, and another 20 percent of the sample comprised of households who have undertaken house construction work in the past one year. The primary survey covered about 3250 households to assess the fuel wood and timber needs of households. Box 1 describes the identification of sample households using an illustrative example.

Along with the households, in each of the selected village about 10 household industries were surveyed to learn about their wood requirements for fuel, process and other needs. Similarly another 10 commercial establishments were surveyed in each of the selected village/town to assess the wood demand in the service sector. The commercial establishments included shops, restaurants, tea shops etc. A total of 157 household industrial units and 187 commercial establishments were surveyed in the ten districts where household survey was carried out.

¹ The seven agro-climatic zones Tamil Nadu are: Cauvery Delta Zone, North Eastern Zone, Western Zone, North Western Zone, Hilly Zone, Southern Zone, and High Rainfall Zone. The mapping of the districts of Tamil Nadu with the Agro-Climatic Zones is shown in Annexure 2 along with the population proportions in rural and urban regions attributable to the agro-climatic zones.

² No survey could be conducted in Cuddalore district, and hence not reported in Table 7.

Further, in each of the village/town covered in the primary survey, an assessment of the tree stock has also been attempted to assess the supply of wood from non-forest sources.

Due to its significantly different demand pattern and large size Chennai was surveyed separately. Table 8 shows the survey details for Chennai city. As could be noted along with households, commercial establishments, and small scale industries, this survey covered timber depots, saw mills, furniture shops and construction companies in order to gather information from multiple transitory points in the wood consumption.

Table 7: Primary Survey – Sample Details

Agro-climatic Zone	District	Taluk	Village/Town Name	Rural / Urban	Total Households (Census)	Households Surveyed	Service Units Surveyed	Household Industrial Units Surveyed
Cauvery		Miluppuram	Miluppuram	Urban	90601	60		
			Miluppuram	Rural	530	20		
			Kanal	Rural	653	22		
			Miluppuram	Total	635210	102	15	17
North eastern	Ariyalur	Kallankuruchi	Ariyalur	Urban	6305	44		
			Ariyalur (North)	Rural	775	48		
			Thirumanur	Rural	1521	95		
			Ariyalur *	Total	165569	187	30	30
Western	Coimbatore	Tirupur	Tiruppur	Urban	139057	265		
			Mannarai	Rural	2236	42		
			Muthanampalayam	Rural	2521	46		
			Coimbatore	Total	1095354	353	30	19
Western	Theni	Bodinayakanur	Bodinayakanur	Urban	24854	216		
			Kottagudi	Rural	557	10		
			Bodi Hill North	Rural	510	9		
			Andipatti	Rural	7277	126		
			Myaladumparai	Rural	2281	39		
			Megamalai	Rural				
			Theni	Total	272033	400	23	32
North Western	Dharmapuri	Pennagaram	Pennagaram	Urban	6032	69		
			Pennagaram R. F.	Rural	38	19		
			Perumbalai	Rural	1786	185		
			Jodampatty	Rural	371	54		
			Kottapatty	Rural	733	90		
			Dharmapuri	Total	638305	417	30	1

(Contd... Table 7)

Agro-climatic Zone	District	Taluk	Village/Town Name	Rural / Urban	Total Household (Census)	Households Surveyed	Service Units Surveyed	Household Industrial Units Surveyed
North Western	Salem	Velapady	Vazhapadi (TP)	Urban	3968	194		
			Kurichi	Rural	1693	70		
			Chandrapillaivalasai	Rural	973	40		
			Anaiyampatty	Rural	1279	348		
			Salem	Total	736562	652	7	6
Hilly	The Nilgiri	Kotagiri	Kotagiri	Urban	10911	147		
			The Nilgiris	Total	182682	147	0	1
Southern	Dindigul	Kodaikanal	Kodaikanal	Urban	9986	138		
			Poondi	Rural	903	65		
			Sendurai	Rural	2439	94		
			Sirugudi	Rural	1862	94		
			Dindigul	Total	465179	393	8	6
Southern	Ramana-thapuram	Kamuthi	Kamuthi	Urban	4208	104		
			Kamuthi	Rural	22025	25		
			Peraiyur	Rural	1540	61		
			Mandapam	Rural	1720	67		
			Sakkarakottai	Rural	3737	144		
			Ramanathapuram	Total	266200	401	44	28
High Rainfall	Kanniyakumari	Kalkulam	Tirupparappu	Urban	83775	24		
			Tirupparappu	Rural	36199	130		
			Thovala	Rural	13838	45		
			Kanniyakumari	Total	376499	199	10	10
			Total			3249	187	157

Box 1: Steps in Identifying the Sample Households in each Selected Village/Town

The following steps explain in detail the steps involved in identifying the sample households in each of the selected village/town given in Table 7 across the seven agro-climatic zones of TN.

The idea behind the selection of sample households is to use the random numbers and number of streets within a village/town, and at the same time ensuring that a maximum of 20 percent of the sample includes 'richer' households (whose definition is given below) and another maximum of 20 percent of the sample includes households who have constructed their houses in the recent past (one or little more than one year).

For illustration the case *Kanai* village in *Villupuram* Taluk of *Villupuram* district is used for explanation. The sample size is 22 out of a total number of 653 households (as per 2001 census).

Thus, in the present case of *Kanai* the sample selection will be as follows:

- a) Identify the number of **major** streets/therus in the village/town - this information could be obtained from the village panchayat office.
- b) Divide the sample size with the number of major streets to identify the kind of random number table to refer. If the resulting number is single digit then we can refer 'two-digit' random numbers to identify the sample households. Alternatively, if the resulting number of the division has two-digits, then we can refer 'three-digit' random numbers to identify the sample households.

For example, if there are five major streets in *Kanai*, then the ratio of sample size to the number major streets yields a single digit (i.e., $22 \div 5 =$ approximately 4). Accordingly we should look at two-digit random numbers identify the sample households.

- c) Now, refer the two-digit random number sheet given. For instance the first number in the sheet you select is '34', then read it as the '4th' house on the '3rd' street. In other words, the digit in the units place refers to the household number, and the

digit in the tenths place refers to the street number. The count of houses (and also streets) can be made starting at any end – but has to be consistently maintained.

If the selected random number from the random sheet turns out to be '20' (and for that matter any other number ending in zero), then you may skip that number and select another random number – because it could be difficult to associate a zero to the house number.

Similarly, if the selected random number from the random sheet turns out to be '74', then you may skip that number and select another random number – because there is no '7th' street in the present case (there are only four major streets). In other words, the selected random number must be consistent with the information about the number of major streets in the village/town.

- d) Continue picking up the random numbers till the total selected households' matches with the required sample size in the village/town.
- e) It will be convenient to arrange the selected houses/streets in order before embarking upon the survey.
- f) If necessary the by-lanes of the street could also be used for the selection of households.
- g) If the final sample of households does not contain sufficient representation of the richer households (for example, in case of *Veeranallur* the final sample should have about five rich households), then add additional richer households to the sample by purposively selecting them.

The richer household can be defined as one satisfying one or more of the following criteria:

- In rural areas: Having a concrete house; having a vehicle; owning a large land; owning mechanized farm equipments; employing five or more laborer;
- In urban areas: Owning independent house/flat; owning a house/flat in an affluent neighborhood; having a vehicle(s)

- h) Similarly, if the final sample of households does not contain sufficient representation of the households who have constructed the house in the recent past, then add additional such households to the sample by purposively selecting them.
- i) The procedure is similar in spirit for the larger villages/towns also. In such cases one may get a two-digit number by dividing the sample size by the number of major streets. Consequently one has to use a three-digit random number sheet for household selection.

For instance, in such case if the first random number selected is '310', it implies that we will include the '10th' household in the '3rd' street in the selected sample households.

Table 8: Chennai Survey – Sample Details

Category	Surveys per zone	Total surveys in 10 zones	Remarks
Households	20	200	In each zone 20 % of the respondents include BPL households; 20 % of the respondents include middle income households; 20 % of the respondents include higher income households; and 40 % of the respondents include households who have recently renovated/constructed their houses
Commercial establishments	5	50	Includes restaurants, shopping malls, tea shops etc.
Small scale industries	5	50	Includes factories operating from houses, factories employing less than 15 laborers
Timber depots/Saw mills	9	93	Besides assessing the demand for various wood varieties, this survey also enquired about the sources of wood along with demand for wood
Furniture shops	3	30	Would include readymade furniture shops as well as carpenters operating from home
Construction companies	2	20	Would include firms involved with construction of housing complexes as well as commercial complexes
Total	40	443	

Summary of Data Sources

Household-level fuel-wood consumption is also assessed using the unit-record data collected through the quinquennial rounds of National Sample Survey Organization (NSSO) conducted in the years 1993-94, 1999-2000 and 2004-05. These are large sample surveys of the NSSO. The analysis based on such large data set spanned over a decade will enable accurate estimation of consumption and also provide scope for estimation of future demand for fuel-wood. This database is used to assess fuel-wood consumption across rural and urban areas, agro-climatic regions, and across income classes in Tamil Nadu. The share of market and non-market sources in the fuel-wood consumption is also assessed using this database. Further, the NSS database is used to assess the penetration of alternative fuels for cooking, such as kerosene and LPG. Since the NSS database provides scope for identifying the factors influencing the consumption of fuel-wood, an attempt is also made to estimate the demand for fuel-wood econometrically and use the same for future projection of fuel-wood in Tamil Nadu.

Thus, the fuel-wood demand at the seven agro-climatic zones of Tamil Nadu in 2008 is estimated through two different methods – based on data collected through primary survey, and using the unit-record data from NSSO.

For timber consumption at the household level both secondary and primary data are used. Using per-capita annual consumption norms scouted from the literature, wood demand by the household sector for construction and furniture needs is estimated for the year 2008. These estimates are cross-compared with the estimates made from the primary survey. Similar approach is also adopted for the case of household industrial units and service establishments.

In the case of organized industries, data collected from concerned industrial associations, large-firms, and secondary sources is used to assess the wood demand.

Trade statistics – both exports and imports – are collected from two major sea ports in Tamil Nadu, namely, Chennai and Tuticorin. The statistics collected include the time-series data over past five/six years, import/export quantities of various wood varieties over the year 2008, sources and destinations of wood import and export, and movement of wood from Tamil Nadu to the neighboring states. Data on timber logs, pulpwood, and plywood entering and leaving Tamil Nadu are used to assess the demand through exports and supply from the imports.

Supply of wood from forests is assessed through the official statistics of forest produce in Tamil Nadu. For assessing the wood supply from plantations, agro-forestry, and trees outside forests several sources are used and these include, the estimates of trees outside forests by Forest Survey of India, village level tree stock assessment done as part of the primary survey described above, and various secondary sources scouted from the literature.

Table 9 provides an overview of various data sources and approaches adopted for the assessment of demand and supply of wood in Tamil Nadu.

Table 9: Summary of Data Sources Used

Sl. No.	Wood Demand / Supply	End User / Source	Data Sources and Remarks
1	Demand	Household – Fuel-wood	a) NSS unit record data corresponding to TN from 61 st (2004-05), 55 th (1999-2000) and 50 th (1993-94) rounds b) Primary survey of households (sample size = 3249) from 37 villages/towns spread over 10 districts representing the seven agro-climatic zones of TN c) Fuel-wood demand for the year 2008 is estimated and compared using the data sources (a) and (b)
2	Demand	Household – timber	a) Timber used for construction and furniture is estimated for year 2008 based on standard norms and also primary survey of households (sample size = 3249) from 37 villages/towns spread over 10 districts representing the seven agro-climatic zones of TN b) Timber used for construction, furniture and other household needs in Chennai for year 2008 is based on primary survey of households (sample size = 200) from 10 zones of the city
3	Demand	Small scale industries and service establishments	a) Fuel-wood and timber used in small scale industries and service establishments for the year 2008 is based on primary survey of household industries (sample size = 157) and service providers (sample size = 187) from 37 villages/towns spread over 10 districts representing the seven agro-climatic zones of TN b) Timber used in small scale industries and service providers in Chennai for year 2008 is based on primary survey of such units (sample size = 100) from 10 zones of the city

(Contd... Table 9)

Sl. No.	Wood Demand / Supply	End User / Source	Data Sources and Remarks
4	Demand	Organized Industries	a) Demand for timber in organized industries such as paper and pulp, for the year 2008 is based on secondary statistics of the concerned industry b) Demand for timber in other industries such as matchsticks, for the year 2008 is based on the inputs from the concerned associations and literature
5	Demand and Supply	Exports and imports	a) Wood demand through exports and supply from imports for the year 2008 is based on trade statistics of the two major ports of Tamil Nadu (Chennai and Tuticorin) b) Wood demand and supply from neighboring states for the year 2008 is based on inter-state wood transit data
6	Supply	Forests	Wood supply in the form of fuel-wood and timber from forests for the year 2008 is based on the official statistics of the Forest Department
7	Supply	Plantation, agro-forestry, and trees-outside-forests	a) Wood supply in the form of fuel-wood and timber from plantations and agro-forestry for the year 2008 is based on the village level assessments and secondary sources b) Wood supply in the form of fuel-wood and timber from trees-outside-forests for the year 2008 is based on the Forest Survey of India assessments
8	Demand and Supply	Timber depots, saw mills, furniture shops and construction companies	Overall cross-check of wood demand and supply is achieved through primary survey of various transaction points in the wood use chain with focus on the urban centre Chennai for the year 2008 (sample size: 93 timber depots and saw mills, 30 furniture shops, and 20 construction companies)

Chapter 4

WOOD DEMAND IN TAMIL NADU

Demand for fuel-wood and timber in Tamil Nadu is assessed at several levels – the households, industries, service sector and exports. The following sub-sections describe the wood demand estimates at these levels for the year 2008.

Wood Demand by the Household Sector

The household sector demands wood in the form of fuel-wood and timber for cooking, construction, and furniture purposes. As mentioned in the previous section, fuel-wood demand for the households is estimated using NSS unit record data as well as primary survey data. The demand for timber, on the other hand is estimated based on information gathered through primary survey and secondary sources. The following sub-sections describe the estimates of fuel-wood and timber demanded by the households in the year 2008.

Fuel-wood Demand by the Household Sector

Based on NSS Data

The fuel-wood consumption pattern in Tamil Nadu is assessed using data corresponding to Tamil Nadu state from three surveys conducted in the years 1993-94, 1999-2000 and 2004-05 (referred as 50th, 55th, and 61st NSS rounds). The sample sizes in each of these three rounds across rural and urban Tamil Nadu are shown in Table 10.

Table 10: NSS Sample Size Details

NSS Round	No. of Villages	No. of Blocks	No. of Households		No. of Persons	
			Rural	Urban	Rural	Urban
1993-94	391	407	3901	4042	16242	16373
1999-2000	352	359	4173	4212	17338	16571
2003-04	416	416	4159	4137	16223	15620

Source: Various reports of NSSO.

Consumption Pattern of Primary Cooking Fuel

Rural Areas

Figure 6 shows that the demand for fuel-wood as a primary fuel across monthly per-capita consumption expenditure (MPCE) decile classes³ over the three time periods.

