

8.1 Introduction

Urban tree resources play an important role in urban life due to rapid economic growth and urbanisation. Urbanisation has become a global phenomenon. More than half of world's population, 3.3 billion people are living in urban areas. By 2030, this is expected to rise to almost five billion. While the world's urban population grew very rapidly from 220 million to 2.8 billion over the 20th century, the next few decades will see an unprecedented scale of urban growth in the developing world. This will be particularly notable in Africa and Asia where the urban population will be doubled between 2000 and 2030. The accumulated urban growth of these two regions during its whole span of history will be doubled in a single generation. By 2030, the towns and cities of developing world will make up 80 percent of urban humanity (state of world population 2007).

As far as the population in Asia Pacific Region is concerned, it constitutes about 61 per cent of the world population out of which about 43 per cent population is in the urban areas. The Asia Pacific region constitutes the second lowest urban proportion of a region in the world. However, in the last two decades, the Asia-Pacific urban proportion has risen by 29 percent, more than any other region. Within Asia and Pacific, the Pacific sub-region is the most urbanised, with 71 percent of the population living in the cities and towns. In contrast, South and South-West Asia is the least urbanised with only 33 per cent of the population living in urban areas. However, in terms of urban population growth, south and south-west had the fastest growth rate with an average of 2.4 percent in the Asia and Pacific region.

As per the Population Reference Bureau, the 10 most populous countries of the world in 2013 and 2050 would be:

Table 8.1: Population of Top Ten Countries in 2013 and 2050

2013		2050 (Projected)	
Countries	Population (million)	Countries	Population (million)
China	1,356	India	1,652
India	1,277	China	1,314
United States	316	Nigeria	440
Indonesia	249	United States	400
Brazil	196	Indonesia	366
Pakistan	191	Pakistan	363
Nigeria	174	Brazil	227
Bangladesh	157	Bangladesh	202
Russia	143	Congo Dem. Rep	182
Japan	127	Ethiopia	178

As evident from the above table, India is going to be the most populous country of the world by 2050. As per the census 2011, the level of urbanisation in India has increased from 27.81 per cent in 2001 to 31.16 in 2011. The growth rate of urban population in India has increased from 31.5 per cent as observed during 1991-2001 to 31.8 per cent in the period 2001-2011. The numbers of towns, statutory towns and census towns have been increased in the census of 2011 from 5,161 to 7,935, 3,799 to 4,041 and 1,362 to 3,849 respectively. Thus there is an increase of 2,774 towns, 242 statutory towns and 2,352 towns during the decade 2001-2011. Among states, Maharashtra has the maximum urban population of 50.8 million (13.5 per cent of the country's urban population), followed by Uttar Pradesh with 44.4 million (11.8 per cent) and Tamil Nadu with 34.9 million (9.3 per cent). Sikkim has the lowest urban population of 0.15 million.

The main reasons of urban growth in India is due to a spurt in the migration of people from rural areas to urban areas due to availability of better employment opportunities and access to services such as medical, educational, recreation, communication, transport and other daily needs in the urban areas. Other factors of urban growth are population growth in urban areas and reclassification of rural areas as urban.

The urbanisation pattern in India is mainly lopsided with faulty urban planning, poor economic base and without functional categories. This urbanisation has led to many problems such as shortage of housing, increase in slum population, heavy pressure on transport, poor sanitation, water and air pollution etc.



Photo Shri S. K Singh, FSI

Urban Park

With the rapid urbanisation and growth in economy, the urban environment of India has undergone a dramatic change predominated by concrete high-rise structures and traffic. The degeneration of living environment in urban areas is largely due to new housing and townships, electrification, metro rail, widening of roads, automobiles etc. As a result, the balance of urban climate has been disrupted and most of the vegetation has been destroyed to make way for the so-called 'urban development'.

