NATURAL RESOURCE ACCOUNTING IN KARNATAKA: A STUDY OF THE LAND & FORESTRY SECTOR (EXCLUDING MINING)

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Natural Resources are indispensable not only for sustaining life but also as an important input for economic growth. The global economy is expanding amidst global depletion in the natural resources. Due to poor availability of information on various aspects of natural resources and problem of quantification of natural resources, it is not possible to fully assess the damage being done to natural resources. It is therefore necessary to develop a system of accounting of natural resources, which is likely to provide ample support to design the economic system, in such way that it is possible to attain economic growth without destroying natural resources. The concept of natural resource accounting started almost three decades back and the procedures for accounting evolved gradually after identifying the gaps in the System of National Accounts. While general procedures were evolved it was not possible to visualize a number of issues and challenges that the actual researcher would face at the time of their application in the context of a particular situation. A necessity was felt to initiate specific case studies with reference to selected items of natural resources and also in the context of specific regions. The present study aims at developing a methodology for natural resource accounting in the state of Karnataka with a focus on selected natural resources.

Centre for Multi disciplinary Development Research Dharwad feels privileged to have been asked by the Central Statistical Organization (CSO), Ministry of Statistics and Programme Implementation (Environment and Statistics Unit) to undertake a study on Natural Resource Accounting (NRA) in Karnataka : A study of the Land & Forestry Sector (Excluding Mining). The study proposed to develop a methodology for quantifying Natural Resources to be included as a part of SDP.

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Prof.P.R.Panchamukhi
Principal Investigator and former Director, CMDR

List of Tables

Table No.	Table Title		Page No.
Table 1.1.	Format for summary physical flow accounts	…….	6
Table 1.2	A Simple Supply and Use Table for All Physical Flows	…….	7
Table 1.3	A Simple Hybrid Supply and Use Table	…….	8-9
Table 1.4	Supply and Use Table for Environmental Protection Services	…….	10
Table 1.5	Illustrative Physical Asset Account	…….	11
Table 2.1	Demographic Profile of Karnataka	…….	19
Table 2.2	Broad composition of Workers in Karnataka (As a % percentages of total population)	…….	20
Table 2.3	Total and per capita GSDP of Karnataka	…….	21
Table 2.4	Agro-Climatic Zones of Karnataka	…….	26
Table 2.5	Satellite Data for forest Cover Assessments as Provided in SFR (2003)	…….	30
Table 2.6	Forest Area in Karnataka An Inter-State Comparison (Area in sq kms)	…….	32
Table 2.7	A Comparison of the Recorded forests and Actual Forest cover (area in sq.km)	…….	34
Table 2.8	Area of different forests in Karnataka	…….	35
Table 2.9	Forest Area in Karnataka District-wise (Area in hectares and Ratios in %)	…….	37
Table 2.10	District-wise Forest Area by Legal Status 2002-03 (As a % of Total Area of the State)	…….	*38*
Table 2.11	Types of Forest Cover in Karnataka and India	…….	39
Table 2.12	District-wise Forest Cover of Karnataka in 2001(area in sq.kms.)	…….	41
Table 2.13	Forest Cover Change Matrix of Karnataka in 2003(Area in sq.kms)	…….	42
Table 2.14	Forest Cover Change Matrix of India(Area in sq.kms)	…….	43
Table 2.15	District-wise Forest Cover of Karnataka as per 2003 Assessment (sq kms)	…….	44
Table 2.16	Change in Forest Cover in Karnataka (Area in Sq. Kms)	…….	45
Table 2.17	Groundwater Position in Karnataka (As on March 1998-Provisional)	…….	51
Table 2.18	Resource-Activity impact matrix	…….	52