³ In this study the analysis is carried out by summarizing the unit level household data given by NSSO into MPCE deciles and quartiles. A decile is the percentile group with each group containing 10% of the population after ranking the

About 25% of the richest group uses fuel-wood as primary fuel in 2004/05 while more than 70% households among the lower decile classes use fuel-wood as primary fuel.

Figure 6: Primary Cooking Fuel Use Across MPCE Decile Classes: Rural TN

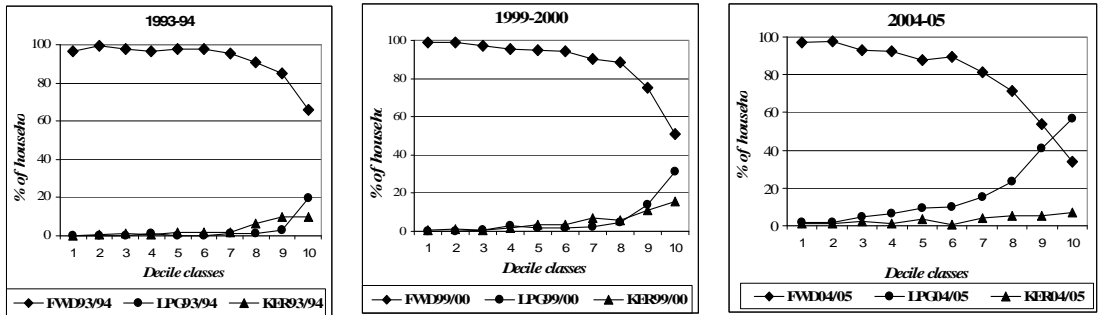


Figure 7 (a) to (d) are the region wise estimates of the change in fuel-wood consumption across four quartiles. Thirty districts in Tamil Nadu are grouped into four regions – Coastal Northern, Coastal, Southern and Inland. Annexure 4 shows the classification of the districts into these four regions. The annexure also shows the classification of the old districts into the four regions. In the first quartile about 97-99% of households were using fuel-wood as primary fuel in 1999-2000 and this proportion remained more or less the same in 2004-05 except in region 4 (inland- Dahrmappuri, Salem, Coimbatore, Nilgiris and Periyar) where there was a small decline. The second quartile showed some decline in fuel-wood as primary fuel usage except in districts of region 2 (coastal- Thiruchirapalli, Nagapattinam, Thanjavur, and Pudukottai). In quartile 3 there was larger decline in fuel-wood as primary fuel and the gap between Q3 and A4 is about 10% in 2004-05 with region 4 districts having a lower proportion of households with fuel-wood as primary fuel. Finally the fourth quartile has shown significant increases in LPG as the primary fuel and there was not much inter-regional variation as well.

In terms of numbers about 77.2 lakh households were using fuel-wood as primary source which has declined to 74.09 lakh households in 2004-05. If we look at the region-wise contributions to the total pool then share of region 3 has come down from 28.8% to 25.4% while that of region 1 has gone up from 25.2% to 27.8%, that of region 4 from 22.5% to 23%, and remained same for region 2.

households in the increasing order of the MPCE. Thus, first decile is the poorest 10 percent of the population and the tenth decile is the richest 10% of the population as in the sample. Since NSSO provides information in current prices such a conversion is useful for comparison across time. Similarly a quartile contains 25% population in each group and the first quartile has the poorest 25% of the population and the fourth (and last) quartile has the richest 25% of the population.

Figure 7 (a): Primary Fuel Usage in 1999/00 and 2004/05 in Region 1: Rural

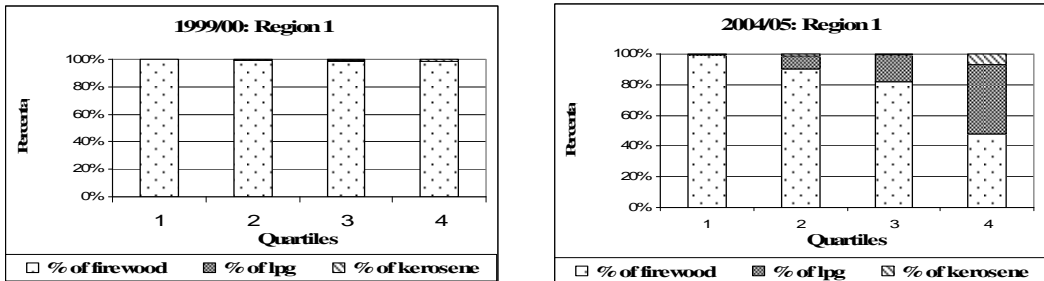


Figure 7 (b): Primary Fuel Usage in 1999/00 and 2004/05 in Region 2: Rural

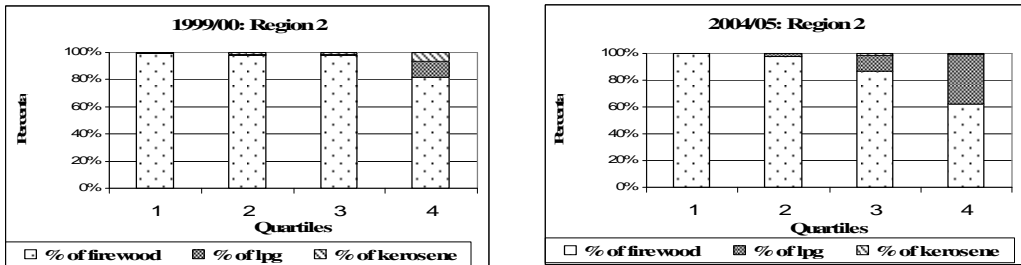


Figure 7 (c): Primary Fuel Usage in 1999/00 and 2004/05 in Region 3: Rural

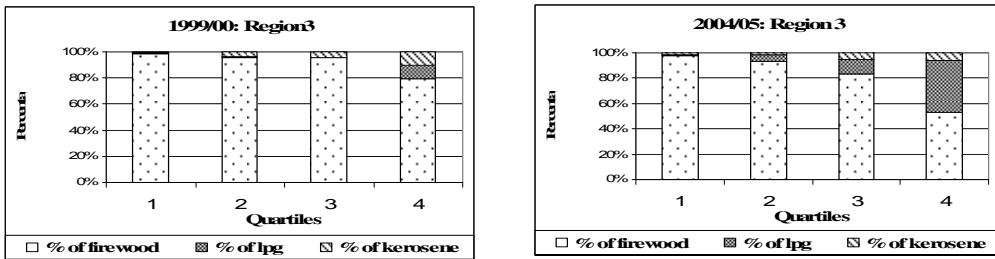
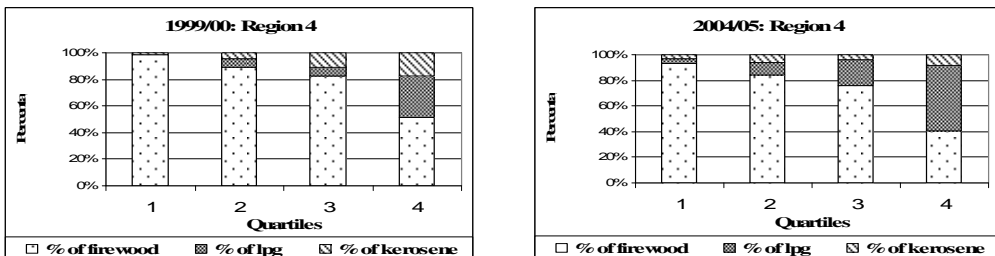


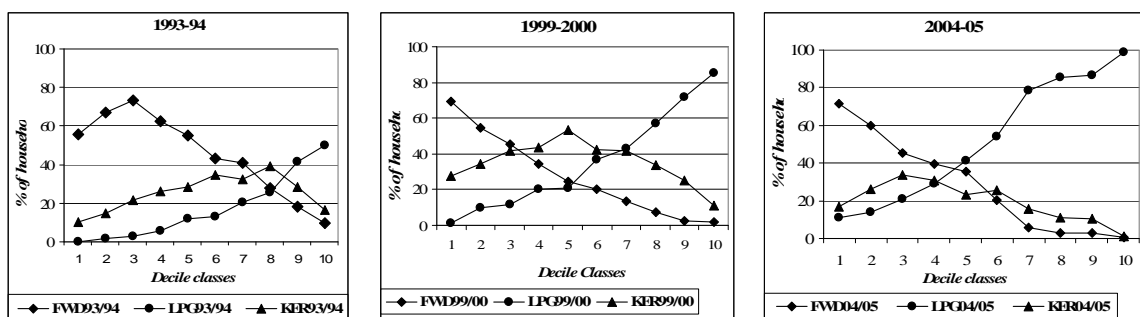
Figure 7 (d): Primary Fuel Usage in 1999/00 and 2004/05 in Region 4: Rural



Urban Areas

In the urban households reporting fuel-wood as primary fuel the pattern is rather interesting as shown in figure 8. In the urban areas LPG is the primary fuel among most households in the richer sections. However, the proportion of households reporting fuel-wood as primary fuel has not changed much between 1999/00 and 2004/05 among the poorer sections of the population. What has changed substantially is the use of kerosene as the primary fuel. It has an inverted U pattern with sharp peak in 1999/00 and substantial decline by 2004/05.

Figure 8: Primary Cooking Fuel Use Across MPCE Decile Classes: Urban TN



The region wise changes are shown in figures 9 (a)-(d). For quartile 1 the changes are interesting in that there has been an increase in percentage of households reporting fuel-wood as primary fuel except in region 3 which showed a marginal decline (from about 1.83 lakh households to 1.65 lakh households). The increase is rather dramatic in region 2 and this is mainly caused by a decline in kerosene as the primary fuel. However, in terms of absolute number there has been a decline in fuel-wood as primary fuel.

The regional contribution has changed in terms of the decline in share of region 2 from 20% to 12.5% with a sharp rise in share for region 4 from 17.4% to 24.6% and small increase in the share of region 3. The share of rural is between 80-90% with exception of region 2 contributing about 93% of the households with fuel-wood as the primary fuel.

Figure 9 (a): Primary Fuel Usage in 1999/00 and 2004/05 in Region 1: Urban

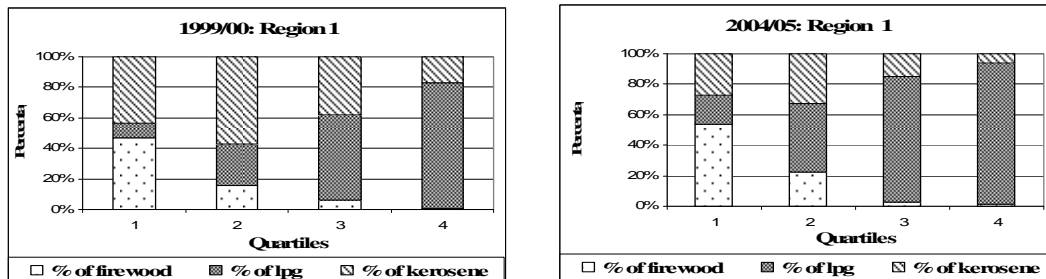


Figure 9 (b): Primary Fuel Usage in 1999/00 and 2004/05 in Region 2: Urban

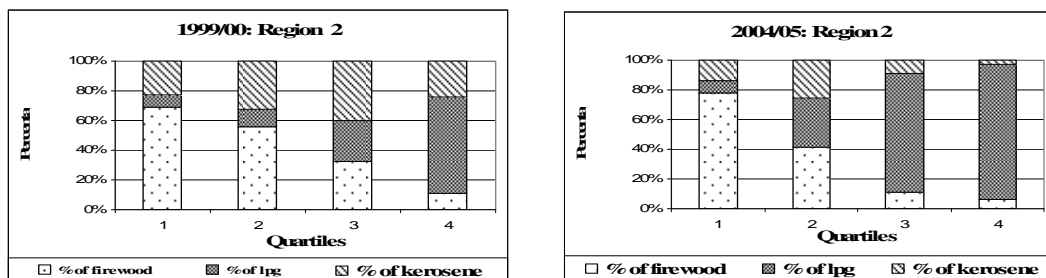


Figure 9 (c): Primary Fuel Usage in 1999/00 and 2004/05 in Region 3: Urban

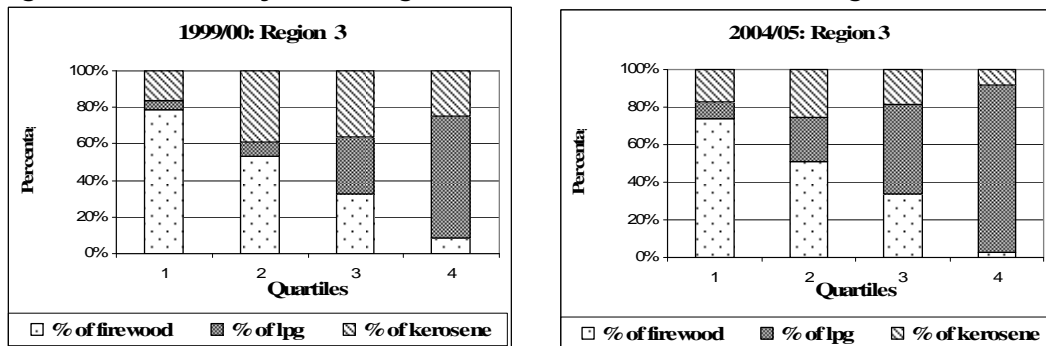
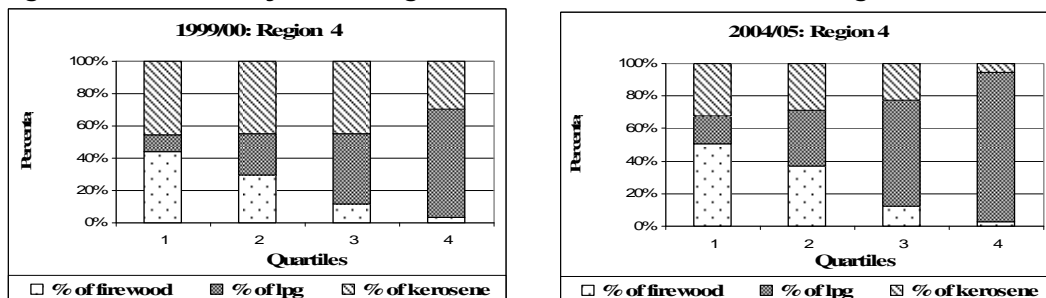


Figure 9 (d): Primary Fuel Usage in 1999/00 and 2004/05 in Region 4: Urban



Trends in Quantity of Consumption: Fuel Wood and Alternate fuels

Fuel wood consumption in Tamil Nadu has increased from 9.24 million tons in 1993/94 to 12.24 million tons in 2004/05, an increase of about 33% in the past ten years. In 1999/00 the consumption was 9.73 million tons so the increase has been very steep in the last five years than in the previous five-year period. At the all India level fuel-wood consumption rose from 132 million tons in 1993/94 to 159 million tons in 1999/00 to 207 million tons in 2004/05.

