CHAPTER TWO

SCOPE AND METHODOLOGY OF THE STUDY

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This chapter elaborates the methodology used in data collection. The present study concentrates on estimating the stock and flow of biomass in Uttara Kannada district. Hence the study intends to collect data from two entirely different sources. Firstly, to estimate the biomass stock, vegetation data from reserve forest and minor forest is needed. Secondly, to estimate the biomass flow, data from households regarding the collection of forest produce is required. The chapter provides a brief note on the Western Ghats and also on Uttara Kannada district, which is the scope of the study and provides the profile of the study villages. The chapter provides in detail, the methodology followed to collect vegetation data and various parameters those can be estimated from the collected data. Finally, the chapter gives detailed methodology used for the estimation of biomass flow, which is done with the help of data collected from household survey.

2.1 Scope of the present study

Broadly speaking, the study is undertaken in the Western Ghats area and specifically in Uttara Kannada district where people depend on forest for wide range of forest products. The demand for many forest products mainly timber, fuelwood, bamboo, canes, medicinal herbs are increasing sharply in the recent years. Forest based industries like plywood, paper, polyfiber and matchwood industries also depend upon the rich forest reserves of the
Western Ghats. There is also competing demand for the forest land of the Western Ghats especially for cultivation and river valley projects.

Uttara Kannada district falling in Western Ghats is also not free from forest depletion. The depletion of forest resources in the district has a long history that even stretches to the period of Dutch and British. The district well known for pepper and cardamom attracted Dutch and British to establish their colonies. The natural harbour of the district facilitated for the transportation of these spices items. The inhabitants of the district at that time had strict measures to conserve the rich natural heritage of the district. The evidence for this is sacred groves as mentioned by Francis Buchanan, a British traveller who travelled through the district during 1802. But British started exploiting rich forests to satisfy the needs of their country. In 1880s during the period of Cleghorn, the first British Conservator of Forests, British became aware of the need to use forests in a sustainable manner. Even then forest management system was running smoothly, as population of the district was very low because of malaria, and contribution of the district to the population growth of the country was negligible. But the situation changed after the Second World War. There was an increase in population of the district due to eradication of the malaria. This has resulted in rising commercial demand for biomass. Many industries like Indian Plywood Manufacturing Company (1944) West Coast Paper Mills (1955) in Dandeli, Harihar Polyfibres (1972) in Haveri took were started with added dependency on forest. At the same time in 1976, the National Commission on Agriculture (NCA) suggested for a change

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in conservation-oriented forestry to production forestry. The commission emphasised on clear felling of valuable mixed forests and planting of fast growing species. This has lead to the ruthless cutting of valuable trees of ecological importance. Thus the process of biomass loss started in the district.

Many studies have accounted for the depletion of forest resources in the Western Ghats and Uttara Kannada. Continuous deforestation, encroachment of forest land, use of forest land for non-forest uses and mining activities have resulted in serious damage to biomass and ecology. Conservation of biomass and ecology of the Western Ghats does not mean restricting the use absolutely, which is simply impossible. But what is needed is the sustainable use of resources for which a proper mechanism should be developed. Hence, it is necessary to save the rich natural forests and ecosystems of the Western Ghats including Uttara Kannada district.

2.2 A brief note on the Western Ghats

The Western Ghats also known as Sahyadris start in the north from river Tapti and run towards south up to Kanyakumari (Map 2.1). These ranges run parallel to the West coast on an average about 40 km away from the shoreline with an average elevation of 1,500 metres from the sea level. Except the Palghat gap of 330 km, this is a continuous hill tract covering an area of 1,600 km comprising of 134 taluks from Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala put together (Tewari, 1995). The average annual rainfall ranges between 2,000 mm to 6,000 mm and average temperature ranges between 10° C in the winter to 30° C in the summer.
The Western Ghats are endowed with rich forest resources having the cover of evergreen forests in its western slope and gets changed to moist deciduous and then to dry deciduous type as one moves towards the east. It is one of the ecologically richest regions of the world. It is said to be supporting more than 4,000 species of flowering plants, 48 genera of mammals, 275 genera of birds and 60 genera of reptiles (Tewari, 1995).

The Western Ghats, particularly the northern parts have rich mineral resources. Specifically, the region has 147 million tones of bauxite, 375 million tones of iron ore and 5190 million tones of manganese ore deposits (Tewari, 1995). Apart from this the region also has the reserves of limestone, gold, magnesium, mica, silica, titanium and other economically valuable minerals.
Map 2.1: The Western Ghats region in India
2.3 A brief note on Uttara Kannada

Uttara Kannada, sometimes called North Kanara or North Canara is the northern most coastal district (located between 13°.55' to 15°.31' N lat; 74°.9' to 75°.10' E long) of the Karnataka state (Map 2.2). The district famous for its natural beauty and lush forest is bordered by Haveri in the east, Arabian Sea in the west, Belgaum in the north, Udupi in the south, Shimoga in the south-east, Dharwad in the north-east, and the state Goa in the north-west. The range of Western Ghats passing through the district has endowed the district with rich natural resources.