The greening of urban landscape is one of the important measures to mitigate some of the problems of urbanisation. Urban trees and forests can contribute immensely to the quality of life in towns and cities in the region. The urban forest is one of the resources of an urban area; it is part of the urban infrastructure and is integral to the quality of life of its residents. In urban areas, trees and forests can directly meet basic needs including food, fuel, fodder and timber products which remain important for the poor in many cities. Social benefits of urban trees and forests relate to health,

employment, education, recreation, aesthetic and landscape benefits and community strengthening. Environmental services of urban forests are climate and air quality improvement, energy savings, reduction of global warming and carbon dioxide, noise abatement, water conservation, soil conservation, solid waste and land reclamation and nature conservation. The relative importance of these functions varies for each city.

8.2 Assessment of Urban Trees

Trees grown outside forest (TOF) in urban areas have contributed significantly not only in cleaning the urban environment but also in fulfilling the timber and fuel wood requirement of poor people living in the Indian cities. FSI started assessment of tree resources outside forest in early 1990s. The initial assessment was focussed only in rural areas. With the onset of 10th five year plan in 2002-03, FSI modified its sampling design and assessment of urban trees became a regular feature of TOF inventory under National Forest Inventory (NFI) programme of FSI.



Photo Shri S. K Singh, FSI

Tree in urban area

The results of inventory were published in the biennial report of FSI. However separate information on urban TOF has not been given in earlier reports. Considering importance of urban trees, a separate chapter has been given on urban trees in the present ISFR. The information on number of stems and volume according to species and diameter class at national and state level, in urban trees has been given in the chapter.

8.2.1 Concepts and Definitions:

The concept of Urban is the same as followed in the decennial Census Operations in the country. Urban areas in 2001 census consist of:

- (a) All places with a Municipality, Corporation Sanitary Board, Cantonment Board or Notified Town Area Committee etc.
- (b) All other places which satisfy the following criteria.
 - A minimum population of 5000.
 - At least 75 per cent of the male working population being engaged in non-agricultural (and allied) activity and
 - A density of population of at least 400 persons per sq km.
 - Also any other place which according to the State Director of Census Operations possesses pronounced urban characteristics and amenities. In such a case the population of the town can be less than 5000.

Tree is defined as a woody perennial with a single main stem, having 10 cms or more diameter at breast height (dbh1.37m). If there are more than one stem in a tree having

diameter 10 cm or above, all such stems are considered as individual trees. In this survey all urban trees outside recorded forest area have been considered. If any recorded forest area falls within the urban boundary, such area has been excluded for the purpose of estimation of wood volume (growing stock).

8.2.2 Methodology of Data Collection

The detailed methodology has already been described in Chapter 5. However, for completeness, the methodology of assessment has been briefly described here. The assessment is done on sampling basis using multistage stratified random sampling. For this purpose, the entire country has been stratified into 14 physiographic zones on the basis of similarity in vegetation, topography, climate etc. 60 districts spread over the entire country are randomly selected for detailed inventory of trees of urban areas. The study areas for this survey within the selected districts are the urban centers defined in the corresponding District Census Book. The sampling frame for survey and inventory of urban area is list of UFS Blocks taken from National Sample Survey Office (NSSO). Field inventory was carried out on optimum number of UFS blocks representing all town classes.

The town class wise total number of towns & cities, inventoried towns and number of UFS blocks surveyed from each class of town for the period 2006-2012 is given in Table 8.2.

Complete enumeration of all the trees of 10 cm and above dbh is carried out in the randomly selected blocks in each district and data is recorded in prescribed formats. The data collected in the field is checked manually to detect any inconsistency or recording error before entering into the computer. The data is entered and processed using data entry and processing module which has been designed and developed by FSI. The district level data is used for estimation of growing stock at physiographic level and finally physiographic zone level data is added up to get the estimates at national level.