The reason for this change is due to increase in fuel consumption needs of people and the slower penetration of alternate fuels like kerosene and LPG. The increase in fuel-wood consumption is due to decrease in kerosene as a cooking fuel despite significant increase in LPG consumption. The fuel-wood consumption increased at the rate of 1.1 per cent per annum between 1993/94 and 1999/00 and at the rate of 5.2 per cent per annum between 1999/00 and 2004/05 as shown in Table 11. The corresponding increase in LPG consumption has been 20.3% per annum and 10.5% per annum in the two five-year periods. However kerosene consumption increased by 4.8% per annum between 1993/94 and 1999/00 while it *declined* at the rate of 8.6% per annum in the period 1999/00 to 2004/05.

At the all India level fuel-wood consumption has risen faster than Tamil Nadu but the rate of change is not very different, that is, about 4% per annum between 1993/94 and 1999/00 and about 6% per annum between 1999/00 and 2004/05.

Table 11: Trend in Cooking Fuel Consumption and Annual Growth rates

Source of Cooking Fuel	Consumption in Year #			Change per annum (%)		
	1993 /94	1999 /00	2004 /05	93/94 to 99/00	99/00 to 04/05	93/94 to 04/05
Fuel-wood	9.25	9.73	12.24	1.1	5.2	3.2
LPG	0.20	0.40	0.61	20.3	10.5	20.8
Kerosene	0.80	0.99	0.56	4.8	-8.6	-2.9

Fuel-wood and LPG are in millions of tons and kerosene is millions of liters.

Source: Calculated from unit record data of NSS for various quinquennial rounds

Rural and Urban

The increase in consumption is due to both rural and urban consumption in the last five years compared to the previous five-year period during the decade between 1993/94 to 2004/05. The consumption of fuel-wood increased from 7.37 (1993/94) to 8.44 (1999/00) to 10.50 (2004/05) million tons per year in rural areas while in urban it

decreased from 1.88 million tons to 1.29 million tons between 1993/94 and 1999/00 and then increased to 1.75 million tons in 2004/05 (Table 12). The decline in kerosene consumption and the increased fuel needs seems to have prompted the need for this despite a huge increase in LPG consumption.

The per capita total energy consumed from different fuels in Tamil Nadu increased from 293.62 mJ in 1993/94 to 412.47 mJ in 2004/05 among rural population (see Annexure 5 for energy conversion units used in the analysis). This has happened when the rural population has declined from 36.1 million people to 34.5 million and the monthly per capita consumption expenditure (MPCE) has increased from Rs.293.62 to Rs. 602.17 (both in nominal terms) during the 10 year period. In urban areas the population increased from 19.7 million to 21.6 million and the MPCE increased from Rs. 438.29 to Rs. 1079.65 with the per capita cooking energy increasing 178.76 mJ to 198.62 mJ.

As can be noted from Table 12, LPG consumption rate has grown more in the first five-year period when the kerosene consumption has also increased while the fuel-wood consumption increased marginally in rural and decreased in urban. However, in the second five year period LPG consumption grew at a slower rate with a substantial decline in kerosene consumption. The fuel-wood consumption has grown at a faster pace during this period.

Table 12: Trend in Cooking Fuel Consumption – Rural and Urban TN

Source of Cooking Fuel	Rural			Urban		
	1993/94	1999/00	2004/05	1993/94	1999/00	2004/05
Fuel-wood	7.37	8.44	10.50	1.88	1.29	1.75
LPG	0.04	0.10	0.15	0.15	0.30	0.45
Kerosene	0.36	0.48	0.30	0.43	0.51	0.26

Fuel-wood and LPG are in millions of tons and kerosene is millions of liters.

Source: Calculated from unit record data of NSS for various quinquennial rounds

Regional Consumption Patterns

Table 13 shows region-wise consumption of various fuels for cooking purposes in Tamil Nadu over the three time points. Coastal North has the highest consumption of all the fuels. This is due to much higher population but the MPCE and energy requirements are moderate. The fuel-wood consumption has increased in all regions over the period in rural areas but in urban areas the pattern of consumption varies across regions. For instance, in coastal north and inland the consumption has declined while in the other two regions it has increased marginally. The direction of change in the LPG and kerosene

consumption patterns are similar to what was described earlier for Tamil Nadu and all India with a significant increase in consumption of LPG in urban areas of coastal north.

Table 13: Trends in Region wise[@] Consumption of Cooking Fuels in TN

Cooking Fuels/ Regions	Rural			Urban		
	1993/94	1999/00	2004/05	1993/94	1999/00	2004/05
Fuel-wood[#]						
Coastal North	2.24	2.83	3.23	0.56	0.42	0.45
Coastal	1.45	1.91	2.73	0.22	0.25	0.24
Southern	1.88	1.87	2.17	0.49	0.37	0.54
Inland	1.80	1.83	2.38	0.60	0.25	0.52
LPG[#]						
Coastal North	0.025	0.035	0.053	0.087	0.156	0.235
Coastal	0.007	0.011	0.021	0.013	0.028	0.053
Southern	0.003	0.013	0.031	0.025	0.051	0.071
Inland	0.010	0.041	0.048	0.029	0.062	0.096
Kerosene[#]						
Coastal North	0.113	0.135	0.077	0.196	0.260	0.101
Coastal	0.065	0.085	0.061	0.038	0.055	0.023
Southern	0.086	0.123	0.079	0.103	0.091	0.063
Inland	0.100	0.133	0.085	0.095	0.106	0.073

Fuel-wood and LPG are in millions of tons and kerosene is millions of liters per annum.

@ For the district composition in each region see Annexure 4.

Source: Calculated from unit record data of NSS for various quinquennial rounds

Table 14: Consumption of Various Fuels for Cooking Across Agro-climatic Zones, 2004-05

Agro-climatic zones	Rural			Urban		
	Fuel-wood [#]	Kerosene [#]	LPG [#]	Fuel-wood [#]	Kerosene [#]	LPG [#]
Cauvery	2.54	1.4	0.022	0.23	2.6	0.051
N_east	2.42	4.1	0.046	0.37	9.2	0.114
West	1.27	4.8	0.027	0.32	11.3	0.062
N_West	1.36	3.4	0.018	0.20	3.7	0.028
Hilly	0.11	0.8	0.004	0.04	0.5	0.005
Southern	2.17	6.3	0.029	0.45	10.1	0.063
Rainfall	0.12	0.1	0.002	0.04	1.0	0.004
Chennai	-	-	-	0.02	15.7	0.113
Total	10.01	21.0	0.146	1.75	54.1	0.441

Fuel-wood and LPG are in millions of tons and kerosene is thousands of liters per annum.

@ For the composition of agro-climatic zones see Annexure 2.

Source: Calculated from unit record data of NSS for 2004-05.

Table 14 shows primary cooking fuel usage pattern across agro-climatic zones for 2004-05. The three most dominant regions are the Cauvery, North east and Southern

which use about three-fifths of the total rural consumption. However, in urban areas southern has the largest consumption followed by North East and West while Cauvery zone does not have a higher usage. As the number of districts and hence the population size varies across these zones the quantum of fuel also varies substantially. A comparison of the distribution of each fuel across these regions in Table 14 shows Cauvery and North-east dominate in rural while Southern and North-east dominates in urban for fuel-wood consumption. Chennai dominates in both kerosene and LPG usage.

The per capita per month consumption of fuel-wood in rural areas varies across agro-climatic zone as shown in Table 15. Cauvery zone has the highest with 29.4 kgs while the rainfall region has the lowest with 17.11 kgs in rural areas. The Northeast, West and Hilly areas have about 26 kgs per capita per month while Northwest and Southern have about 23 kgs. Interestingly, in Hilly areas wood is not the primary fuel for cooking while in Rainfall (includes only Kanyakumri district) there are about 91% households reporting it as primary fuel but their per capita consumption is far lower including that of alternate fuels.

Table 15: Per Capita Consumption of Various Fuels for Cooking and Proportion of Households using Fuel-wood as Primary Fuel Across Agro-climatic Zones, 2004-05

Agro-climatic zones	Rural				Urban			
	Fuel-wood [#]	Fuel-wood as Primary Fuel [@]	Kero-sene [#]	LPG [#]	Fuel-wood [#]	Fuel-wood as Primary Fuel [@]	Kero-sene [#]	LPG [#]
Cauvery	29.43	89.4	0.02	0.25	8.67	27.8	0.19	1.92
N_east	26.60	80.7	0.04	0.50	6.34	22.0	0.32	1.95
West	26.61	73.4	0.10	0.57	8.14	21.0	0.50	1.59
N_West	22.67	84.8	0.06	0.30	10.18	33.7	0.27	1.40
Hilly	25.97	58.4	0.19	0.83	12.37	32.9	0.29	1.68
Southern	23.36	85.5	0.07	0.31	9.08	38.1	0.31	1.28
Rainfall	17.11	91.5	0.02	0.21	11.03	41.9	0.33	1.23
Chennai					0.55	2.7	0.69	2.52
Total	25.65	83.3	0.05	0.37	7.15	23.3	0.40	1.80

Per capita per month in kgs for fuel-wood and LPG and liters for kerosene

@ Percentage of households using fuel-wood as the primary fuel

Source: Same as Table 14

Overall in urban areas the per capita per month consumption of fuel-wood is about half to one-third in rural except in Rainfall zone which is nearly the same. The

Rainfall and Hilly zones show a high percentage of households as also in Southern and the proportions are more or less uniform in the remaining zones.

Projection of Demand for 2008 based on 2004-05 consumption

Since the NSSO data is based on information gathered in 2004-05 the per capita estimates have been used to project the annual consumption for the year 2008 using the projected population estimates for 2008. The mid-year estimates of population projection for 2005 across districts of Tamil Nadu as given by the State Planning Commission are used. The growth rates are calculated for the period between 2001 and 2005, which is then used for projecting for 2008. The districts level projections are aggregated to estimate the population for each agro-climatic zone. If \bar{q}_1 is the per capita per month estimated consumption of fuel-wood and \bar{p}_1 is the projected population for Zone 1 then total fuel-wood consumption per year in 2008 is $\bar{Q}_1 = (\bar{p}_1 * \bar{q}_1 * 12) / (1000 * 1000 * 1000)$ millions of tons. The total fuel-wood consumption for Tamil Nadu $\bar{Q} = \sum_{i=1}^7 \bar{Q}_i$ is estimated as the sum of consumption from each of the seven agro-climatic zones.

The estimates in Table 16 show that the total fuel-wood consumption goes up from 11.76 million tons per year in 2004-05 (see Table 14) to 12.92 million tons. The share of rural is highest in zones of Cauvery and Northeast while both Hilly and Rainfall have the lowest as they comprise of smaller region and are more urbanized.

Table 16: Projected Estimates of Fuel-wood Consumption in 2008
(millions of tons per year)

Agro-climatic Zones	Total Quantity of Fuel-wood (millions of cu.m. per year)			Share of (%)	
	Rural	Urban	All	AGCZ	Rural
Cauvery	3.90	0.59	4.49	24.30	86.94
N_east	3.61	0.78	4.39	23.76	82.41
West	1.61	0.98	2.59	14.01	62.43
N_West	1.74	0.57	2.32	12.54	75.31
Hilly	0.12	0.12	0.24	1.32	52.94
Southern	3.02	1.07	4.09	22.21	73.87
Rainfall	0.03	0.31	0.34	1.86	8.33
Total	14.06	4.40	18.46	100.00	85.12

Source: Based on NSSO per capita estimates and projected population

Based on Primary Survey Data

To assess the actual demand in the year 2008, a primary survey was carried out in the agro-climatic zones. The details of the survey are discussed in Chapter 3. The socio-economic profile of the households surveyed is given below.

Socio-economic Profile of the surveyed households

Depending on the population share the numbers of households were assigned to each agro-climatic zone and the survey was carried out by the forest rangers of these different regions. As the primary survey in Cuddalore district could not be completed, the households surveyed in the Cauvery agro-climatic zone is smaller than those surveyed in other zones.

Table 17a: Number of Households Surveyed and Share of Each Region

Agro-climatic Zones	Rural		Urban	
	Total Households	AGCZ Share	Total Households	AGCZ Share
Cauvery	42	2.1	60	4.1
N_East	143	7.2	44	3.0
N_West	272	13.7	481	32.9
West	806	40.5	263	18.0
Hilly	0	0.0	147	10.1
Southern	550	27.7	242	16.6
Rainfall	175	8.8	24	1.6

Table 17b shows the distribution of the gender of the head of household which is expectedly in favour of men. In urban areas there are more women headed households than in rural. Table 17c reports the distribution of the age of household head with about two-thirds in the age of 30-60, about one-third to one-fourth in age about 50 years and about 5% or lesser in the age group of 20-30 years. On the whole there is not much difference between rural and urban areas.

Table 17b: Distribution of Households based on Gender of Household Head (%)

Agro-climatic Zones	Male Headed		Female Headed	
	Rural	Urban	Rural	Urban
Cauvery	92.9	90.0	7.1	10.0
N_East	91.6	90.9	8.4	9.1
N_West	94.9	92.1	5.2	7.9
West	89.5	90.9	10.6	8.4
Hilly		91.2		8.8
Southern	92.7	89.7	7.3	9.9
Rainfall	91.4	83.3	8.6	16.7

Table 17c: Distribution of Households based on Age of Household Head (%)

Agro-climatic Zones	Age of Household Head									
	20 – 30 years		30 – 40 years		40 – 50 years		50 – 60 years		Above 60 years	
	R	U	R	U	R	U	R	U	R	U
Cauvery	4.8		21.4	21.7	21.4	18.3	31.0	23.3	21.4	36.7
N_East	2.8		20.3	6.8	29.4	31.8	25.9	27.3	21.7	34.1
N_West	7.7	4.2	21.7	23.9	36.4	29.1	22.8	21.2	11.0	21.4
West	6.8	5.7	20.8	23.3	31.8	30.9	20.0	22.9	20.6	17.2
Hilly		2.0		15.7		32.7		27.2		22.5
Southern	5.8	9.1	24.2	19.0	25.7	35.1	23.3	22.7	19.3	12.8
Rainfall	4.0		17.1	20.8	28.0	33.3	26.9	16.7	24.0	29.2

Table 17d shows the distribution of households based on the family size or the number of members in the household. Both in rural and urban areas about one-third of the households are of size four and about one-fourth each of sizes three and five. These household sizes also compare well with the NSSO estimates. In the Cauvery zone households are much larger in size.

Table 17d: Distribution of Households based on Family Size

Agro-climatic Zones	Family Size									
	<=2		3		4		5		>=6	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Cauvery	2.4	3.3	7.1	6.7	31.0	31.7	31.0	26.7	28.6	31.7
N_East	11.2	6.8	14.7	22.7	39.2	38.6	18.2	11.4	16.1	20.5
N_West	9.9	13.5	16.9	22.0	41.5	38.9	21.3	16.4	9.9	9.2
West	14.1	11.0	16.0	12.2	35.0	36.1	21.0	22.8	13.8	17.9
Hilly		8.2		9.5		49.7		17.7	0.0	15.0
Southern	8.7	5.4	13.1	14.1	23.3	42.2	21.5	20.7	31.8	12.0
Rainfall	10.9	8.3	12.0	12.5	38.3	50.0	21.7	20.8	17.1	8.3

Table 17e reports the distribution of households according to the education of the head of the household. More number of households in rural areas are in the lower levels of education while about one-third have completed schooling between V and X standard and so is it in Hilly and Rainfall zones. Northeast zone has the highest share of those with above higher secondary schooling; Rainfall zone in rural follows similar trend.