The average annual rainfall of the district is 2,500 mm with coastal areas receiving 3,000 mm and the eastern plains receiving 1,500 mm of it. The district receives rainfall from south-west monsoon from June to September every year. The total geographical area of the district is 10,291 km² which is 5.37 per cent of the total geographical area of the Karnataka state. Total forest area of the district is 7,806.75 km² which covers 75.86 per cent of its total geographical area. Major portion of the district consists of moist deciduous forest with most of the trees shedding their leaves in winter.

The district is divided into eleven talukas for the administrative purposes Karwar being the administrative head quarters. The Western Ghats divide the district into two parts of which, five talukas are in the coastal line along Arabian Sea and six talukas are above the ghats.
The major rivers originating and/or flowing in the district are Kali, Aghanashini, Sharavati, Gangavali, Varada and Dharma. As the district is full of hills, the rivers running in create a number of waterfalls, which have given the district a nickname- the district of waterfalls. One of them known to everyone is found in Jog where river Sharavati jumps to form the world famous Jog falls.

To its credit, the district has a nuclear power plant at Kaiga. Dandeli is the major industrial town of the district with paper, plywood and manganese industries and electric power generating station.

As the district has three different type of topography, different crops and cultivation methods are adopted depending upon the local topography, soil type and rainfall. Paddy, coconut and cashew are grown in the coastal region as main crops. And the upghat region full of valleys provides scope for growing pepper and cardamom along with arecanut (Areca catechu, also known as betelnut) cocoa and plantain. Vanilla is a recent addition to the already existing mixed farming. Sugarcane, ginger, cotton, pineapple, other cereals and pulses are grown in the plain regions of the district. People living in the villages surrounded by forests are dependent on NTFPs to some extent. The major NTFPs collected are, Garcinia indica (Murugalu), Garcinia cambogia (Uppage), Cinnamomum zeylanicum (Dalchinni) and Myristica malabaricum (Rampatre).
Map 2.2: District map of Karnataka state

[Map image showing districts of Karnataka state, including major cities and regions such as Bidar, Gulbarga, Bijapur, Raichur, Bellary, and Bangalore.]
Total population of the district according to 2001 census is 13,53,644 of which 6,86,876 are men and 6,66,768 are women (sex ratio is 971). Out of the total population, 28.66 per cent is the urban population. The district has noticed 10.90 per cent increase in population since 1991 census. The district has 1,246 numbers of inhabited villages and average literacy rate of the district is 76.6 per cent. Interestingly there is not much disparity between the literacy rate of rural (72.7 per cent) and urban areas (86.3 per cent) but there are a high disparity between the literacy rate of male (84.5 per cent) and female (68.5 per cent). The main language spoken in the district is Kannada with some people speaking Konkani and Marathi.

According to Saxena et al. (1997), the district has experienced several waves of settlers; Havik Brahmins (also called Havyak Brahmins) from north India, Marathas, Kunbis, Saraswat Brahmins from Goa, Siddis of African origin, and Goulis with nomadic nature from Maharashtra. The district has 79 per cent Hindus, 3 per cent Christians, 6 per cent Muslims and 12 per cent others. Among the total Hindu population, 7 per cent is the share of scheduled castes and less than one per cent is of scheduled tribes.

A study by Gadgil et al. (1987) provides an insight into the brief history of Uttara Kannada district that. According to him, in Skandapurana the district was called by the name Haigdesha which fell in Sahyadrikhanda.
It was ruled by many historical rulers like Kadambas of Banavasi, Vijayanagara emperors, Sultans of Bijapur, Rajas of Sonda, Hyder Ali and Tippu Sultan. Under the British rule, the district was under Madras Presidency later it was added to Bombay Presidency in 1860s. After independence, Bombay Presidency was reconstituted as Bombay State. As the district belongs to the Kannada peaking portion of the Bombay state, it was added to the Mysore state which was then renamed Karnataka.

2.3.1 Tragedy of commons in Uttara Kannada

Tragedy of commons, the well-known metaphor of Hardin (2001) considers population as the main cause for degradation of commons. Along with the increase in population, freedom of access to the resources leads to tragedy of commons. He illustrates this point with a series of examples, well known being the pastureland and the herdsman. Every herdsman trying to maximise his utility adds more and more animal to the herd. Similar is the case of National Park, which everybody uses without limit. He says, it is not taking something from the commons but putting something to it and calls it ‘fouling our own nest’ and says this freedom in commons brings ruin to all. As a remedy, he emphasises on abandoning the commons as the population has increased.
Rawat (1998) opines that absence of an effective institution to manage CPRs is the universal reason behind the 'tragedy of commons'. He says, to formulate an effective institution, people should be aware of their dependence on CPRs and there is a need for the sustainable management of CPRs through village-level institution.

In the case of biomass depletion in Uttara Kannada district, both the above given reasons seem to be contributing. It has been a world-wide phenomenon- that which is available free of cost is exploited to the maximum extent for which, biomass is not an exception. CPRs are often compared for free lunch and forests with free access have provided biomass as a free lunch for the community and are being eaten away continuously over the years. The same practice has caused depletion of biomass in the district. Increase in population has added fuel to the burning fire. As a result, forest land is encroached and used for cultivation purposes. According to Saxena et al. (1997), the proportion of net area sown has increased by 67 per cent during the period 1959-60 to 1992-93 and 75 per cent the forests have no seedling or sapling regeneration due to the deficit of large stems because of over-exploitation. In the recent years, people and the government have recognised need for conservation of biomass and are taking initiatives to check the depletion of biomass. Above all, people have started to understand value of forests and they have become aware of the need to be involved and
participate in conservation and development of the forests for enhancing their socio-economic and ecological benefits.