8.2.3 Estimation Procedure

The urban area of districts and states has been taken from the Census 2011. To compute the urban tree cover, the crown diameter of each tree above 10 cm dia falling in the selected UFS block is collected during the field inventory. With the help of crown diameter, the crown area of each tree is calculated. From the field inventory, the

Table 8.2: Number of Towns and Cities

Town Class	Total Towns & Cities*	Inventoried Towns & Cities	UFS Blocks Surveyed
I	441	68	2,547
II	503	98	963
III	1,395	241	1,241
IV	1,574	192	915
V	1,446	99	486
Total	5,359	698	6,152

*2001 Census

green cover area of each UFS block is computed. The district level green cover in the urban area is estimated from inventoried UFS blocks in the district. The district level estimates are used for estimation of urban green cover at the physiographic level. The total urban green cover area at the national level is estimated by adding up the green cover of all physiographic zones. It is pertinent to mention here that the urban green cover has been estimated on the basis of enumeration of trees having diameter 10 cm or more in the selected UFS blocks, as a result the contribution of trees below 10 cm dia are not taken into account in the urban tree cover. Thus the urban green cover given in the report pertains to the trees having dbh 10 cm and above only. The growing stock has been estimated as per the methodology described in chapter 5.

8.3 Results and Discussion

The results of this report are based on 6,152 UFS blocks spread over 179 districts inventoried during the year 2006-2012.

The state wise urban tree cover has been estimated on the basis of inventoried UFS blocks in the states. A small area estimation technique has been used for deriving the estimates for states. The total urban green cover in the country is estimated to be 12,790 sq km which is 16.40 per cent of the urban area. Among states, Tamil Nadu has maximum green cover of 1,509 sq km followed by Maharashtra (1,373 sq km), Karnataka (1,276 sq km) and Kerala (1,241 sq km). The green cover as a proportion of urban areas has been observed maximum in Lakshadweep (40.55 percent), Goa (40.55 percent), followed by Kerala (38.17 percent) and Karnataka (24.69 per cent).

Table 8.3: States/UTs-wise Urban Tree Cover

States/UTs	Geographical Area (sq km)	Urban Area (sq km)	Urban Tree Cover Area (sq km)	Per cent of Urban Area
Andhra Pradesh	275,069	4,747	809	17.04
Arunachal Pradesh	83,743	105	6	5.52
Assam	78,438	962	128	13.27
Bihar	94,163	1,805	254	14.08
Chhattisgarh	135,191	1,866	300	16.07
Delhi	1,483	797	97	12.17
Goa	3,702	512	207	40.55
Gujarat	196,022	5,228	1,210	23.15
Haryana	44,212	1,280	156	12.18
Himachal Pradesh	55,673	242	18	7.57
Jammu & Kashmir	222,236	950	72	7.57
Jharkhand	79,714	1,792	288	16.07
Karnataka	191,791	5,167	1,276	24.69
Kerala	38,863	3,252	1,241	38.17
Madhya Pradesh	308,245	6,962	996	14.30
Maharashtra	307,713	7,313	1,373	18.78
Manipur	22,327	144	15	10.74
Meghalaya	22,429	230	24	10.51
Mizoram	21,081	587	63	10.81
Nagaland	16,579	147	16	10.56

States/UTs	Geographical Area (sq km)	Urban Area (sq km)	Urban Tree Cover Area (sq km)	Per cent of Urban Area
Odisha	155,707	2,794	376	13.46
Punjab	50,362	2,079	248	11.92
Rajasthan	342,239	5,431	702	12.92
Sikkim	7,096	3.54	0.261	7.36
Tamil Nadu	130,058	12,492	1,509	12.08
Tripura	10,486	139	15	10.67
Uttar Pradesh	240,928	6,558	816	12.45
Uttarakhand	53,483	797	68	8.58
West Bengal	88,752	3,325	464	13.95
Andaman & Nicobar Islands	8,249	26	3	10.74
Chandigarh	114	79	10	12.17
Dadra & Nagar Haveli	491	17	4	21.03
Daman & Diu	112	24	4	18.21
Lakshadweep	32	11	4	40.55
Puducherry	480	133	17	12.76
TOTAL	3,287,263	77,997	12,790	16.40

The total estimated number of trees found in the urban area of the country is 304 million. Total volume in the urban tree has been estimated to be 98 m. cum. Maximum tree

volume has been observed in Karnataka (9.7 m. cum) followed by Maharashtra (9.6 m. cum), Madhya Pradesh (8.9 m. cum) and Kerala (6.7 m. cum) as given in table 8.4.