Table 17e: Distribution of Households based on Education of Household Head (%)

Agro-climatic Zones	Education of Household Head									
	No Schooling		Up to 5 th Std		Up to 10 th Std		Up to 12 th Std		Graduate and Others	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Cauvery	33.3	18.3	16.7	23.3	38.1	28.3	11.9	21.7	0.0	8.3
N_East	18.9	13.6	11.9	4.6	33.6	15.9	18.2	27.3	17.5	38.6
N_West	38.2	16.6	30.5	26.0	25.4	38.7	2.2	9.2	3.7	9.6
West	42.2	30.0	20.2	14.5	25.8	34.6	6.5	7.2	5.3	13.7
Hilly	-	7.5	-	11.6	-	48.3	-	17.7	0.0	15.0
Southern	32.9	5.4	26.2	40.1	28.4	36.0	5.8	8.3	6.7	10.3
Rainfall	12.0	12.5	23.4	33.3	33.7	41.7	21.1	8.3	9.7	4.2

Table 17f shows the distribution of the economic status based on monthly income. A majority of the households have monthly income below Rs. 5000 per month. In North-west, West and Southern more than 75% of households are in this category more so in rural than in urban. On an average the urban areas have higher income than rural and this could also be because reporting incomes is easier for urban residents as they have a regular flow.

Table 17f: Distribution of Households according to Monthly Income

Agro-climatic Zones	Monthly Income									
	< 5000		5000-10000		10000-15000		15000-20000		>20000	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Cauvery	59.5	45.0	35.7	41.7	4.8	1.7	-	10.0	-	-
N_East	55.2	31.8	31.5	20.5	8.4	27.3	2.8	2.3	2.1	18.2
N_West	84.6	83.6	14.7	13.1	0.7	2.3	-	0.4	-	0.6
West	77.9	79.1	17.1	14.1	2.6	3.8	0.6	0.8	1.6	0.8
Hilly	-	76.9	-	17.0	-	6.1	-	-	-	-
Southern	82.2	73.6	15.1	23.1	1.5	0.8	1.1	-	-	-
Rainfall	65.7	91.7	31.4	-	1.1	4.2	0.6	-	0.6	-

Table 17g reports the distribution of households based on the nature of material used for building the house. Except in Cauvery and West, most regions have either semi-pucca or pucca houses. More houses in urban areas have pucca houses except in Rainfall and Southern zones.

Table 17g: Distribution of Households according to House-type (%)

Agro-climatic Zones	House-type							
	Kutcha		Semi Pucca		Pucca		Others	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Cauvery	31.0	23.3	19.1	16.7	45.2	56.7	4.8	3.3
N_East	11.9	4.6	28.7	20.5	58.0	75.0	1.4	-
N_West	22.8	3.7	47.1	43.9	11.4	30.2	16.2	21.2
West	25.4	23.2	41.6	33.8	22.6	38.4	9.8	4.2
Hilly	-	0.7	-	68.7	-	30.6	-	-
Southern	13.5	3.7	43.8	52.5	30.0	36.4	3.5	-
Rainfall	7.4	4.2	25.1	20.8	58.3	58.3	9.1	16.7

Table 18 shows that primary survey and NSSO results give very similar pattern in terms of the primary fuel used for cooking. Zones like Cauvery, West and Southern have higher fuel-wood usage in rural areas. Urban Rainfall zone also has a very high share of households using fuel-wood as found in the NSSO estimates. North-west and Hilly urban have a far lower share perhaps because the sample sizes were lower in the primary survey and perhaps did not capture the heterogeneity. The advantage of the primary survey has been that there is a small presence of 'other fuels' which is mainly shrubs and crop residues that are perhaps under-reported in NSS data.

Table 18: Distribution of Primary Cooking Fuel across Households in 2008, Primary Survey

Agro-climatic Zones	Fuel-wood		Kerosene		LPG		Others	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Cauvery	66.7	26.7	7.1	15.0	4.8	56.7	21.4	1.7
N_East	54.6	20.5	3.5	0.0	41.3	79.6	0.7	0.0
N_West	43.8	5.6	24.6	19.5	28.3	69.0	3.3	5.8
West	75.4	50.6	5.2	8.0	16.8	40.7	2.6	0.8
Hilly	NA	0.7	NA	12.9	NA	86.4	NA	0.0
Southern	63.5	19.8	2.7	4.1	31.1	74.0	2.7	2.1
Rainfall	34.3	83.3	20.6	4.2	44.0	8.3	1.1	4.2

The per capita estimates from the survey are also similar in most zones as shown in Table 19. Cauvery has about 16 kgs while Rainfall has about 19 kgs in rural areas. The

Hilly and Rainfall zone in urban areas have reported per-capita monthly consumption of about 8 kgs while West zone has reported about 3kgs, which are somewhat lower than the NSSO estimates reported in the previous section.

Table 19: Consumption of fuel-wood based on Primary Survey, 2008

Agro-climatic Zone	Per capita quantity (per capita per month, kgs.)	
	Rural	Urban
Cauvery	37.62	13.4
N_east	30.40	5.3
West	17.54	3.0
N_West	30.54	9.0
Hilly	21.00	8.8
Southern	22.87	11.6
Rainfall	19.00	8.5
Total	25.6	8.5

In order to get the state level estimates the per capita estimates are aggregated using projected population estimates of 2008 as discussed in Box 2. Table 20 reports these estimates indicating 13.81 million tons per year as the total fuel-wood consumption, which compares well with the NSSO based estimate of 12.92 million tons per year reported earlier. The fuel-wood consumption in rural areas is about 10.9 million tons with a share of about 80% and in urban areas the consumption is about 2.9 million tons. As in NSSO Rainfall and Hilly zones have the lowest share (so is the rural share least in Rainfall zone) and Cauvery, Northeast and Southern have a higher demand in both rural and urban areas.

Box 2: Methodology to estimate the total fuel wood consumption from primary survey of select villages

Total consumption for each agro-climatic zone is obtained in the following manner.

(a) For each village/town surveyed the average per capita consumption of fuel wood is estimated based on total consumption from the surveyed households and divided by the total number of people in these households.

(b) Suppose in any given agro-climatic zone let there be two surveyed villages with sample mean values as \bar{q}_1 and \bar{q}_2 . Further let \bar{q}_3 be the sample mean from a surveyed town or city in that agro-climatic zone. Then using village and town level population estimates (from the census) the average consumption for this agro-climatic zone is estimated as follows:

$$\bar{q}_1^A = \frac{p_1\bar{q}_1 + p_2\bar{q}_2 + p_3\bar{q}_3}{p_1 + p_2 + p_3}$$

where p_1 , p_2 and p_3 are the population estimates from census for the two villages and a town surveyed in this agro-climatic zone 1.

(c) This average consumption \bar{q}_1^A from agro-climatic zone 1 is multiplied by the *projected* population estimates for 2008 of that agro-climatic zone denoted by P_1^A so that the total consumption for this zone is

$$Q_1^A = \bar{q}_1^A * P_1^A$$

The same steps from (a) to (c) are repeated for the remaining six zones to get the state level estimates $Q = \sum_{i=1}^7 Q_i^A$ for the year 2008.

Table 20: Total Fuel-wood Consumption based on Primary Survey, 2008

Agro-climatic Zone	Total Quantity of Fuel-wood (millions of cu.m. per year)			Share of (%)	
	Rural	Urban	All	AGCZ	Rural
Cauvery	4.99	0.91	5.90	29.91	84.50
N_east	4.13	0.66	4.79	24.26	86.27
West	1.06	0.36	1.41	7.17	74.75
N_West	2.34	0.50	2.84	14.41	82.41
Hilly	0.10	0.09	0.19	0.94	53.85
Southern	2.96	1.37	4.33	21.94	68.32
Rainfall	0.03	0.24	0.27	1.38	10.53
Total	15.60	4.13	19.73	100.00	79.07

Source: Based on per capita estimates from primary survey and projected population

The fuel-wood demand in Tamil Nadu in 2008 stands at 19.73 million cu.m.

Sources of Fuel Wood

In rural areas out of the total fuel-wood consumption of 105.1 lakh tons reported in 2004-05, about 13% comes from home consumption (see Table 21). Though the total quantity of fuel-wood comes down for higher decile classes, a larger share of it is from home consumption. Expectedly, the urban consumption from market is substantially higher but here also a fairly large part of the consumption of the rich is from home.

Table 21: Fuel Wood Consumption across Deciles and Sources – Evidence from NSS Data

(Except shares, all figures are in lakh tons)

Decile class	Rural				Urban			
	Home	Share from Home (%)	Market	Total	Home	Share from Home (%)	Market	Total
1	0.29	2.2	12.84	13.20	0.032	1.3	2.47	2.51
2	1.17	8.0	13.56	14.64	0.045	1.8	2.39	2.44
3	1.03	7.8	12.36	13.32	0.040	1.7	2.36	2.41
4	1.30	9.9	11.83	13.08	0.242	7.0	3.24	3.48
5	1.28	10.7	10.78	12.00	0.151	4.8	3.00	3.14
6	1.70	15.2	9.54	11.24	0.200	9.3	1.96	2.15
7	1.78	16.6	8.95	10.72	0.111	14.5	0.66	0.77
8	1.87	25.4	5.48	7.36	0.055	17.4	0.26	0.32
9	1.67	29.6	3.97	5.64	0.034	18.8	0.15	0.18
10	1.48	39.2	2.29	3.77	0.031	34.2	0.06	0.09
ALL	13.6	12.9	91.6	105.1	0.9	5.4	16.6	17.5

In terms of the Agro-climatic zones, contribution of non-market sources in the fuel-wood consumption is highest in the Rainfall zone, followed by Hilly, Cauvery, and North West zones in the rural areas (see Table 22). In the urban areas, the Rainfall zone reports the highest share of non-market sources with the other zones have far lower contribution from the non-market sources in the fuel-wood consumption. Expectedly, the richer households in both rural and urban areas on an average consume fuel-wood from non-market sources.

Table 23 shows the contribution of market and non-market sources of household fuel-wood consumption across agro-climatic zones as estimated from the primary survey. The pattern of consumption from non-market sources is similar to that reported from the estimates based on NSS data.

Table 22: Contribution of Non-market Sources in Fuel-wood Consumption across Agro-climatic Zones – Evidence from NSS Data

Agro-climatic Zone	Rural			Urban		
	Bottom 20%	Top 20%	All	Bottom 20%	Top 20%	All
Cauvery	9.28	33.88	16.70	0.65	25.60	9.32
North East	2.26	27.48	14.11	1.12	1.29	4.14
West	1.25	17.86	8.78	1.53	9.08	2.84
North West	0.28	29.60	14.34	3.12	8.84	7.44
Hilly	0.00	23.49	18.64	0.00	0.00	1.73
Southern	4.64	14.49	7.40	3.15	14.93	5.23
Rainfall	9.59	30.25	22.61	5.12	24.76	19.21
Total	5.22	30.40	12.82	1.68	22.60	5.38

Table 23: Contribution of Market and Non-market Sources (%) in Fuel-wood Consumption across Agro-climatic Zones – Evidence from Primary Survey Data

Agro-climatic Zone	Market	Non-market
Cauvery	37.7	62.3
N_East	65.8	34.2
N_West	10.5	89.5
West	66.9	33.1
Hilly	31.5	68.5
Southern	66.8	33.2
Rainfall	10.0	90.0

Determinants of Fuel-wood Consumption

Regression estimation is carried out to understand the determinants of fuel wood consumption in Tamil Nadu. Two specific aspects of fuel-wood consumption are

considered for assessing the determinants: (a) fuel-wood as primary fuel for cooking, and (b) the quantum of fuel-wood used for cooking. Table 24 gives the estimates for rural and urban households separately for the fuel wood choice equation. For a 1% increase in monthly per-capita expenditure (mpce) the impact on probability of fuel choice away from fuel-wood is higher in urban than rural. Similarly agro-climatic zone 6 that is, Southern is no different from zone 1 that is Cauvery (which is the base group). In urban all the AGCZ are similar except Northeast and Chennai which has very low probability of fuel wood as the primary fuel. If the expenditure share of LPG in the total fuel expenditure goes up then the probability declines in both rural and urban areas.

Table 24: Probit[#] model Estimates for Fuel-wood as Primary Fuel Choice

Variables	Rural		Urban	
	Coefficients	t-statistics	Coefficients	t-statistics
Lmpce	-0.631	-4.88	-0.862	-6.40
_lagrcl_2	-0.373	-1.83	-0.279	-1.58
_lagrcl_3	-0.889	-4.33	-0.693	-4.21
_lagrcl_4	-0.391	-1.82	-0.136	-0.67
_lagrcl_5	-1.744	-3.96	-0.186	-0.69
_lagrcl_6	-0.321	-1.48	-0.096	-0.61
_lagrcl_7	0.753	2.09	-0.212	-0.93
_lagrcl_99	--	-	-1.874	-7.79
Svlpgt	-0.052	-19.04	-0.033	-14.25
Hhsz	0.038	0.75	-0.008	-0.24
Dscst	0.948	2.34	0.501	1.26
Dobc	0.330	0.87	-0.105	-0.27
Drseag (Duse) [@]	-0.414	-2.01	0.198	0.85
Draglab (Dure) [@]	0.225	1.15	-0.067	-0.28
Droth (Ducl) [@]	-0.425	-2.37	0.228	0.96
Prsse	-0.909	-3.73	-0.483	-2.76
Prchld	0.023	0.07	-0.204	-0.81
Prold	-0.255	-1.20	0.100	0.50
_lland_qua~2	0.117	0.74	0.260	2.21
_lland_qua~3	0.274	1.43	0.805	5.28
_lland_qua~4	0.830	4.85	1.121	5.61
_cons	5.851	6.32	5.921	5.71

Probit model gives the probability of a household choosing firewood as primary fuel.

For names of variables used in the regression model please refer to Annexure 6.

@ the names in brackets refer to urban households.

Further as Table 24 shows that SCST households have a higher probability than the OBCs and other castes; also those households engaged in non-agriculture activities

have lower probability in rural areas. Expectedly neither caste nor occupation has a significant impact on fuel-wood choice as primary fuel. Similarly if the proportion of members in the household with secondary education and above increases then the primary choice of cooking fuel shifts away from fuel-wood. This is more so in rural than urban as firstly the proportion of households with higher education will be higher in urban areas and also a smaller proportion uses fuel-wood as the primary cooking fuel in urban areas. In rural areas the first three quartiles of land holding classes have similar fuel choice but as they move to higher land holding class the probability increases due to easier availability of fuel wood in their own land.