2.3.2 Forests of Uttara Kannada

The Western Ghats part of Uttara Kannada has different types of forests namely, Evergreen, Semi-evergreen, Moist deciduous and Scrub and thorny forests. Evergreen forests are found in the places where annual rainfall is more than 2,250 mm and they form a narrow strip along the Western Ghats. The semi-evergreen forests are found in the regions with the annual rainfall of 1,500 mm to 2,500 mm. Both evergreen and semi-evergreen forests are the home for soft wood trees. The moist deciduous forests are situated in the rainfall area of 1,000 mm to 1,500 mm annually. These types of forests are rich in timber species like Rosewood, Teakwood, *Terminalia*, *Lagestroemia* which grow naturally. In areas receiving annual rainfall less than 900 mm, dry deciduous forests are found. The scrub and thorny forests are found in the places where the annual rainfall is below 600 mm. In these forests, minor forest produce species and other fuelwood species are grown (Kamat, 1985). The district also has fringes of mangroves distributed in the inter-tidal regions along estuaries, backwaters and islands (Saldanha, 1986).

Apart from these natural differences, forests of Uttara Kannada are classified legally as Reserve forests, Village forests and Protected forests.
respectively under the chapters II, III and IV of Indian Forest Act 1927. Reserve forests are subdivided into two categories namely, Proper forest and Minor forest (referred to as MF henceforth).

Proper forests are popularly known as Reserve forests (referred to as RF henceforth). This legal classification of the forests has created different forest land use systems in the district. In general RF is strictly owned by the forest department or the government without the allowance of community to collect forest produce. MF is also owned by the forest department but provides allowance for the community to collect some forest produce. Uttara Kannada district has very negligible quantity of village forest that is let entirely for the use of community. But the district has a special forest category called Protected forest popularly known as Betta or Soppina betta (Soppu means leaf and Betta means hill). It is a patch of natural forest adjacent to arecanut orchards and assigned to arecanut cultivators as a special privilege. Though owned by the forest department they are controlled and accessed by the private individuals to meet the daily biomass requirements. Depending upon availability and condition of the forests, one acre of arecanut orchard was assigned with four to nine acres of betta. This system was started during the time of British government with the view to provide the arecanut growers a means to meet their biomass requirements and was stopped during early 1960s. MF and betta were especially meant for meeting biomass requirements of people where RF was under the strict vigilance of the state.
According to Buchy (1996) RF is closed to the public and that only rights of passage and access to water are tolerated. Both ownership and user right rests in the hands of forest department. MF is that forest patch for which the community has user right privileges but the ownership right is with the forest department. *Betta* lands refer to tracts of forest land held without proprietary right by garden owners near their gardens which they could lop for leaf manure, fodder and fuel (Nadkarni *et al.* 1989). The view of RF and MF are given in Picture 2.1 and 2.2 respectively.

![Picture 2.1: A view of reserve forest of Bilur village in Uttara Kannada](image)
Uttara Kannada district has 74.80 per cent of forest under the category of RF and has only 18.34 per cent as MF that is accessible to the community (Table 2.1). But many villages of the district do not have MF or Village forest but are found to be having only RF. Hence, for the biomass requirements, people depend upon RF. As Village forests are in very little quantity (Table 2.1) all the forests especially the MFs are treated as common property resources. Figure 2.1 shows the percentage distribution of forests according to different forest categories in Uttara Kannada district.

Picture 2.2: A view of minor forest of Bilur village in Uttara Kannada
Table 2.1: Details of forest area according to legal status in Uttara Kannada

<table>
<thead>
<tr>
<th>Forest category</th>
<th>Area in (ha)</th>
<th>Percentage forest area to total forest area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserve forests</td>
<td>620218.30</td>
<td>74.79</td>
</tr>
<tr>
<td>Minor forests</td>
<td>152085.60</td>
<td>18.34</td>
</tr>
<tr>
<td>Protected forests</td>
<td>54294.50</td>
<td>6.55</td>
</tr>
<tr>
<td>Village forests</td>
<td>2617.60</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>829216.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

*Source:* Kamat (1985)

Figure 2.1: Percentage distribution of forest area according to legal status in Uttara Kannada

*Source:* Table 2.1
For the administrative purposes, forests of Uttara Kannada have been systematically arranged on a hierarchical basis. The entire district is called Kanara Circle, which is under the control of Conservator of forests (CF), is divided into five forest divisions; each division under the control of Deputy Conservator of forests (DCF) who was formerly called Divisional Forest Officer (DFO). Each forest division is sub-divided into Forest Ranges and each range is under the control of a Range Forest Officer (RFO). The details of forests in different forest divisions of Kanara Circle are given in Table 2.2. Karwar division is found to be having maximum forest area with maximum RF followed by the Sirsi division with maximum Protected forest (Table 2.2). Upghat divisions do not have any village forests (Table 2.2). Maximum Protected forest of Sirsi forest division indicates the greater dependency on the forest.