Table 8.4: States/UTs-wise Estimated Stems and Volume in Urban Areas

States/UTs	Geographical Area(sq km)	Urban Area (sq km)	Urban Growing stock (Volume in m.cum.)	Stems (000')
Andhra Pradesh	275,069	4,747	6.559	20,007.374
Arunachal Pradesh	83,743	105	0.368	2,100.378
Assam	78,438	962	1.156	4,651.696
Bihar	94,163	1,805	2.496	9,233.578
Chhattisgarh	135,191	1,866	3.186	4,499.846
Delhi	1,483	797	0.801	2,078.498
Goa	3,702	512	1.115	4,629.459
Gujarat	196,022	5,228	6.591	26,888.272
Haryana	44,212	1,280	1.287	33,38.374
Himachal Pradesh	55,673	242	0.147	455.524
Jammu & Kashmir	222,236	950	0.579	1,790.550
Jharkhand	79,714	1,792	3.061	4,323.012
Karnataka	191,791	5,167	9.741	30,137.189
Kerala	38,863	3,252	6.706	28,224.774
Madhya Pradesh	308,245	6,962	8.995	19,077.329
Maharashtra	307,713	7,313	9.649	31,608.286
Manipur	22,327	144	0.082	489.820

States/UTs	Geographical Area(sq km)	Urban Area (sq km)	Urban Growing stock (Volume in m.cum.)	Stems ('000')
Meghalaya	22,429	230	0.128	765.031
Mizoram	21,081	587	0.336	2,011.005
Nagaland	16,579	147	0.082	492.443
Odisha	155,707	2,794	3.606	7,700.788
Punjab	50,362	2,079	2.042	5,335.348
Rajasthan	342,239	5,431	5.561	13,891.888
Sikkim	7,096	3.54	0.002	8.369
Tamil Nadu	130,058	12,492	11.447	42,441.373
Tripura	10,486	139	0.079	471.388
Uttar Pradesh	240,928	6,558	6.812	17,219.536
Uttarakhand	53,483	797	0.555	1,628.633
West Bengal	88,752	3,325	4.543	17,021.223
Andaman & Nicobar Islands	8,549	26	0.023	87.965
Chandigarh	114	79	0.080	206.812
Dadra & Nagar Haveli	491	17	0.021	103.540
Daman & Diu	112	24	0.024	96.149
Lakshadweep	32	11	0.023	95.816
Puducherry	480	133	0.127	496.907
TOTAL	3,287,263	77,997	98.008	303,608.262

The species wise estimated number of stems in the urban areas under different diameter class has been given in Table 8.5. The information has been given for top 41 species which are contributing one percent or more in the total volume. The total estimated number

of trees found in the urban area of the country is 304 million. The species found in maximum number in urban areas is *Cocos nucifera* (65 million), followed by *Azadirachta indica* (30 million), *Mangifera indica* (19 million) and *Areca catechu* (18 million).