Table 25 gives the regression results for the determinants of quantum of fuel wood used across the households in rural and urban areas respectively. Firstly in rural areas this quantum increases with income (lnmpce) while it decreases with income in urban areas. This is an expected result as a majority of households in rural areas use fuel-wood and cooking needs increases with income while in urban areas the richer households shift to either kerosene or LPG. This becomes obvious from the coefficients for share of LPG expenditure (svlpgt) and share of kerosene expenditure (svkerot) in total fuel expenditure which are both negative in these two regression equations. The purchase of kerosene from PDS and using it for cooking has different effects in rural and urban areas. In rural the kerosene seems inadequate and the households tend to use more and more of fuel-wood but in urban the quantity seems to be adequate for cooking needs and also with electricity being provided most households the diversion of kerosene for lighting purpose will be limited. An interesting result is that larger households given same level of per capita expenditure use less of fuel wood due to scale effect as indicated by the negative coefficient of this variable (hhsz). Households with higher proportion of children (prchld) use less firewood as their cooking needs are lower while those households with higher proportion of members in older age groups (prold) demand more fuel-wood due to higher cooking needs.

Table 25: Tobit[#] Model Estimates for Per Capita Quantity of Firewood Across Households, 2004-05

Variables	Rural		Urban	
	Coefficients	t-statistics	Coefficients	t-statistics
Lmpce	4.549	9.25	-4.243	-5.67
Svlpgt	-0.354	-43.57	-0.350	-37.05
svkerot	-0.504	-12.99		
			-21.041	-27.17
dcpdsker	9.308	3.24	-2.638	-2.62
_lagrcl_2	-0.833	-1.45	-0.161	-0.16
_lagrcl_3	-1.576	-2.24	-1.053	-0.90
_lagrcl_4	-5.452	-8.37	1.213	0.53
_lagrcl_5	-0.640	-0.34	-2.987	-3.06
_lagrcl_6	-5.992	-10.56	-3.028	-1.43
_lagrcl_7	-11.663	-7.93		
_lagrcl_99			-16.548	-10.53
hhsz	-2.390	-19.46	-0.537	-2.81
prchld	-7.367	-7.46	-6.697	-4.53
prold	3.652	3.90	3.174	2.10
dscst	4.922	3.07	4.999	3.03
dobc	4.698	3.00	4.651	3.08
drsenag (duse) [@]	2.646	3.93	3.469	4.99
draglab (dure) [@]	0.250	0.39	5.137	6.08
droth (ducl) [@]	0.514	0.99	9.248	7.55
_lland_qua~2	-2.072	-3.42	0.091	0.06
_lland_qua~3	-3.127	-5.00	-0.859	-0.57
_lland_qua~4	-1.149	-1.82	-0.142	-0.09
prsse	-3.752	-4.40	-4.597	-4.19
_cons	13.711	3.80	48.723	8.61

[#] Tobit model is like OLS estimation but accounts for zero-observations.

For names of variables used in the regression model please refer to Annexure 6.

[@] the names in brackets refer to urban households.

The results across variations in agro-climatic zones are similar to the primary fuel choice as fuel wood (reported in Table 24) but both the socially disadvantaged groups SCST and OBC consume higher fuel-wood for cooking compared to the other castes in both rural and urban areas. Similarly the households self-employed in agriculture (*drseag*) have a much higher consumption in rural areas while consumption is not very different across different occupations in urban areas once social and economic status are controlled for. Higher education reduces fuel-wood consumption probably due to increased health awareness and may also complement the income effect. Land ownership has counter-intuitive effect in rural areas, that is larger land owners consume less and less of fuel-wood but in the urban areas richer households who have large landholding seem to supplement more and more with fuel wood.

These results from the regressions are utilized for projecting the fuel wood demand discussed later in the report.

Timber Demand by the Household Sector

This section provides aggregate region wise estimates of timber requirements in the household sector across the agro-climatic regions of Tamil Nadu. The household sector's demand for timber arises from construction and furniture needs in the rural and urban sectors, and from need for agricultural implements (including bullock carts etc.) in the rural regions. The estimation is based on the primary survey of households and also norms scouted from various studies in the literature.

Tables 26 and 27 show the timber consumption by the household sector (for the year 2008) towards construction across agro-climatic regions of Tamil Nadu – estimated based on the results from the primary survey data and the norms, respectively.

Tables 28 and 29 show the timber consumption by the household sector (for the year 2008) towards furniture items in Tamil Nadu – estimated based on the results from the primary survey data and the norms, respectively.

Table 30 shows the timber consumption by the household sector (for the year 2008) towards agricultural implements in the rural Tamil Nadu.

In case of estimates based on norms, distinction is made between population living in close proximity to the forest areas and the population in areas farther from forests. With the exception of furniture, all other estimates are provided across the same

agro-climatic zones of TN for which the fuel-wood estimates are provided in the previous section.

Table 26: Timber Consumption for Construction in Household Sector: 2008 – Estimates based on Primary Survey Data

(in million cu.m.)

Agro-climatic Zone	Rural	Urban	Total
Cauvery	0.089	0.052	0.141
North East	0.091	0.094	0.185
West	0.041	0.091	0.132
North West	0.054	0.045	0.099
Hilly	0.003	0.007	0.010
Southern	0.087	0.090	0.177
Rainfall	0.001	0.021	0.022
Chennai	0.000	0.331	0.331
Total	0.366	0.731	1.097

Table 27: Timber Consumption for Construction in Household Sector: 2008 – Estimates based on Norms

(in million cu.m.)

Agro-climatic Zone	Rural		Urban		Total
	Forest Areas	Non-Forest Areas	Forest Areas	Non-Forest Areas	
Cauvery	0.024	0.143	0.014	0.086	0.267
North East	0.050	0.133	0.044	0.147	0.375
West	0.028	0.057	0.074	0.127	0.287
North West	0.043	0.072	0.034	0.064	0.213
Hilly	0.004	0.004	0.008	0.009	0.024
Southern	0.031	0.135	0.039	0.143	0.348
Rainfall	0.001	0.001	0.023	0.027	0.052
Chennai	0.000	0.000	0.000	0.109	0.109
Total	0.180	0.546	0.237	0.712	1.675

As could be seen from Tables 26 and 27, timber consumption estimated through primary survey data is lower than that based on the norms. However, the pattern of consumption across agro-climatic regions is almost similar across the two estimation procedures. Further, as revealed in Table 26, the demand in the urban centre Chennai is significantly higher as could be expected. Overall the demand for timber for construction is assessed as 1.097 million cu.m.

Table 28: Timber Consumption for Furniture in Household Sector: 2008 – Estimates based on Primary Survey

(in million cu.m.)

Furniture Item	Wood		Plywood	
	Chennai	Rest of TN	Chennai	Rest of TN
Dining Table	0.014	0.0029	0.0441	0.0091
Chair	0.0536	0.00867		
Cot	0.0113	0.00828	0.0128	0.0158
Table	0.0025	0.0023	0.0053	0.0048
Sofa	0.0158	0.0011		
Almirah			0.0165	0.0012
Total	0.0973	0.0232	0.0786	0.031

Table 29: Timber Consumption for Furniture in Household Sector: 2008 – Estimates based on Norms

(in million cu.m.)

Agro-climatic Zone	Rural		Urban		Total
	Non-Forest Areas	Forest Areas	Non-Forest Areas	Forest Areas	
Cauvery	0.005	0.057	0.004	0.055	0.121
North East	0.010	0.053	0.014	0.094	0.171
West	0.006	0.023	0.024	0.081	0.133
North West	0.009	0.029	0.011	0.041	0.089
Hilly	0.001	0.002	0.003	0.006	0.010
Southern	0.006	0.054	0.012	0.091	0.164
Rainfall	0.000	0.001	0.007	0.017	0.025
Chennai	0.000	0.000	0.000	0.070	0.070
Total	0.036	0.218	0.076	0.455	0.785

As could be seen from Tables 28 and 29, the timber demand for furniture is over-estimated if one were to depend on the norms. Against the total demand of 0.785 million cu.m., the primary survey provided a much lower demand of 0.2301 million cu.m. for timber across important furniture items in Tamil Nadu. The regional distribution of the demand for furniture is not attempted as the data was relatively small in some of the agro-climatic regions such as Hilly areas. Primary survey also showed that about 51 percent of the total wood consumption is for plywood in Tamil Nadu.

As the primary survey did not provide clear picture on the timber demand for agricultural implements in the rural sector, the estimation is restricted to that based on norms for rural Tamil Nadu. Given the evidence from the construction and furniture

estimates presented above, this estimate based on norms could be over-estimating the demand for timber for agricultural implements as well.

Table 30: Timber Consumption for Agricultural Implements in Household Sector: 2008

(in million cu.m.)

Agro-climatic Zone	Non-Forest Areas	Forest Areas	Total
Cauvery	0.031	0.189	0.221
North East	0.066	0.177	0.243
West	0.037	0.075	0.112
North West	0.057	0.096	0.153
Hilly	0.005	0.005	0.010
Southern	0.041	0.179	0.220
Rainfall	0.001	0.002	0.003
Chennai	0.000	0.000	0.000
Total	0.238	0.723	0.961

Overall demand for timber in the household sector in Tamil Nadu is estimated (based on results presented in Tables 26, 28 and 30) as, 2.2881 million cu.m.

Wood Demand by the Industrial Sector

Fuel-wood and Timber Demand by the Small-scale Industries

Along side the household primary survey, the small-scale industries using wood are also surveyed to assess the fuel-wood and timber demand by these industries in Tamil Nadu. Tables 31a to 31c show the profile of the industries surveyed.

Table 31a: Distribution of Industries across Annual Turnover Quartiles (in Rupees) in Rural and Urban Tamil Nadu

(in percent)

Sector	Annual Turnover – Quartiles (Rupees)				Total
	Less than 50000	50000 to 100000	100000 to 600000	More than 600000	
Rural	40.85	33.80	21.13	4.23	100
Urban	7.04	15.49	32.39	45.07	100
Total	23.94	24.65	26.76	24.65	100

The selection of industries is fairly uniform across the annual turnover quartiles. Further, there is more representation of low turnover units in the rural areas and high turnover units in the urban areas.

Table 31b: Distribution of Industries based on Nature of Business in Rural and Urban Tamil Nadu

(in percent)

Sector	Nature of Business			Total
	Industry	Wood Shop	Others	
Rural	27.40	13.70	58.90	100
Urban	45.95	22.97	31.08	100
Total	36.73	18.37	44.90	100

Table 31c: Distribution of Industries based on Purpose of Wood Use

Purpose of Wood Use	Number	Percent
As Fuel	29	19.73
As Raw Material	43	29.25
Others	17	11.56
None	58	39.46
Total	147	100

Of the total industrial units surveyed, about 60 percent units used wood in one or the other form. Based on the average consumption of fuel-wood and timber among the sampled industrial units, the agro-climatic zone-wise consumption of fuel-wood and timber are estimated for Tamil Nadu. For this purpose the district-wise distribution of the industries under the category 'wood and wood products' reported in the economic census is utilized. Annexure 7 reports the number of industrial units across districts under the 'wood and wood products' category as per the Economic Census over the recent years and projected number of units in 2008. The estimated fuel-wood and timber demand among the small-scale industrial units is reported in Table 32. Among the agro-climatic zones, the Southern zone consumes large quantity of wood both in the fuel-wood form and as timber. It is followed by North-East, Cauvery and North-West regions.

Table 32: Demand for Wood by Industries across Agro-climatic Zones

(million cu. m)

Agro-Climatic Zones	Wood Usage	
	Fuel	Timber
Cauvery	0.217	0.207
North East	0.337	0.322
Western	0.153	0.146
North West	0.207	0.197
Hilly	0.035	0.034
Southern	0.877	0.838
High Rainfall	0.151	0.144
Chennai	0.102	0.097
TOTAL	2.079	1.986

Thus, the wood demand by small-scale industrial units is 2.08 million cu.m. for fuel-wood and 1.98 million cu.m. for timber in 2008.

Timber Demand by the Organized Industries

Among the organized industries the most prominent industry in Tamil Nadu is paper and pulp industry. There are two major paper industries in Tamil Nadu – Tamil Nadu Newsprint and Papers Limited and Seshasayee Paper and Board Limited. The characteristics of the two plants are shown in Table 33.

Table 33: Wood and Wood Pulp Consumption in Paper Mills – Tamil Nadu

Characteristic	Tamil Nadu News Print Ltd.	Seshasayee Paper and Board Ltd.
Capacity (tons per year)	230000	122000
Timber consumption – 2004-05 (million cu.m.)	0.287777	0.248529
Timber consumption – 2005-06 (million cu.m.)	0.298614	0.218235
Timber consumption – 2006-07 (million cu.m.)	0.298069	0.210254
Timber consumption – 2007-08 (million cu.m.)	0.340422	N.A.

Total wood consumption in the organized sector in 2008 in Tamil Nadu is estimated as 0.5604 million cu.m.

Wood Demand by the Service Sector

Wood consumption in the form of fuel-wood and timber (towards construction and furniture) in the service sector is mainly assessed through a primary survey of tea-shops, hotels and other service providers. The 'others' include marriage halls, mid-day meal centers at schools, and petty-shops. A total of 261 service sector units are surveyed across all the agro-climatic zones along side the household survey to assess the fuel and timber needs of service sector. Aggregation to the Tamil Nadu state level is made through the use of census data on number of villages and towns across the agro-climatic zones. Some characteristics of the survey are reported in tables 34a to 34d.

Table 34a: Distribution of Survey Units Across Monthly Revenue (in Rupees) Quartiles for Agro-climatic Zones

(in percent)

Agro-Climatic Zones	Monthly Revenue (in Rupees)				Total
	Less than 4250	4250-10000	10000-32500	Greater than 32500	
Cauvery	53.3	20.0	13.3	13.3	100.0
North East	36.7	20.0	33.3	10.0	100.0
Western	18.2	38.6	25.0	18.2	100.0
North West	57.4	23.4	19.1	0.0	100.0
Southern	13.6	38.6	34.1	13.6	100.0
High Rainfall	0.0	10.0	90.0	0.0	100.0
Chennai	0.0	4.0	14.0	82.0	100.0
Total	25.0	23.8	26.3	25.0	100.0

As could be seen from Table 34a the survey units are fairly uniformly distributed across monthly revenue quartiles and also the agro-climatic zones, with the exception of High Rainfall and Chennai zones.

Table 34b: Distribution of Survey Units Across Nature of Business for Agro-climatic Zones

(in percent)

Agro-Climatic Zones	Nature of Business			Total
	Hotels	Tea Shops	Others	
Cauvery	20.00	53.33	26.67	100
North East	33.33	50.00	16.67	100
Western	28.30	22.64	49.06	100
North West	25.53	25.53	48.94	100
Southern	26.42	35.85	37.74	100
High Rainfall	50.00	40.00	10.00	100
Chennai	28.00	68.00	4.00	100
Total	27.97	39.85	32.18	100

Tea shops constitute almost 40 percent of the total sample, followed by 32 percent of units in 'others' category, and 28 percent of hotels.

Table 34c: Distribution Across Nature of Business for Rural and Urban Tamil Nadu
(in percent)

Sector	Nature of Business			Total
	Hotels	Tea Shops	Others	
Rural	28.9	34.8	36.3	100.0
Urban	27.6	46.3	26.0	100.0
Rural Share (%)	53.4	45.2	60.5	52.3

Table 34d: Distribution across Source of Firewood, Rural and Urban Tamil Nadu
(in percent)

Sector	Market	Forest Land	Other Area	No Response	Total
Rural	40.00	14.07	11.85	34.07	100
Urban	17.07	8.13	6.50	68.29	100
Total	29.07	11.24	9.30	50.39	100

The average fuel-wood consumption is estimated as 0.4 ton per month in tea-shops, 1.323 tons per month in hotels, and 0.6 ton per month in the 'other' units. The average timber consumption is estimated as 0.5 cu.m. per month among all the service units. Using this the overall consumption of fuel-wood and timber among various categories of service sector units is reported in Table 35.