Table 2.2: Details of division-wise area under different forest categories of Kanara Circle (Uttara Kannada)

<table>
<thead>
<tr>
<th>Forest Division*</th>
<th>Reserve Forest** (ha)</th>
<th>Protected Forest (ha)</th>
<th>Village Forest (ha)</th>
<th>Total Forest (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honnavar</td>
<td>136353</td>
<td>2184</td>
<td>2361</td>
<td>140898</td>
</tr>
<tr>
<td>Karwar</td>
<td>201369</td>
<td>2140</td>
<td>235</td>
<td>203744</td>
</tr>
<tr>
<td>Sirsi</td>
<td>130451</td>
<td>40845</td>
<td>0</td>
<td>171296</td>
</tr>
<tr>
<td>Yellapur</td>
<td>161330</td>
<td>7852</td>
<td>0</td>
<td>169182</td>
</tr>
<tr>
<td>Haliyal</td>
<td>142636</td>
<td>1532</td>
<td>0</td>
<td>144168</td>
</tr>
<tr>
<td><strong>Total</strong>*</td>
<td><strong>772139</strong></td>
<td><strong>54553</strong></td>
<td><strong>2596</strong></td>
<td><strong>829288</strong></td>
</tr>
</tbody>
</table>

Note : * The forest divisions do not follow the limits of taluks  
** Includes both RF and MF  
*** Total forest area of Table 2.2 and Table 2.1 differs on account of two entirely different sources  
Source: Bhat et al. (2000)
2.4 Sample villages of the study

The study is confined to the Sirsi forest division of Uttara Kannada district in the Western Ghats. Among the five divisions of Kanara Circle, Sirsi forest division covering Sirsi and Siddapur taluks is the appropriate area to undertake the present research. In the coastal regions of the district people are more dependent on sea and other services rather than forests. The upghat hilly regions of the district have both dense forest and plain regions with thin forest, with a wide difference in the cultivation process.

The rationale behind the selection of Sirsi forest division (Map 2.3) is that the forest division falls in the hilly region of the district and the area under arecanut orchard is more as compared to the other forest divisions. Dependency of people on agriculture especially on arecanut cultivation is more and they are more dependent on forest to meet their biomass requirement. According to Ramachandra et al. (2000b) biomass requirement especially the fuelwood requirement in hilly region is greater than that in coastal region. Sirsi forest division with greater biomass requirement falls in the transitional region of coastal region and plains. Hence, the study has selected the Sirsi forest division for the study. Sirsi forest division has six forest ranges namely, Banavasi, Sirsi, Hulekal, Janmane, Siddapur and Kyadgi.
Map 2.3: Map of Uttara Kannada district showing Sirsi forest division with sampled villages
As mentioned earlier, main intension of the study was to estimate biomass stock of RF and MF, to estimate biomass flow into the village according to household category and to estimate the savings in biomass. Keeping these ideas in view, the villages were selected for study based on the following criteria. Firstly, the selected village should have RF and MF but should not have betta as the village having betta will have less pressure on MF. It is noticed that, whenever possible major portion of the biomass is met from betta rather than MF. Secondly, the selected village should be under JFM programme. This is helpful in assessing dependency of people on JFM plantation and thereby to understand the shift to pressure from natural forests to artificial plantation. Thirdly, the selected village should have households without land and with large and small land holding which facilitates to compare the pattern of biomass extraction across those categories.

Hence, the selected villages are Bilur from Banavasi forest range, Manjguni from Janmane forest range, Nidgod from Siddapur (14°.18' N lat; 74°.54'E long) forest range and Kabbe from Sirsi (14°.37' N lat; 74°.51'E long) forest range (Map 2.3). All the selected villages have both RF and MF and do not have betta. Exceptionally, out of the selected villages Nidgod has betta but in a negligible quantity (0.5 per cent of the total forest area). All four villages are under the active JFM programme for more than ten years which is sufficient to assess the impact of it. The villages have good literacy rate and have both economically poor and non-poor class of people. The villages have
households without land, with large and small holding which has helped in knowing their dependency on forests. In all these villages, JFM programme has already created awareness about biomass conservation and under the programme the households are given fuel-efficient cooking media and that has helped the study to estimate savings in fuelwood. Brief profile of the sampled villages is given in Table 2.3.
Table 2.3: Profile of the study villages