Table 8.5: Species and Diameter Class-wise Estimated Stems in Urban Areas (Nos. in '000')

Species	Diameter (cm)				Percentage
	10-30	30-50	50+	Total	
<i>Acacia nilotica (Acacia arabica)</i>	3,503	715	72	4,290	1.41
<i>Ailanthus excelsa</i>	370	138	38	546	0.18
<i>Albizia lebbek</i>	150	288	292	730	0.24
<i>Anthocephalus chinensis</i>	660	102	5	768	0.25
<i>Areca catechu</i>	17,941	7	0	17,948	5.91
<i>Artocarpus heterophyllus</i>	3,383	665	61	1,409	1.35
<i>Azadirachta indica</i>	21,853	6,379	1,815	30,047	9.90
<i>Bombax ceiba</i>	297	109	41	448	0.15
<i>Borassus flabellifer</i>	1,517	2,746	43	4,307	1.42
<i>Butea monosperma</i>	470	133	14	617	0.20
<i>Cassia siamea</i>	1,600	211	9	1,820	0.60
<i>Cocos nucifera</i>	57,362	7,662	15	65,039	21.42
<i>Dalbergia latifolia</i>	440	92	10	542	0.18
<i>Dalbergia sissoo</i>	1,878	538	98	2,514	0.83
<i>Delonix regia</i>	2,485	855	107	3,447	1.14

Species	Diameter (cm)				Percentage
	10-30	30-50	50+	Total	
<i>Eucalyptus sp.</i>	5,942	1,716	287	7,945	2.62
<i>Ficus benghalensis</i>	244	105	110	459	0.15
<i>Ficus religiosa</i>	1,219	761	1,009	2,989	0.98
<i>Ficus sp.</i>	373	208	133	714	0.24
<i>Holoptelea integrifolia</i>	629	184	49	862	0.28
<i>Hevea brasiliensis</i>	4,621	32	0	4,652	1.53
<i>Saraca indica</i>	1,883	287	28	2,198	0.72
<i>Leucaena leucocephala</i>	3,871	198	9	4,078	1.34
<i>Mangifera indica</i>	14,413	3,531	882	18,825	6.20
<i>Melia azadirachta</i>	1,599	140	5	1,744	0.57
<i>Moringa oleifera</i>	1,411	75	4	1,489	0.49
<i>Moringa sp.</i>	1,929	309	23	2,262	0.74
<i>Morus sp.</i>	940	108	7	1,055	0.35
<i>Pittosporum ferrugineum</i>	3,088	965	193	4,246	1.40
<i>Phoenix sylvestris</i>	1,133	401	1	1,536	0.51
<i>Polyalthia longifolia</i>	1,931	139	23	2,093	0.69
<i>Pongamia pinnata</i>	2,935	285	31	3,252	1.07
<i>Prosopis juliflora</i>	5,746	252	9	6,006	1.98
<i>Samanea saman</i>	633	443	380	1,456	0.48
<i>Syzygium cumini (Eugenia jambolana)</i>	2,441	929	190	3,560	1.17
<i>Tamarindus indica</i>	914	518	311	1,743	0.57
<i>Tectona grandis</i>	6,708	253	26	6,987	2.30
<i>Terminalia arjuna</i>	234	60	20	314	0.10
<i>Thespesia populnea</i>	624	133	22	778	0.26
<i>Ziziphus mauritiana</i>	2,308	197	9	2,513	0.83
Rest of Species	70,218	9,925	2,536	82,679	27.23
Total	251,892	42,795	8,921	303,608	100

In addition to number of stems, the estimated volume has also been given for top 41 species under different diameter class in Table 8.6. The total volume in the urban trees has been estimated to be 98 m.cum. In terms of volume, *Cocos nucifera* is contributing maximum volume of 16.84 m.cum, followed by *Azadirachta indica*

(16.40 cum), *Ficus religiosa* (5.83 m.cum) and *Mangifera indica* (5.5 m.cum). in term of percentage contribution, *Cocos nucifera* is contributing maximum to the total volume (17.18 per cent), followed by *Azadirachta indica* (16.74 per cent), *Ficus religiosa* (5.95 per cent) and *Mangifera indica* (5.63 per cent).