Table 35: Fuel-wood and Timber Consumption Among Service Sector Units in Tamil Nadu

Detail	Fuel-wood			Timber
	Tea Shops	Hotels	'Others'	
Consumption	0.34	0.78	0.42	0.292

Total fuel-wood consumption in 2008 is estimated as 1.54 million cu.m. and timber consumption is assessed as 0.292 million cu.m.

Overall Wood Demand in Tamil Nadu

Putting together the demand for fuel-wood and timber across the household, industrial and service sectors, the overall demand for wood is arrived at in Tamil Nadu for the year 2008. Table 36 presents the overall demand for wood in Tamil Nadu.

Table 36: Overall Demand for Wood in Tamil Nadu – 2008

(in million cu.m.)

Sector	Wood Demand		Total
	Fuel-wood	Timber	
Household	19.73 (84.5)	2.288 (44.6)	22.02 (77.3)
Industry	2.08 (8.9)	2.553 (49.7)	4.63 (16.3)
Services	1.54 (6.6)	0.292 (5.7)	1.83 (6.4)
Total	23.35 (100)	5.133 (100)	28.48 (100)

Note: The numbers in brackets are percentages.

Timber demand constitutes about 18 percent of the overall wood demand in Tamil Nadu. In terms of wood variety, 'Teak', 'Padak', and 'Neem' are among the widely used varieties. Table 37 shows the wood varieties used for construction and furniture in different sectors.

Table 37: Wood Varieties used in Different Sectors

(in percent)

Wood Variety	Household	Industry		Service	
	Furniture	Construction	Furniture	Construction	Furniture
Teak	37	22	15	23	32
Padak	19	30	52	0	27
Neem	4	1	0	23	8
Others	40	47	33	54	32

One of the major limitations of the estimated demand is that it does not include the transfers from TN to other states. Since data from the state border check-posts could not be obtained it has not been included in the analysis.

Chapter 5

WOOD SUPPLY IN TAMIL NADU

Supply of wood is assessed through various secondary sources including: (a) forest statistics of Tamil Nadu; (b) agricultural statistics of Tamil Nadu; (c) trees-outside-forest database of Forest Survey of India; (d) port-specific imports data from Chennai and Tuticorin ports; and (e) Multi-purpose tree database (MARAM) prepared by the French Institute of Pondicherry.

The study has also carried out a survey of villages where the household demand survey has been conducted to assess the stock of trees in plantations and out-side forest areas. However, the survey results have not been very satisfactory and hence are not used for supply analysis here.

The following sections present the assessment made with regard to the supply of wood.

Wood Supply from the Forests

Table 4 in section 2.3 reports time series data of forest produce from Tamil Nadu forests. From the latest year's data (2006-07) the forest produce in TN were taken as follows:

Fuel-wood: 0.09015 million cu.m.
Timber: 0.008013 million cu.m.
Pulpwood: 0.059186 million cu.m.

Besides the reported statistics it is possible that people living in the vicinity of forest areas would be collecting wood for fuel purposes. The estimation of this made was made as follows:

- a) Based on FSI (1995) estimates, the growing stock of forests in Tamil Nadu was taken as 69.602 million cu.m.
- b) With a rotation length of about 99.86 years, the annual increment of growing stock was estimated using Von Montel's formula

$$t = 2 * GS / R$$

where, t is the annual increment

GS is the growing stock

R is the rotation length of the dominant species

The annual increment in TN forests is calculated as 1394000 cu.m.

- c) Assuming that 30 percent of the annual increment would be available as fuel-wood for collection, the annual availability of fuel-wood was estimated as 418200 cu.m.
- d) Further assuming that 20 percent of the forest area will not be accessible, the feasible annual availability of fuel-wood was estimated as 334560 cu.m., or 0.33456 million cu.m.

Thus, the total fuel-wood supply from forests is taken as 0.42471 million cu.m. and total timber supply from forests is taken as 0.0672 million cu.m.

Wood Supply from Trees Outside Forests

There is growing evidence that people depend to a large extent on the trees-outside-forests for both fuel-wood and timber needs. Recently Pandey (2008) made an estimate of growing stock of trees in all the physiographic zones of India using the survey data collected over the period 2002-2005 by the Forest Survey of India. Accordingly the volume of growing stock in the three physiographic zones that cover Tamil Nadu is estimated as:

Western Ghats:	109.273 million cu.m.
Eastern Ghats:	89.839 million cu.m.
East Coast:	109.439 million cu.m.

Out of this, 84.77 million cu.m. of growing stock is attributable to Tamil Nadu (estimated based on the geographical area of Tamil Nadu and the area under each of the physiographic zones). The annual increment of wood is calculated using Von Montel's formula and rotation length that is half the rotation assumed in case of trees inside forests. The annual increment is accordingly estimated as 3.391 million cu.m. from the trees-outside-forests in Tamil Nadu. Of this 30 percent is taken as fuel-wood and the remaining as timber.

Further, the fuel-wood demand estimates made using primary survey data indicated that a substantial portion of the demand is met through non-market sources (Table 23). The fuel-wood in such cases would be collected from sources near to home. The supply of fuel-wood from these sources is estimated by multiplying the agro-climatic zone specific non-market share of fuel-wood (Table 23) with the demand figures. The total supply of fuel-wood assessed is 8.5313 million cu.m.

Thus, the fuel-wood from trees-outside-forests in Tamil Nadu is taken as 9.5486 million cu.m. and the timber from the same source is estimated as 2.374 million cu.m.

Wood Supply from Plantations and Agro-forestry

In the agricultural lands farmers grow trees for commercial purposes and agricultural statistics division of Tamil Nadu government provides the area under various trees in its Crop and Season Reports. Using such data and available evidence from literature on mean-annual-increment (MAI) for various tree crops, the wood availability from plantations and agro-forestry is estimated. Table 38 provides the estimated wood availability from these sources in Tamil Nadu. It is assumed that with the exception of 50 percent of Casuarina wood, all other wood could be used as timber.

Table 38: Wood Availability from Agricultural Lands in Tamil Nadu

(in cu.m.)

Tree Variety	Irrigated Land	Unirrigated Land	Total Wood Availability
Teak	1038	3888	4926
Eucalyptus	21576	143916	165492
Casuarina	682513	1098326	1780838
Babul	231	1900	2131
Bamboo	5712	56459	62171
Total			2015558

Thus, total fuel-wood available from this source is 0.8904 million cu.m. and total timber available from the plantations is 1.125 million cu.m.

Wood Supply from Imports

There are two sea ports in Tamil Nadu – Chennai and Tuticorin. While Chennai port receives wood in both log and wood-pulp forms, bulk of the imports at Tuticorin are in log form only. Table 39 shows the import of wood to these two ports over the past few years.

Table 39: Import of Wood at Tamil Nadu Ports

(in tons)

Year	Chennai Port		Tuticorin Port
	Wood Logs	Wood Pulp	Wood Logs
2004-05	90763	38487	476459
2005-06	76099	41684	428295
2006-07	91988	59654	451916
2007-08	94168	65961	523188

Thus, total timber supply from this source for Tamil Nadu for the year 2008 is taken as 0.9747 million cu.m.

Wood Supply from Other Sources

The balance of demand after accounting for all the supply sources discussed in the sections 5.1 through 5.4 is taken as supply from other sources. These include supply from neighboring states such as Kerala – which according to Krishnankutty et al. (2005) contributes a substantial amount of wood to Tamil Nadu.

The supply of timber from the other sources is estimated as 0.5924 million cu.m. and that of fuel-wood is assessed as 12.486 million cu.m.

Overall Wood Supply in Tamil Nadu

Table 40 provides an overview of the supply and demand for timber and fuel-wood in Tamil Nadu in 2008.

Table 40: Overall Supply of Wood in Tamil Nadu – 2008

(in million cu.m.)

Supply Source	Fuel-wood	Timber	Total
Forests	0.42 (1.8)	0.07 (1.3)	0.49 (1.7)
Trees-outside-Forests	9.55 (40.9)	2.37 (46.2)	11.92 (41.8)
Farm-Forestry	0.89 (3.8)	1.13 (21.9)	2.02 (7.1)
Imports	0 (0)	0.97 (19.0)	0.97 (3.4)
Other Sources	12.49 (53.5)	0.59 (11.5)	13.08 (45.9)
Total	23.35 (100)	5.13 (100)	28.48 (100)

Note: The figures in brackets are percentages.

Chapter 6

WOOD SUPPLY-DEMAND GAP IN TAMIL NADU

As could be seen from Tables 36 and 40, there is a significant demand-supply gap for wood – especially, fuel-wood in Tamil Nadu. For closure purpose this gap is attributed to ‘other sources’ under the supply estimation. While some of it could be due to conservative estimates of wood supply from forests areas, the bigger challenge is to identify the means for controlling the fuel-wood demand in Tamil Nadu. Here an attempt has been made to generate a few future scenarios of demand for fuel-wood as well as timber. For fuel-wood, five year projection period is considered, whereas for timber, demand projection over the next ten years is presented.

Future Projections of Fuel-wood Demand in Tamil Nadu

Discussion here focuses on the fuel-wood demand projections in rural and urban Tamil Nadu under various scenarios. The scenarios considered include: (a) same population growth rate to continue for next five years; (b) more urbanization over the next five years; (c) a twenty percent decline in per capita consumption of fuel-wood over the next five years under the two urbanization scenarios considered in (a) and (b); and (d) a forty percent decline in per capita consumption of fuel-wood over the next five years under the two urbanization scenarios considered in (a) and (b).

It must be noted that decline in per capita fuel-wood consumption envisaged under these scenarios would be feasible only if the ‘cleaner’ fuels like kerosene and LPG make significant penetration in both urban and rural areas. However, looking at the past data at rural and urban Tamil Nadu, only LPG penetration has shown consistent increase. Kerosene – which typically serves as the transition fuel – showed fluctuating trend. Table 41 shows the change in overall consumption of various cooking fuels at household level in Tamil Nadu over the period 1993-94 and 2004-05.

Table 41: Changes in Consumption Pattern of Cooking Fuels

(in percent)

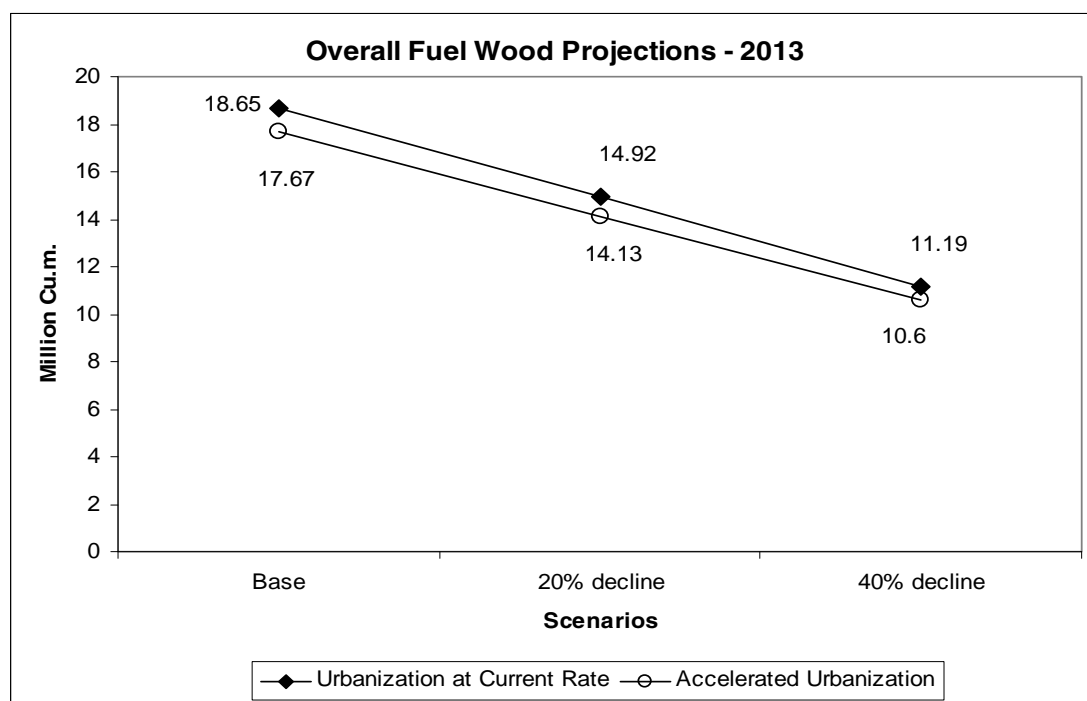
Cooking Fuel	Rural		Urban	
	1993-94 to 1999-2000	1999-2000 to 2003-04	1993-94 to 1999-2000	1999-2000 to 2003-04
Fuel-wood	14.5	24.4	-31.4	35.7
Kerosene	33.3	-37.5	18.6	-49.0
LPG	150.0	50.0	100.0	50.0

As could be seen from the above table, penetration of 'cleaner' fuels is not consistent. While LPG penetration has been consistent, kerosene consumption has declined between 1999-2000 and 2003-04. Due to decline in kerosene consumption, fuel-wood consumption has increased. It is against this background the future fuel-wood demand scenarios should be analyzed. Table 42 shows the fuel-wood demand under various future scenarios in Tamil Nadu. Figures 10 and 11 present the information graphically.

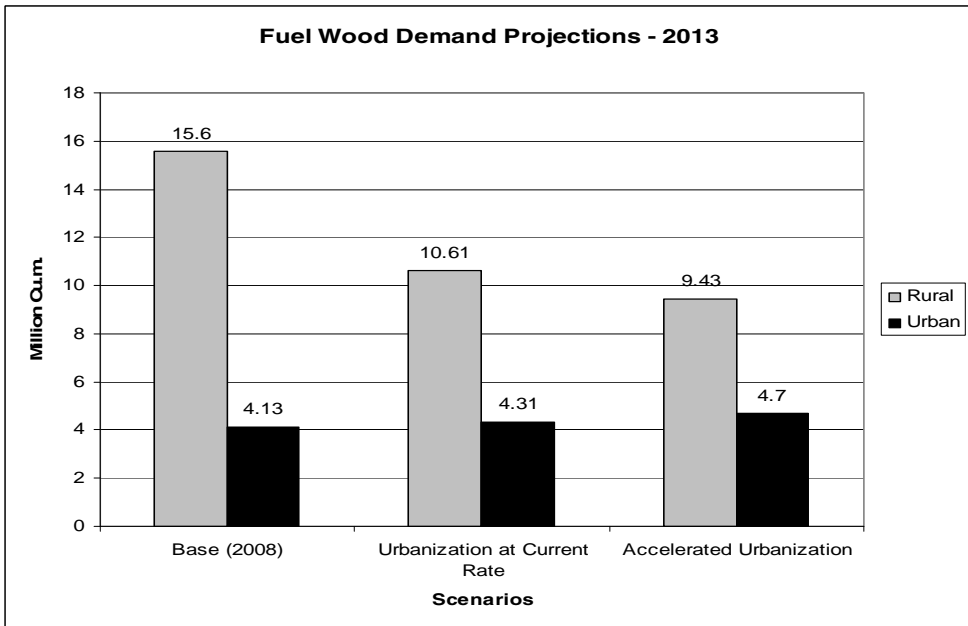
Table 42. Fuel-wood Consumption Scenarios – 2013 (in million cu.m.)