List of Tables *(Contd..)*

Table No.	Table Title		Page No.
Table 2.19	Priority Matrix	…….	53
Table 2.20	Areas cleared and diverted for non-forestry purposes	…….	54
Table 3.1	Environmental Assets in SNA 1993	…….	59
Table 3.2	SEEA 2003 Asset Classification	…….	60
Table 3.3	Links between SNA and SEEA classifications	…….	61
Table 3.4	The strength and weakness of different techniques	…….	65
Table 4.1	Valuation Methods Used and Select Details of the Sample	…….	75
Table 4.2	Studies on Valuation of NTFPs (continued)	…….	78-79
Table 4.3	Strengths and Weaknesses of the methods used in the literature	…….	80
Table 4.4	Relevant Information about Selected Villages (continued)	…….	81-82
Table 4.5	Sample of HHs Collecting NTFPs	…….	82
Table 4.6	Collection of NTFPs* in Selected Villages per Household per Month	…….	83
Table 4.7	Local Price of NTFPs in Selected Villages of Karnataka	…….	84
Table 4.8	Value of NTFPs Collected in Selected Villages (per Household per month, Rupees)	…….	85
Table 4.9	Total Value of NTFPs Collected in the Selected Villages (Rs/Month).	…….	86
Table 4.10	Per HH Value of NTFPs Collected & Sold in the Selected Villages (Rs/HH/Month)	…….	86
Table 4.11	Yearly Average Value of NTFPs collected per HH in Selected Villages (Rs)	…….	87
Table 4.12	Estimated Value of NTFPs per Hectare Across Forests Types	…….	87
Table 4.13	Estimates of NTFPs in Karnataka for 2002-03	…….	88
Table 4.14	Composition of Livestock in Selected Districts of Karnataka	…….	91
Table 4.15	Sample of HHs Owning Livestock in the Selected Villages	…….	92
Table 4.16	HHs Depending on Forest for Grazing Livestock	…….	93
Table 4.17	Number of livestock grazing in forest during various Seasons in the Study area	…….	93
Table 4.18	No of Animal Units* Grazing in Forest during Various Seasons in the Study area	…….	94

List of Tables *(Contd..)*

Table No.	Table Title		Page No.
Table 4.19	Total animal units grazing in the forest area	…….	94
Table 4.20	Grazing Intensity (Animal Units per HH) in Various Forests of Villages of Study Area	…….	95
Table 4.21	Estimation of Value of Grazing Services Provided by Various Types of Forests in Karanatka State	…….	96
Table 4.22	Variables Used, Notations and Hypotheses to be Tested	…….	102
Table 4.23	No. of Visits (VIS) as a Function of TC, INC, AGE and EDN (Linear Model)	…….	105
Table 4.24	Log of No. of Visits (LV) as a Function of TC, INC, AGE and EDN (Linear Model)	…….	106
Table 4.25	Linear demand curve for No. of Visits (VIS)	…….	106
Table 4.26	Log-Linear Linear demand curve for No. of Visits (LV)	…….	106
Table 4.27	Valuation of Recreational Services of Dandeli Park	…….	107
Table 4.28	Consumers' Surplus and Recreational Value of Dandeli Park	…….	108
Table 4.29	Carbon sequestration potential	…….	113
Table 4.30	Financial Potential of carbon Sequestration	…….	114
Table 4.31	Carbon flow in the Indian forests	…….	116
Table 4.32	Estimated carbon stock (t/ha) and carbon dynamics (t/ha/yr) in different forestland use types and in the Uttar kannada district of the Western Ghats	…….	117
Table 4.33	Different study areas of Karnataka with biomass and carbon stock estimation	…….	118
Table 4.34	General profile of fuel wood using local producers	…….	122
Table 4.35	Fuel wood consumption and prices	…….	123
Table 4.36	General profile of households surveyed for Medicinal plants	…….	126
Table 4.37	Approach to Medicinal plants	…….	127
Table 4.38	Willingness to pay for conservation of medicinal plants	…….	128
Table 4.39	General profile of the households surveyed for Sacred Groves	…….	130
Table 4.40	Attitudes Regarding Sacred Groves	…….	131
Table 4.41	Willingness for conservation of sacred groves	…….	132