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Villages</th>
<th>Bilur</th>
<th>Manjguni</th>
<th>Nidgod</th>
<th>Kabbe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taluk-wise Location</td>
<td>Sirsi</td>
<td>Sirsi</td>
<td>Siddapur</td>
<td>Sirsi</td>
<td></td>
</tr>
<tr>
<td>Forest Range</td>
<td>Banavasi</td>
<td>Janmane</td>
<td>Siddapur</td>
<td>Sirsi</td>
<td></td>
</tr>
<tr>
<td>Total geographical area (ha)</td>
<td>511.16</td>
<td>579.74</td>
<td>814.48</td>
<td>341.60</td>
<td></td>
</tr>
<tr>
<td>Net area sown (ha)</td>
<td>50.40</td>
<td>91.95</td>
<td>77.76</td>
<td>51.45</td>
<td></td>
</tr>
<tr>
<td>Area sown more than once (ha)</td>
<td>10.10</td>
<td>5.32</td>
<td>9.00</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>Permanent pasture (ha)</td>
<td>58.00</td>
<td>-</td>
<td>8.89</td>
<td>71.04</td>
<td></td>
</tr>
<tr>
<td>Fallow land (ha)</td>
<td>3.10</td>
<td>13.15</td>
<td>27.56</td>
<td>12.21</td>
<td></td>
</tr>
<tr>
<td>Others (ha)</td>
<td>4.00</td>
<td>3.22</td>
<td>68.35</td>
<td>25.94</td>
<td></td>
</tr>
<tr>
<td>Total forest area (ha)</td>
<td>385.56</td>
<td>466.10</td>
<td>627.92</td>
<td>177.38</td>
<td></td>
</tr>
<tr>
<td>Reserve forest (ha)</td>
<td>303.54</td>
<td>323.32</td>
<td>472.95</td>
<td>172.38</td>
<td></td>
</tr>
<tr>
<td>Minor forest (ha)</td>
<td>82.02</td>
<td>142.78</td>
<td>151.55</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>Betta (ha)</td>
<td>-</td>
<td>-</td>
<td>3.42</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Forest type</td>
<td>Moist deciduous</td>
<td>Semi-evergreen</td>
<td>Dry deciduous</td>
<td>Dry deciduous</td>
<td></td>
</tr>
<tr>
<td>Total Area under JFM (ha)</td>
<td>63.50</td>
<td>86.00</td>
<td>49.00</td>
<td>42.00</td>
<td></td>
</tr>
<tr>
<td>Total number of seedlings planted</td>
<td>79,200</td>
<td>80,000</td>
<td>20,380</td>
<td>38,000</td>
<td></td>
</tr>
<tr>
<td>Species mix in JFM are</td>
<td>Acacia and misc.</td>
<td>Acacia and misc.</td>
<td>Acacia and misc.</td>
<td>Acacia and misc.</td>
<td></td>
</tr>
<tr>
<td>Total population (1991 census)</td>
<td>235</td>
<td>487</td>
<td>511</td>
<td>310</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>118</td>
<td>244</td>
<td>265</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>117</td>
<td>243</td>
<td>246</td>
<td>142</td>
<td></td>
</tr>
<tr>
<td>Total population (2001 census)</td>
<td>526</td>
<td>554</td>
<td>651</td>
<td>504</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>270</td>
<td>276</td>
<td>338</td>
<td>273</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>256</td>
<td>278</td>
<td>313</td>
<td>231</td>
<td></td>
</tr>
<tr>
<td>Sex ratio (2001 census)</td>
<td>948</td>
<td>1007</td>
<td>926</td>
<td>846</td>
<td></td>
</tr>
<tr>
<td>Increase in population in a decade</td>
<td>291 (123.83)</td>
<td>67 (13.26)</td>
<td>140 (27.39)</td>
<td>194 (62.58)</td>
<td></td>
</tr>
<tr>
<td>Increase in population per year</td>
<td>29 (12.38)</td>
<td>7 (1.33)</td>
<td>14 (2.74)</td>
<td>19 (6.26)</td>
<td></td>
</tr>
<tr>
<td>Total literate population (2001 census)</td>
<td>366</td>
<td>351</td>
<td>391</td>
<td>316</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>205</td>
<td>194</td>
<td>277</td>
<td>192</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>161</td>
<td>157</td>
<td>164</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>Literacy rate (2001 census)</td>
<td>81.0</td>
<td>71.6</td>
<td>70.6</td>
<td>72.6</td>
<td></td>
</tr>
<tr>
<td>Total number of households</td>
<td>98</td>
<td>123</td>
<td>150</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Average household size</td>
<td>5.4</td>
<td>4.5</td>
<td>4.3</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>Major occupation</td>
<td>Agriculture and Coolie</td>
<td>Agriculture and Coolie</td>
<td>Agriculture and Coolie</td>
<td>Agriculture and Coolie</td>
<td></td>
</tr>
<tr>
<td>Major crops grown</td>
<td>Paddy, Sugarcane, Arecanut, Plantain, Ginger, Coconut, Pulses</td>
<td>Paddy, Arecanut, Coconut, Plantain</td>
<td>Paddy, Plantain, Mango, Coconut, Arecanut</td>
<td>Paddy, Arecanut, Coconut, Sugarcane, Pulses</td>
<td></td>
</tr>
<tr>
<td>Total livestock population</td>
<td>455</td>
<td>295</td>
<td>428</td>
<td>434</td>
<td></td>
</tr>
</tbody>
</table>

**Note**: Figures in parenthesis indicate percentage to the total population

**Sources**: Office of DCF, Sirsi Division, Census 2001, Village accountants of study villages, Tahashildar offices of Sirsi and Siddapur taluks and Micro-plans of JFM of study villages

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2.5 Methodology followed in vegetation survey

To estimate the biomass stock of RF and MF of the selected villages, direct measurement of entire vegetation has to be undertaken. But practically it is not possible to undertake the measurement of all trees and seedlings in entire area of RF and MF, which stretches for hectares together. Thus following the well-known methodology of enumerating one-hectare area of both RF and MF is followed. According to Ravindranath and Premnath (1997) if the area of study is large and/or, there is a limitation in the manpower available, a minimum of one-hectare of forest area can be studied to give fairly good information about the entire forest area.