Scenario	Rural	Urban	Total
Base (2008)	15.60	4.13	19.73
Urbanization at Current Rate	13.27	5.38	18.65
Accelerated Urbanization	11.79	5.87	17.67
20% Decline in per-capita fuel-wood consumption			
Urbanization at Current Rate	10.61	4.31	14.92
Accelerated Urbanization	9.43	4.70	14.13
40% Decline in per-capita fuel-wood consumption			
Urbanization at Current Rate	7.96	3.23	11.19
Accelerated Urbanization	7.08	3.52	10.60

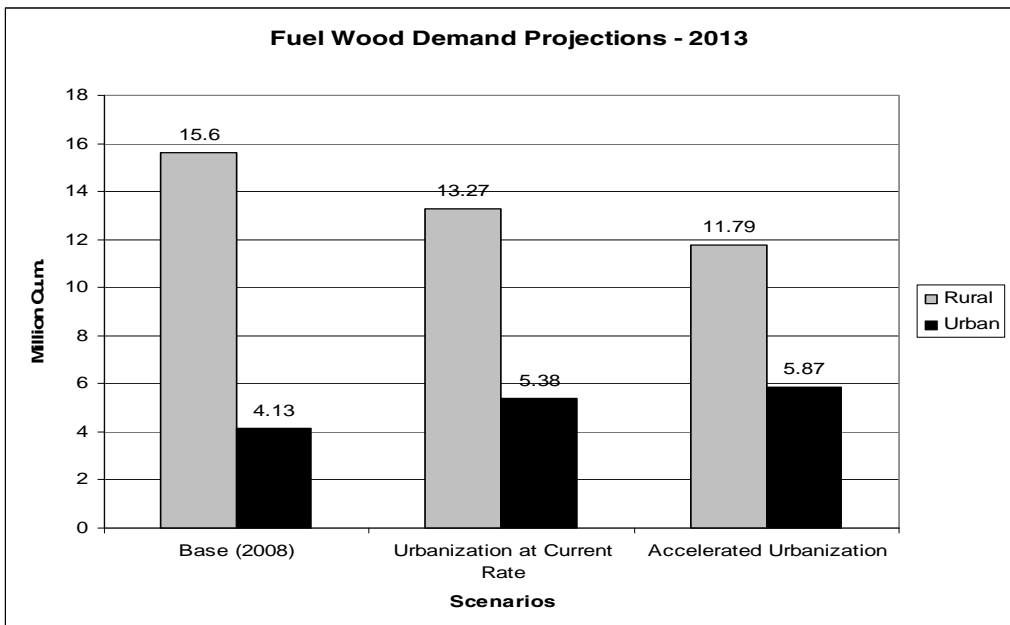
Figure 10: Fuel-wood Demand Projections in Tamil Nadu - 2013



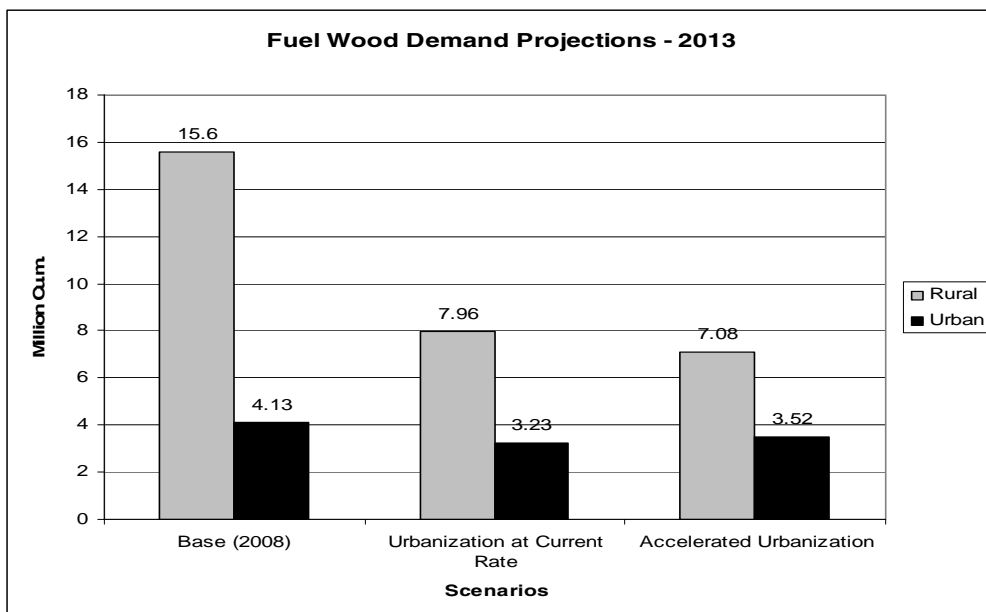
**Figure 11a: Fuel-wood Demand Projection Across Rural and Urban TN – 2013:
Prevailing Average Per-capita Consumption**



**Figure 11b: Fuel-wood Demand Projection Across Rural and Urban TN – 2013:
20% Decline in Per-capita Consumption**



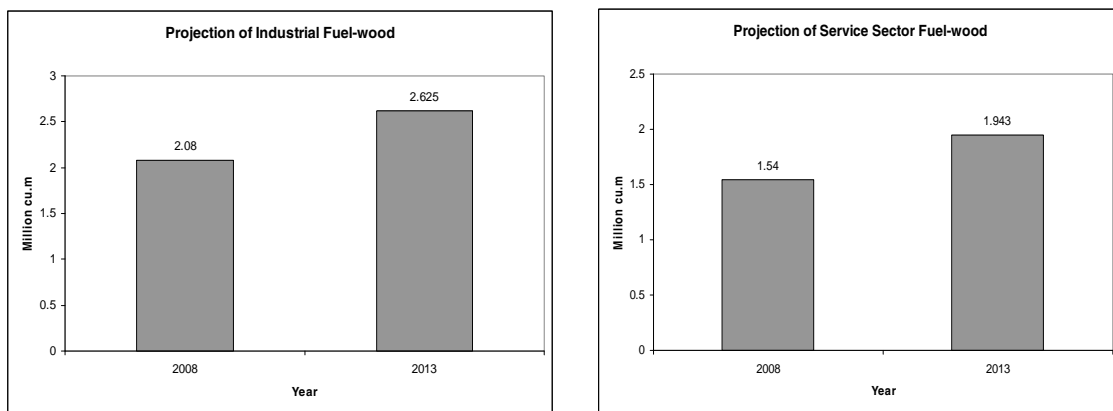
**Figure 11c: Fuel-wood Demand Projection Across Rural and Urban TN – 2013:
40% Decline in Per-capita Consumption**



Thus it is clear that while urbanization at current rate would bring down the fuel-wood consumption by 5 percent, accelerated urbanization will double the rate of decline in fuel-wood consumption. Twenty percent decline in per-capita fuel-wood consumption will bring down the overall fuel-wood consumption between 24 and 28 percent under the two urbanization scenarios. Forty percent decline in per-capita fuel-wood consumption will reduce the overall fuel-wood consumption by 43 and 46 percent under the two urbanization scenarios. Such decline in fuel-wood consumption alone can effectively bridge the gap between the supply and demand in Tamil Nadu.

Fuel-wood consumption in the industrial and service sectors is also projected for the year 2013 and Figure 12 shows the projected fuel-wood demand in these sectors under the scenario of constant population projection (at the prevailing rate of growth) and 20 percent increase in the per-capita consumption over the next five years. Under this scenario total fuel-wood demand from the industrial and service sectors increases by about 26 percent over the next five years.

Figure 12: Fuel-wood Demand Projection in Industrial and Service Sectors of Tamil Nadu – 2013



Future Projections of Timber Demand in Tamil Nadu

Timber demand is projected across sectors for two future years – 2013 and 2018. In each case two scenarios are considered: (a) constant population growth rate accompanied by unchanged per-capita consumption; and (b) declining population growth rate along with increased per-capita consumption. The factors contributing to increase in per-capita consumption of timber in the household sectors include growth in construction sector and growth in income. The per-capita timber consumption in the household sector is assumed to increase by 20 percent over the next five years and by 10 percent in the subsequent five years. In case of industrial timber demand, increase in the growth of the paper and pulp industry is expected to play an important role, which in turn is positively effected by the rising literacy levels. The per-capita consumption of industrial timber is assumed to grow by 20 percent over the next ten years. In service sector, the boom in construction of office and commercial buildings is expected to rise the timber demand. The per-capita consumption of timber in service sector is assumed to grow by 20 percent over the next five years and by 15 percent over the subsequent five years. Using these assumptions the projections of timber demand are made and figures 13, 14 and 15 present the estimated future demand in the household, industrial, and service sectors.

Figure 13: Timber Demand Projection in Household Sector of Tamil Nadu – 2013 and 2018

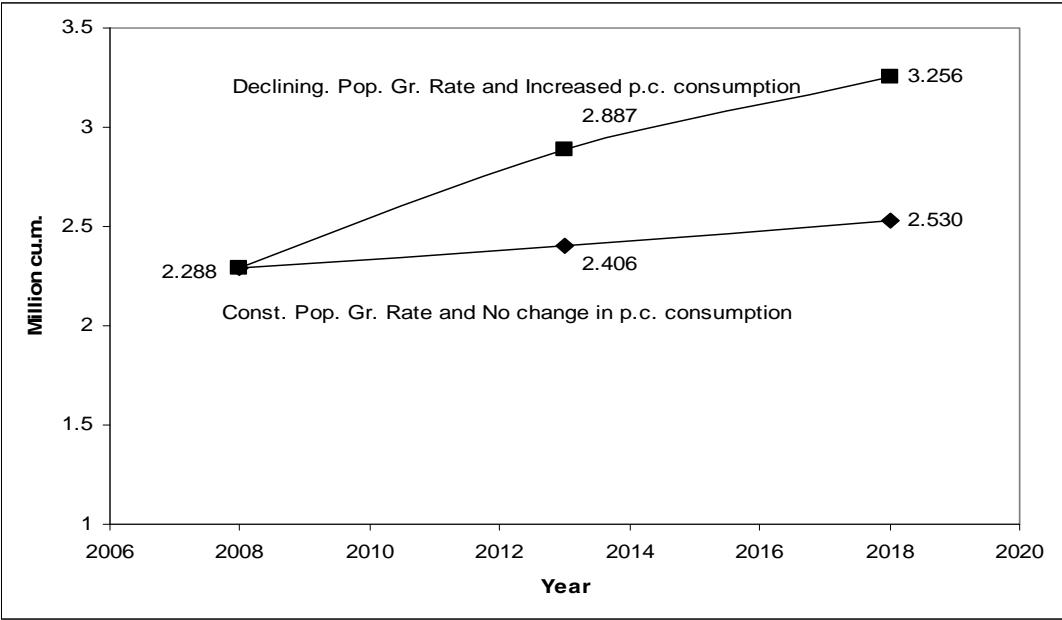


Figure 14: Timber Demand Projection in Industrial Sector of Tamil Nadu – 2013 and 2018

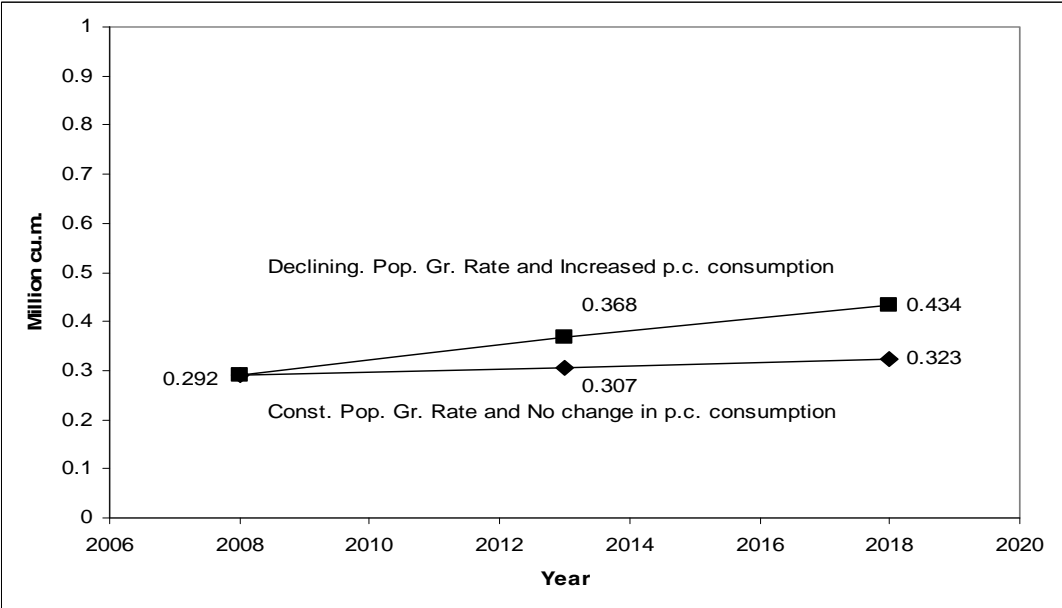
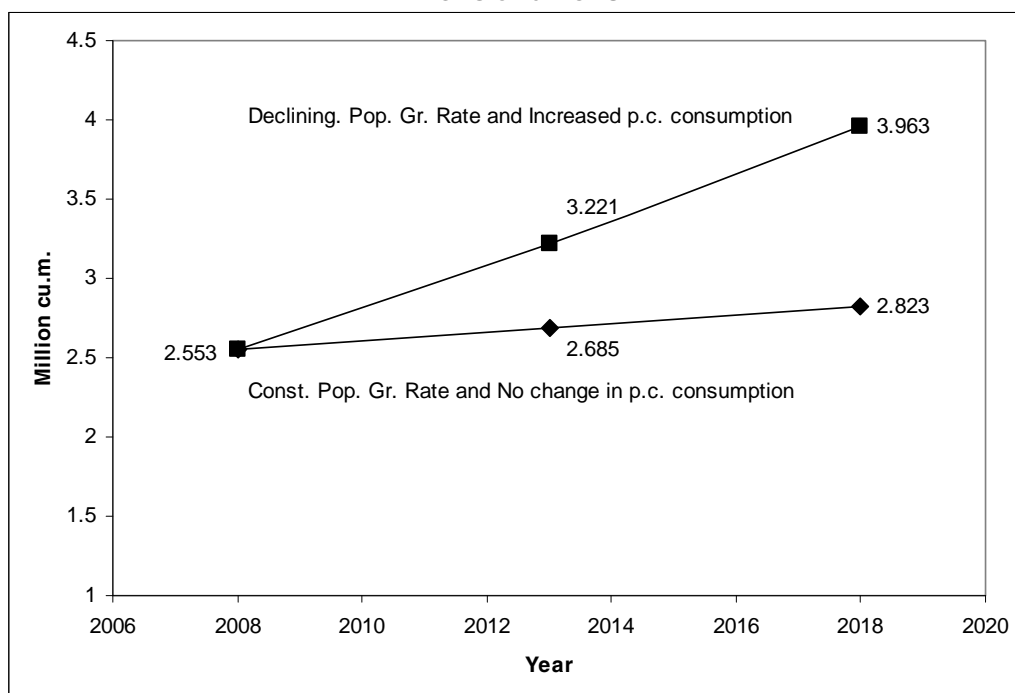


Figure 15: Timber Demand Projection in Service Sector of Tamil Nadu – 2013 and 2018



Putting together, the total demand for fuel-wood under various scenarios would vary between 15.17 to 23.22 million cu.m. by 2013. Household sector, which presently contributes to about 84.5 percent of the total fuel-wood demand, continues to dominate with its contribution ranging between 70 to 80 percent by 2013.