Table 8.6: Species and Diameter Class-wise Estimated Volume in Urban Area (m.cum)

Species	Diameter (cm)				Percentage
	10-30	30-50	50+	Total	
<i>Acacia nilotica (Acacia arabica)</i>	0.470	0.423	0.118	1.011	1.03
<i>Ailanthus excelsa</i>	0.046	0.089	0.085	0.221	0.23
<i>Albizia lebbbeck</i>	0.035	0.268	0.689	0.992	1.01
<i>Anthocephalus chinensis</i>	0.214	0.105	0.014	0.333	0.34

Species	Diameter (cm)				Percentage
	10-30	30-50	50+	Total	
<i>Areca catechu</i>	0.392	0.003	0.000	0.395	0.40
<i>Artocarpus heterophyllus</i>	0.784	0.664	0.227	1.675	1.71
<i>Azadirachta indica</i>	3.849	5.804	6.750	16.402	16.74
<i>Bombax ceiba</i>	0.066	0.101	0.191	0.358	0.37
<i>Borassus flabellifer</i>	0.392	1.528	0.066	1.987	2.03
<i>Butea monosperma</i>	0.066	0.108	0.038	0.212	0.22
<i>Cassia siamea</i>	0.257	0.164	0.066	0.488	0.50
<i>Cocos nucifera</i>	12.816	3.976	0.048	16.839	17.18
<i>Dalbergia latifolia</i>	0.075	0.086	0.029	0.190	0.19
<i>Dalbergia sissoo</i>	0.473	0.472	0.229	1.174	1.20
<i>Delonix regia</i>	0.381	0.614	0.263	1.257	1.28
<i>Eucalyptus sp.</i>	1.051	1.535	0.789	3.375	3.44
<i>Ficus bengalensis</i>	0.040	0.108	0.715	0.863	0.88
<i>Ficus religiosa</i>	0.172	0.598	5.062	5.833	5.95
<i>Ficus sp.</i>	0.058	0.170	0.566	0.795	0.81
<i>Holoptelea integrifolia</i>	0.092	0.142	0.129	0.364	0.37
<i>Hevea brasiliensis</i>	0.605	0.019	0.000	0.625	0.64
<i>Saraca indica</i>	0.208	0.182	0.050	0.439	0.45
<i>Leucaena leucocephala</i>	0.763	0.176	0.022	0.662	0.68
<i>Mangifera indica</i>	1.123	1.920	2.472	5.515	5.63
<i>Melia azadirachta</i>	0.199	0.078	0.008	0.285	0.29
<i>Moringa oleifera</i>	0.136	0.055	0.012	0.203	0.21
<i>Moringa sp.</i>	0.293	0.238	0.050	0.582	0.59
<i>Morus sp.</i>	0.114	0.060	0.061	0.235	0.24
<i>Pittosporum ferrugineum</i>	0.468	0.687	0.449	1.605	1.64
<i>Phoenix sylvestris</i>	0.266	0.198	0.003	0.467	0.48
<i>Polyalthia longifolia</i>	0.169	0.077	0.039	0.285	0.29
<i>Pongamia pinnata</i>	0.333	0.195	0.006	0.594	0.61
<i>Prosopis juliflora</i>	0.475	0.189	0.031	0.695	0.71
<i>Samanea saman</i>	0.113	0.379	1.205	1.697	1.73
<i>Syzygium cumini (Eugenia jambolana)</i>	0.407	0.741	0.447	1.595	1.63
<i>Tamarindus indica</i>	0.138	0.433	1.252	1.823	1.86
<i>Tectona grandis</i>	0.758	0.226	0.073	1.057	1.08
<i>Terminalia arjuna</i>	0.037	0.071	0.075	0.183	0.19
<i>Thespesia populnea</i>	0.074	0.082	0.034	0.191	0.19
<i>Ziziphus mauritiana</i>	0.381	0.131	0.018	0.530	0.54
Rest of Species	7.296	7.242	9.439	23.977	24.46
Total	35.788	30.338	31.882	98.008	100