Prior to the actual vegetation study the basic data and maps of the sampled villages were collected from the Office of the Range Forest Officer. With the help of map of the village, RF and MF of the villages were located. With an idea to collect data from one-hectare of both RF and MF the forest was approached under the guidance of forest watchman. As RF and MF stretch to a fairly vast area with differences in its density, studying one-hectare area at the same place may give a biased result. Hence, to avoid such bias and to get a representative data, both RF and MF were studied at four different places in that stretch of forest totally to get an area of one-hectare. The detailed technique followed in data collection, which is same for both RF and MF, is explained below. The period of data collection lasted for January to March 2006.
A sample plot (also called quadrat) of 50 mtr x 50 mtr was marked using a plastic rope to get a square with an area of 2500 m² (Picture 2.3). This is called a ‘tree quadrat’.

![Image of tree quadrat](image.jpg)

**Picture 2.3: Marking tree quadrat in the RF of Nidgod village in Uttara Kannada**

Girth (circumference) of all trees\(^1\) in that quadrat was measured with a tape (in centimetre unit and then converted into metre unit) at 130 cm (1.3 mtr) height (Picture 2.4). This height of 130 cm is called ‘breast height’. Hence, circumference of a tree at 130 cm of height from the ground is called Girth at Breast Height (GBH). Breast height is the universally adopted standard height for measuring girth of a standing tree which has been recommended by Food and Agriculture Organisation (FAO) in 1958 as a standard for international adherence (Chaturvedi and Khanna 1982). The reasons behind this standard height are, it’s a convenient height for taking

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\(^1\) A tree is an individual with girth greater than or equal to 10 cm at 130 cm height
measurements avoiding all types of unnecessary fatigue, base of the tree is generally covered with grass, shrubs and thorns which need the extra work of clearing and to avoid wrong recording of the data as majority of the trees develop buttress root swelling near the base. Readings were recorded along with the botanical name of the trees and their height (in meter units) in a specially designed sheet (see Appendix). Height of the tree was measured through eye estimation method by the highly skilled fieldwork professionals of Centre for Ecological Sciences (CES), Indian Institute of Science (IISc), Bangalore. The tree for which the girth and height are measured and recorded was marked with white coloured chalk to facilitate the single time enumeration (Picture 2.5).

Picture 2.4: Measuring the girth of a tree *Vitex altissima* at breast height in the RF of Bilur village in Uttara Kannada
A tree having forks (branches) with girth more than or equal to 10 cm below 130 cm height, the branches were considered as A, B, C, and so on. Each fork was measured separately at 130 cm of height to record its girth. But the tree was treated as single individual and the height of the longest fork was considered as height of the tree (Picture 2.6).

Picture 2.6: A tree *Eugenia jambolana* with A and B branches in the RF of Bilur village in Uttara Kannada
Damage (disturbance) to individual noticeable at the time of enumeration was also recorded. The major types of damage found were branches of the tree (A or B or C) cut (Picture 2.7), upper portion of the tree cut (Picture 2.8), lopped (Picture 2.9), Pollarded i.e., lopping the tree by cutting the main branches (Picture 2.10), forked (Picture 2.11), standing dead (Picture 2.12), fallen dead (Picture 2.13) and entire tree cut (actual cut) (Picture 2.14).

Picture 2.7: A tree *Aparosa lindleyana* with B branch cut in the RF of Bilur village in Uttara Kannada
Picture 2.8: Upper portion of a tree *Adina cardifolia* cut in the RF of Bilur village in Uttara Kannada
Picture 2.9: A tree *Terminalia tomentosa* lopped in the MF of Kabbe village in Uttara Kannada
Picture 2.10: A tree *Lagestromea lanceolata* pollarded in the RF of Bilur village in Uttara Kannada
Picture 2.11: A tree *Lagestromea lanceolata* with many forks in the MF of Bilur village in Uttara Kannada

Picture 2.12: A tree standing dead in the RF of Bilur village in Uttara Kannada
Fallen dead

Picture 2.13: A tree fallen dead in the RF of Manjguni village in Uttara Kannada

Fallen dead

Picture 2.14: Entire tree cut (actual cut) in the RF of Bilur village in Uttara Kannada
To understand the future status of the forest, data regarding its present regeneration pattern had to be collected. This was done by measuring the seedlings\(^2\) in the sampled plot. Following the standard procedure, in the marked tree quadrat, another quadrat of the size 10 mtr x 10 mtr covering the total area of 100 m\(^2\) was marked with a plastic rope at random. It is called a ‘shrub quadrat’. As girth of the seedlings was not measurable, their diameter at breast height (DBH) was taken using vernier calipers (Picture 2.15) and the readings were recorded with botanical name in a specially designed sheet (see Appendix). This helps in understanding distribution of DBH, seedling density and species density. Similarly three more shrub quadrats were done in the tree quadrat. Hence the total area covered was 400 m\(^2\).

\(^2\) A seedling is an individual with girth less than 10 cm at 130 cm height

Picture 2.15: Measuring the diameter of a seedling *Macaranga peltata* in the RF of Bilur village in Uttara Kannada
Similar replications of four tree quadrats were laid at randomly selected places and enumeration was done. Thus the total area under tree quadrat is 10,000 m² (1 hectare) and the total area under shrub quadrat is 1600 m² (0.16 hectare).