The total demand for timber under various scenarios would vary between 5.4 to 6.5 million cu.m. by 2013 and between 5.7 and 7.7 million cu.m. by 2018.

Chapter 7

RECOMMENDATIONS FOR ACTION PLAN

Given the substantial gap in wood demand and supply at present and also in future, there is a significant role to be played by the State Forest Department. Alongside the large number of impressive programs that the Department is currently implementing to ensure sustainable management of the forests in the state, the following may be considered for implementation in future to bridge the supply-demand gap.

Demand-side Responses

- The study has clearly indicated that demand for fuel-wood is still high in the rural areas of Tamil Nadu. An assessment of distribution network including the regular supply of LPG cylinders should be made to reduce the usage of firewood even among households who possess LPG cylinders. The usage of kerosene is found to be higher among urban than rural households, perhaps reflecting the urban bias in public distribution system. Since use of kerosene could facilitate transition of households from firewood to LPG and other cleaner alternatives, efforts must be made to ensure greater penetration of kerosene among rural households.
- Another aspect of clean cooking fuel would be to encourage private and publicly funded research and venture capital to finance the research on appliances and devices that can promote use of renewable energy like solar and wind energy.
- The residential and commercial construction is growing at a fast rate given the pace of urbanization and hence the demand for wood is increasing. Incentives to find alternate materials that are cost-effective and environment friendly should be given high priority. State funding for research on minimizing the use of wood in construction would lead to further private investment for this purpose. This should also be supported by the training of personnel in the construction sector for further strengthening this transition.
- Similarly research for alternate material for sleepers in the railway tracks and in manufacturing of the body of buses and trucks should be encouraged.

Supply-side Responses

- The Forest Department has initiated several schemes for encouraging farmers to take-up tree plantations – for timber as well as other purposes. This should be further strengthened by publicizing the economic viability of tree plantation as alternative to agriculture, as well as tree plantation alongside agriculture. Recent

evidence from Tamil Nadu suggest that the benefit-cost ratios of Karuvel and Teak trees range between 2.2 to 3.1 (Joseph, 2008), indicating significant benefits of undertaking tree plantation to the producers.

- While the efforts to reduce the demand for fuel-wood should continue, the Department could also explore options of bringing wasteland under cultivation for fuel-wood supply. Fuel-wood shortage could be effectively addressed by utilizing about 380,000 hectares of cultivable wasteland, and about 950,000 hectares of fallow land. Pandey (2002) argued that these low productive lands would support bushy vegetation that could be suitable for fuel-wood purposes.
- Since the carbon absorbed during the growth of the vegetation is released during the combustion of the fuel-wood, the fuel-wood consumption for cooking purposes could be seen as environment friendly compared to the conventional fuels such as LPG and kerosene which are net-emitters of greenhouse gases. For financing the utilization of waste and fallow lands, the Department could hence explore the CDM opportunities.
- For financing purposes, the Department should explore the opportunities available through 'clean development mechanism' – one of the greenhouse gas mitigation options under the Kyoto Protocol. Since growing trees absorb carbon dioxide and if the end-use of the timber is for non-combustion, then tree growing works as an effective greenhouse gas mitigation strategy. Several private entrepreneurs with assistance from international organizations such as Danish Forestry Extension are presently availing external financial assistance through tree plantations. The Department should make efforts for widespread publicity of these initiatives to ensure large-scale adoption of tree farming by the private farmers.

Integrated Responses

- Since inefficient combustion of fuel-wood would lead to production of 'black-carbon', recent studies have argued that fuel-wood could be considered as a net-emitter of greenhouse gases. Inefficient combustion also leads to health problems due to the particulate matter emissions. Hence an integrated effort involving the departments of environment, forests, and health is needed to ensure realization of multiple goals of greenhouse gas reduction, reducing health burden and bridging the supply-demand gap of fuel-wood.
- Similarly, materials like concrete, whose use in the construction sector is high or is being considered as a replacement for wood in some sectors. However, their

use causes higher emission of greenhouse gases and an integrated approach must be adopted to address the multiple objective of reducing resource degradation and improving environmental quality.

- An important contribution would be made by the State Forest Research Institute to interact on a regular basis with other departments and ministries of the government as well as the industrial federations and business associations to improve their awareness in order find viable solutions that allow for sustainable use of wood as well as effective implementation and monitoring of the green cover within the state.

Chapter 8

LIMITATIONS AND SCOPE FOR FURTHER WORK

Wood balance studies are helpful in identifying appropriate points of policy intervention for effective utilization of the wood resources in a region. While this study with the objective of assessing the demand and supply of wood in Tamil Nadu – where a previous study of similar objective was carried out in early 1980s – fills an important gap in the literature, there are some limitations and scope for further work clearly exists.

Some of limitations include:

- (a) The movement of wood within the state and across the state borders could not captured due to lack of data. Such data would help in capturing the net flow of wood from neighboring states, and also provide scope for identifying the districts/regions within the state that attract bulk of the wood.
- (b) Supply of wood from trees outside forests could be assessed more accurately by undertaking a structured survey of tree stock by the qualified forest staff.

Some of the limitations could serve as extensions for further work. More specifically, following the framework used in this study, a comprehensive work with more focus on wood supply can be undertaken. Such work should more appropriately be undertaken by the Forest Research Institute (with limited inputs from external agencies) as they are best placed to access various statistics necessary for the study and have knowledge about the different species constituting wood supply and demand.

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Annexure 1

Conversion Factors

Volume	1 cu.m.	35.31 cu.ft
Weights		
- Fuel Wood	700 kg	
- Timber	800 kg	
Pulp and paper		
- Mechanical	1 metric ton (air dry)	2.55 cu.m. round wood
- Chemical	1 metric ton (air dry)	5.04 cu.m. round wood
Green log to pulp ratio		4:1

Annexure 2

Mapping of Districts with Agro-Climatic Zones of Tamil Nadu
Table A3. District Population Proportions Attributable to Agro-Climatic Zones

Agro-climatic Zone	Districts	Taluks	Share of Population in the District	
			Rural	Urban
Cauvery Delta Zone	Thanjavur	All taluks	1	1
	Nagapattinam	All taluks	1	1
	Thiruvarur	All taluks	1	1
	Tiruchirappalli	Musiri, Tiruchirappalli, Lalgudi, Thuraiyur and Kulithalai	1	1
	Pudukottai	Aranthangi	0.14	0.16
	Cuddalore	Chidambaram	0.31	0.23
	Villupuram	All taluks	1	1
North Eastern Zone	Kancheepuram	All taluks	1	1
	Tiruvallur	All taluks	1	1
	Vellore	except Yelagiri and Javadhi	1	1
	Thiruvannamalai	All taluks	1	1
	Cuddalore	excluding Chidambaram	0.69	0.77
	Ariyalur	All taluks	1	1
	Western Zone	Erode	All taluks	1
	Coimbatore	except Anaimalai	0.9	0.9
	Namakkal	Tiruchengode	0.3	0.45
	Karur	All taluks	1	1
	Madurai	Usilampatti, Vadipatti & Peraiyur	0.4	0.1
	Theni	All taluks	1	1
North Western Zone	Dharmapuri	Excluding hilly areas	0.95	0.95
	Salem	excluding Shevroys	0.95	0.95
	Namakkal	Excluding Tiruchengode Taluk and Kollimalai	0.7	0.55
	Perambalur	excluding Pachamalai	0.95	0.95

(Contd... Table A3)

Agro-climatic Zone	Districts	Taluks	Share of Population in the District	
			Rural	Urban
Hilly zone	Nilgiris	All taluks	1	1
	Dindigul	Palani	0.001	0.001
	Dindigul	Kodaikanal	0.001	0.001
	Salem	Yercaud	0.001	0.001
	Tirunelveli	Podhigai malai	0.001	0.001
	Coimbatore	Anaimalai	0.001	0.001
	perambalur	Pachaimalai	0.001	0.001
	Namakkal	Kollimalai	0.001	0.001
	Vellore	Yelagiri and Javadhi	0.001	0.001
	Salem	Shevroys	0.001	0.001
Southern Zone	Ramanathapuram	All taluks	1	1
	Virudunagar	All taluks	1	1
	Sivaganga	All taluks	1	1
	Tuticorin	All taluks	1	1
	Tirunelveli	except Podhigai malai	1	1
	Dindigul	except Palani	1	1
	Pudukottai	excluding Aranthangi taluk	0.86	0.84
	Madurai	Natham, Melur, Tirumangalam, Madurai South and Madurai North taluks	0.6	0.9
High Rainfall zone	Kanyakumari	All taluks	1	1

Annexure 3

NSS Regions in Tamil Nadu

Region	Districts		
Coastal Northern	Thiruvallur Kancheepuram Cuddalore	Chennai Vellore	Tiruvanamalai Viluppuram
Coastal	Karur Tiruchirappalli Perambalur	Ariyalur Pudukkottai Thanjavur	Nagapattinam Thiruvarur
Southern	Dindigul Sivaganga Madurai	Virudhunagar Theni Kanniyakumari	Ramanathapuram Toothukudi Tirunelveli
Inland	Dharmapuri Salem	Namakkal Coimbatore	Erode The Nilgiris

NSS Region	Districts (Old and New)
Coastal Northern	Chennai (Madras) Thiruvallur + Kancheepuram (Chengai Anna/Chengalpattu) Tiruvannamalai (Thiruvannamalai-sambuvarayar) Vellore (North Arcot-Ambedkar) Villupuram + Cuddalore (South Arcot)
Coastal	Karur + Perambalur + Ariyalur + Tiruchirappalli Nagapattinam + Thiruvarur + Thanjavur Nagapattinam-Quaie-E-Milleth Pudukkottai
Southern	Madurai + Theni Ramanathapuram Virudhunagar (Kamarajar) Dindigul (Dindigul-Quide Milleth/Anna) Tirunelveli-Kottabomman Kanniyakumari (Nagercoil) Sivaganga (Pasupomthevar) Thirumaganar Toothukudi (V.O. Chidambaram)
Inland	Dharmapuri Salem + Namakkal Erode (Periyar) Coimbatore Nilgiri (Udhagamandalam)

Annexure 4

In order to compare the increase in total cooking fuel consumption overtime different cooking fuels are combined using equivalent energy content of each fuel. The energy conversion factors used in the analysis are shown below in the table:

Energy Conversion factors – in mega-joules per unit of fuel

Coke	Firewood	Dung	Coal	Charcoal	LPG	Kerosene[#]
28.5	15.5	12	29.3	29	45.6	35

This figure is per litre

Annexure 5

Description of Variables Used for the Regression Models Reported in the Determinants of Fuel-Wood Consumption section

Variable	Description
Impce	Log of monthly per capita expenditure
svlpgt	Share of expenditure on LPG in total cooking fuel expenditure
svkerot	Share of expenditure on kerosene in total cooking fuel expenditure
dcpdsker	Takes a value one if household purchases kerosene from PDS and uses it for cooking and zero otherwise
	Dummy variables for agro-climatic zones with the base taken as the first zone (Cauvery)
_lagrcl_2	Dummy variable for agro-climatic zone 2 (Northeast)
_lagrcl_3	Dummy variable for agro-climatic zone 3 (West)
_lagrcl_4	Dummy variable for agro-climatic zone 4 (Northwest)
_lagrcl_5	Dummy variable for agro-climatic zone 5 (Hilly)
_lagrcl_6	Dummy variable for agro-climatic zone 6 (Southern)
_lagrcl_7	Dummy variable for agro-climatic zone 7 (Rainfall)
_lagrcl_99	Dummy variable for agro-climatic zone 99 (Chennai)
hhsz	Household size and captures economies of scale in household consumption
prchld	Proportion of children(0-14years) in the household
prold	Proportion of elderly (above 55 years of age) in the household
dscst	Takes a value one if the household belongs to scheduled caste or tribe and zero otherwise
dobc	Takes a value one if the household belongs to other backward class (OBC) and zero otherwise
drseag	Takes a value one if the household occupation is self-employed in agriculture in rural areas and zero otherwise
drsenag	Takes a value one if the household occupation is self-employed in non-agriculture in rural areas and zero otherwise
draglab	Takes a value one if the household occupation is an agriculture labour household in rural areas and zero otherwise
duse	Takes a value one if the household occupation is self-employment in urban areas and zero otherwise
dure	Takes a value one if the household occupation is regular salaried in urban areas and zero otherwise
ducl	Takes a value one if the household occupation is casual labour in urban areas and zero otherwise
_lland_qua~2	Takes a value 1 if the household belongs to the 2 nd quartile of landholding group and zero otherwise
_lland_qua~3	Takes a value 1 if the household belongs to the 3 rd quartile of landholding group and zero otherwise

_lland_qua~4	Takes a value 1 if the household belongs to the 4 th quartile of landholding group and zero otherwise
prsse	Proportion of household members who have completed secondary schooling and above
_cons	Intercept

Annexure 6

Industrial Units under 'Wood and Wood Products' Category in Tamil Nadu

District	Number of Units under 'Wood and Wood Product' category			
	2003	2004	2005	2008*
Vellore	629	664	674	682
Cuddalore	1172	1389	1403	1419
Dindigul	361	377	388	392
Kancheepuram	1053	1068	1080	1092
Coimbatore	760	777	800	809
Dharmapuri	586	604	611	618
Virudhanagar	5066	5086	5097	5154
Kanyakumari	1421	1499	1523	1540
Chennai	857	897	1029	1041
Madurai	755	778	789	798
Nilgiris	339	357	358	362
Sivagangai	313	320	325	329
Erode	350	372	385	389
Pudukkottai	431	439	449	454
Ramanathapuram	211	212	215	217
Salem	1315	1321	1323	1338
Thanjavur	418	437	458	463
Trichirapalli	733	742	751	759
Tirunelveli	505	540	553	559
Thoothukudi	1004	1280	1302	1317
Nagapattinam	313	326	336	340
Thiruvannamalai	268	281	288	291
Villupuram	70	112	117	118
Karur	74	88	98	99
Perambalur	70	83	91	92
Theni	96	103	106	107
Namakkal	84	85	97	98
Thiruvallur	269	288	332	336
Thiruvarur	78	78	81	82

* Projected

Source: Economic Census

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