2.6 Above Ground Biomass (AGB)

By biomass, we mean the total weight of a tree. Total biomass of a tree includes both Below Ground Biomass (BGB) and Above Ground Biomass (AGB). If the total biomass of a tree is to be estimated, then one should take into account both BGB and AGB. As the term itself indicates, BGB is the total weight of the tree below ground and AGB is the total weight of a tree above ground. Though it is more appropriate to consider total biomass, it is not possible to estimate BGB and AGB in a direct manner. BGB of a tree can be estimated by removing the tree from the ground along with its root and recording its oven-dry weight (i.e. at zero moisture content). AGB can be estimated by cutting the tree bole, limbs and leaves and taking their oven-dry weight. But practically both these procedures are not possible, as the destructive sampling has to be followed in both the cases. As the destructive sampling is not advisable in the case of natural and regenerating forests and not practicable due to legal restrictions, ecologists have developed an indirect, but universally accepted method of taking girth and height of the tree to estimate basal area, volume and AGB.

2.7 Concept and parameters used in the estimation of AGB

The study attempts to quantify and compare the intra-village RF and MF with respect to AGB and regeneration pattern by estimating the
parameters like basal area, volume and biomass of the forest stands. These parameters can be estimated by enumerating the GBH and height of the trees in each forest stand. According to Chaturvedi (1984) measurement of GBH is universally recognised to be a reliable measure of growth of trees. To study differences in the status of RF and MF tree density\(^3\) and species density\(^4\) are calculated for both trees and seedlings.

2.7.1 *Estimation of Basal Area (BA)*

Basal area may be defined as cross-sectional area occupied by the base of a tree (Ravindranath and Premnath, 1997). It can be calculated by the formula \((\text{GBH})^2/4\pi\) with the help of measured GBH. Hence, the total basal area of a forest stand is the sum of cross-sectional area occupied by base of all trees in that forest stand.

**Proof:** Consider tree as a cylinder.

We measure the GBH of it, which is the circumference of that tree

Hence, \(\text{GBH} = \text{Circumference of the tree} = 2\pi r\)

Basal area is given by \(\pi r^2\) (base of a cylinder)

Using the GBH, Basal area has to be arrived at by calculating the radius \(r\).

\[ r = \frac{\text{GBH}}{2\pi} \]

\[ r^2 = \left(\frac{\text{GBH}}{2\pi}\right)^2 \]

Hence, \(\text{BA} = \pi r^2 = \left(\frac{\text{GBH}}{2\pi}\right)^2 / 4\pi\)

---

\(^3\)Number of trees found in 1 hectare area (shows the numerical abundance of trees in a given area)

\(^4\)Also called 'Species richness' is the number of species found in 1 hectare area (shows the numerical abundance of species in a given area)
Thus we arrive at the basal area of a single tree. Sum total of thus estimated basal area of all trees in a sample plot gives the total basal area of that plot.

It is given by,

\[
\text{Total BA} = \left[ \frac{(\text{GBH})^2}{4 \pi} \right]_1 + \left[ \frac{(\text{GBH})^2}{4 \pi} \right]_2 + \ldots + \left[ \frac{(\text{GBH})^2}{4 \pi} \right]_n
\]

Where \( \pi = \frac{22}{7} = 3.142 \)

1,2,\ldots,n are the different trees

i.e. Total BA = \( \sum_{i=1}^{n} \left[ \frac{(\text{GBH})^2}{4 \pi} \right]_i \) (i takes the values 1,2,\ldots,n)

If a tree is forked to give A and B branches, then its GBH will be calculated as below.

\[
\text{GBH} = \sqrt{(\text{GBH}_A)^2 + (\text{GBH}_B)^2}
\]

### 2.7.2 Estimation of volume (V)

Volume of a tree is the product of basal area and height of the tree.

**Proof**: Volume = \( \pi r^2 \times \text{Height} \)

i.e. BA \times Height

Total volume = \( [(BA \times \text{Height})_1 + (BA \times \text{Height})_2 + \ldots + (BA \times \text{Height})_n] \)

i.e. Total volume = \( \sum_{i=1}^{n} (BA \times \text{Height})_i \) (i takes the values 1,2,\ldots,n)

1,2,\ldots,n are the different trees

### 2.7.3 Estimation of biomass

Biomass is a function of wood density, height and basal area of the tree (Murali et al. 2005). Natural forest, unlike man-made plantation, is a heterogeneous assembly. It consists of trees of various species known for their
hardwood to softwood characteristics. For a hardwood tree volume may be less but the wood weight will be more whereas for softwood tree volume may be more but the wood weight will be less. In order to avoid such differences, using a common factor called basic wood density (also called specific gravity) volume is converted into biomass which is an internationally acceptable factor. This basic wood density also varies for trees depending upon their wood structure. Hence estimation of biomass for different trees with different basic wood density becomes a tedious task. To minimise the efforts involved in this process, ecologists have suggested an average basic wood density (0.5) for all timber which is the average oven-dry mass common to all species (Whitmore, 1984).

Hence, Biomass = Volume x 0.5

Total biomass = [(Volume x 0.5)_1 + (Volume x 0.5)_2 + .......+ (Volume x 0.5)_n]

i.e. Total biomass = \[\sum_{i=1}^{n} (Volume x 0.5)_i\] (i takes the values 1,2,......,n)

1,2,......,n are the different trees

2.7.4 Distribution of Diameter at Breast Height (DBH)

DBH (Diameter at breast height) distribution is established to understand the number of individuals under different diameter class. Once the GBH of the tree is known, DBH can be established.

Proof : We know that, GBH = 2 \(\pi\) r

Hence, DBH = 2 \(r = GBH / \pi\)
2.8 Methodology followed in household survey

The villages for which vegetation data was already collected to estimate the biomass stock, the flow had to be estimated. Before entering into the villages, basic information about every village was collected by meeting the village accountant of the respective villages.

In Uttara Kannada district a unique classification of the cultivated land into three categories is noticed. Firstly, Bhagayat land, the most fertile land especially under arecanut orchard or any other plantation crop. Secondly, Tari land, the medium fertile land under paddy cultivation. Finally, Khushki land, the least fertile and totally dry is used for growing fodder or in some cases for growing pulses. To classify the farmers into different categories, a standard procedure of conversion of Bhagayat and Tari land into Khushki land is followed in the district. The criterion for conversion is, one acre of Bhagayat is equal to ten acres of Khushki. One acre of irrigated Tari is equal to four acres of Khushki and one acre of unirrigated Tari is equal to two acres of Khushki. The study based on this criterion has done the conversion of lands into Khushki land in order to classify the farmers into different category of land holding. Farmers with less than five acres of Khushki land were classified under the category of small holding and those having Khushki land more than or equal to five acres were included in the category of large holding.

In order to get a representative data, the study aimed at covering more than 50 per cent of the households in each sampled village. Hence, in every village 53 per cent of the households were selected randomly. Each village
was found to be having farmers with different size of landholding but unequally distributed across the village. Hence, households falling in the category of landless, small holding and large holding were surveyed in every village to get an adequate representation of the population of entire village. In every sampled village, the households falling in each category were selected using simple random method covering more households from the category that had more number of households under it. It was noticed that in three villages out of the four sampled villages, the proportion of households with large holding to the total number of households was less. Hence, the total number of households covered was 247 out of which, 91 households from landless category, 93 households from small holding category and 63 households from large holding category.

The household survey was conducted during the period of April to June 2006. Head of the household was approached personally with a questionnaire prepared to record the information during the interaction (see Appendix). Before interacting directly about the biomass extraction, the respondent was made to feel comfortable by asking the basic questions about his (not necessarily a male, there were also some female head for the households; pronoun of male is considered for the sake of convenience) household and occupation. After that he was interviewed in detail about the dependency on forest in the form of grazing, collection of fuelwood, green leaves, dry leaves and structural material and the answers were noted down immediately. To be more specific, number of days of extraction, number of
people engaged in extraction, time spent on extraction was inquired at each household and was recorded.

Many houses were found to be using fuel-efficient stoves (popularly known as ASTRA stoves) or biogas or LPG (Liquefied Petroleum Gas) for cooking. In the case of such households, data of fuelwood collection before and after the implementation of such stoves were recorded. People also extract biomass in the form of green leaves, dry leaves and structural material. Detailed data regarding their extraction was recorded. Some households were found to have planted *Gliricidia maculata* as live fence. In such cases, data about the collection of structural material before and after live fencing was recorded.

All these extracted forest products were expressed in terms of headloads and cartloads by the villagers. But in the later stage, the data was converted in terms of tonnes by using the standard conversion factor. Hence, the total biomass extracted would be the total of quantity of fuelwood, green leaves, dry leaves and structural material collected.

The next step was to identify the cost involved in the collection of biomass. For certain aspects say grazing, fuelwood, fodder, dry leaves and green leaves market prices are not known because they are not marketed. They are treated as free unless they are purchased. Still there exists a value for them. Hueting (1991) says costs are conceived as forgone alternatives which are quantified but not always in terms of money. For such aspects, the usual practice is to deduce the costs indirectly, using opportunity cost principle (i.e., value of a good in its next best use) or valuing of certain resources saved because of the availability of alternative resources. As costs and benefits of
biomass are not available in terms of monetary units, their costs are arrived at using opportunity cost of time spent (in terms of labour hours) and benefits are estimated using the market price for the collected forest produce.

For instance, suppose one member from a household collecting fuelwood for 200 days in a year. It does not involve any direct cost as family labour is used. But the wage rate being Rs. 100 per day, the total imputed cost of collection of fuelwood per year would be;

(Total number of persons per family collecting fuelwood x Total number of days of fuelwood collection per year x Wage rate per day)

i. e., 1 x 200 x 100 = Rs. 20,000

Further suppose, the total collection of fuel wood per family per year is 5000 kg. Average market rate for fuel wood being Rs 2 per kg, the valued annual benefit per family from the fuel wood would be;

(Quantity of fuel wood collected per family per year x Market rate for the fuelwood per kg)

i. e., 5000 * 2 = Rs. 10,000

Following the same procedure of calculation for all other forest products such as green leaves, dry leaves and structural material including fuelwood, we arrive at the cost of and benefit from the total biomass flow to that household. With reiteration of the same procedure for all the households in a village, we arrive at the total cost of and benefit from the biomass flow to that village.

Data collected using these methods are analysed and presented in the subsequent chapters to give an idea of biomass stock, biomass flow and biomass conservation.