List of Tables *(Contd..)*

Table No.	Table Title		Page No.
Table 4.42	General Profile of the households surveyed in Watershed villages	…….	135
Table 4.43	Willingness to pay for development of watershed	…….	136
Table 5.1	Impact of Land Degradation	…….	141
Table 5.2	Extent of Land Degradation as per NRSA (Mn Ha)	…….	142
Table 5.3	Land Cover Classification in India	…….	148
Table 5.4	Physical Stock of Land in Karnataka- Land Use Pattern	…….	149
Table 5.5	Changes in Land Use in Karnataka (Physical flow account for land)	…….	151
Table 5.6	Irrigation Potential Created (as in March 2000)	…….	155
Table 5.7	Area Submergence in Relation to Irrigation Potential in Different Basins in Karnataka (Area; Ha)	…….	155
Table 5.8	Environmental Hotspots in Karnataka	…….	156
Table 5.9	Area Under Different Types of Roads in Karnataka	…….	158
Table 5.10	Network of Railways in Karnataka	…….	158
Table 5.11	Urban Population by Classification of Towns in Karnataka, 2001 and the Projections for 2011	…….	159
Table 5.12	Demand of Land for Industrial Use in Karnataka by KIADB and KSSIDC	…….	161
Table 5.13	Land Resources in Karnataka PASIR Framework (Continued)	…….	163-166
Table 5.14	Soil Depth Classes in Karnataka	…….	169
Table 5.15	Surface Soil by Texture in Karnataka	…….	170
Table 5.16	Soil Drainage Classes in Karnataka by Area	…….	172
Table 5.17	Water Capacity of Soils in Karnataka by Area	…….	172
Table 5.18	Soil Erosion Status Over the Period in Karnataka	…….	173
Table 5.19	Extent of Soil Gravelliness in Karnataka	…….	174
Table 5.20	Slope Classes and Their Respective Area in Karnataka	…….	174
Table 5.21	Soil Degradation Status in Karnataka (1985-1990)	…….	176
Table 5.22	Soil Degradation Status in Karnataka 1999/2003	…….	176

List of Tables *(Contd..)*

Table No.	Table Title		Page No.
Table 5.23	Area Affected by Salinity of Soil in Karnataka 2000	…….	176
Table 5.24	Land Capability of Soils in Karnataka	…….	177
Table 5.25	Land Irrigability of Soils of Karnataka	…….	178
Table 5.26	Area Under Different Soil Quality Parameters in Karnataka	…….	179
Table 5.27	Reclamation of Degraded Lands for Karnataka (2003-04)	…….	180
Table 5.28	Amelioration Cost of Problematic Soils in Karnataka State (2003-04)	…….	181
Table A5.1	Land degradation severity of human-induced degradation Asia and Pacific	…….	183
Table A5.2	Human-induced land degradation due to agric. Activities Asia and Pacific	…….	184
Table A5.3	Land degradation severity and population distribution Asia and Pacific	…….	185
Table A5. 4	Land Use Pattern in the Various Districts of Karnataka as a % of the State Area under a Given Use (2001-02)	…….	186
Table A5.5	Land Use Pattern in the Various Districts of Karnataka as a % of the Geographic Area of the District (2001-02)	…….	187
Table A5.6	Area under principal crops in Karnataka(Lakh hectares)	…….	188
Table A5.7	Productivity of Land for Different Crops in Karnataka (tones per hectare)	…….	189
Table A5.8	Consumption of Fertilizer from 1970-71 to 2002-03 in Karanataka (in Tonnes)	…….	190
Table 6.1	Reporting Format of Comparison Across Time T1 and T2.	…….	202
Table 6.2	Land Use/Land Cover And Change Statistics Of Hassan District Generated Using Irs Liss Iii Satelite Date	…….	237
Table 6.3	Revised Remote Sensing Based Comprehensive Land Use / Land Cover Classification System From Satellite Data	…….	238-240
Table AI.1	Valuation Methods Used And Results	…….	A1-A3
Table AI. 2	Data Requirements, Data Sources And Data Gaps	…….	A5-A6

List of figures

Figure No.	Figure Title		Page No.
Figure 2.1	Composition of Recorded Forest Area in India (FSI, 2001)	…….	33
Figure 2.2	Composition of Recorded Forest Area in Karnataka (FSI, 2001)	…….	34
Figure 2.3	Forest Land in Karnataka- Classified by Management Type	…….	35
Figure 2.4	Forest Land in Karnataka- Classified by Natural Types	…….	36
Figure 2.5	Forest Cover in Karnataka as a % of India	…….	39
Figure 2.6	Comomposition of Geographical Area of Karnataka (FSI, 2003)	…….	42
Figure 4.1	District-wise Livestock in Karnataka (2003 provisional)	…….	90
Figure 4.2	Composition of Livestock in Districts Selected for Field Study	…….	91
Figure 5.1	Land Use Pattern in Karnataka	…….	149
Figure 5.2	Changes in Land Use in Karnataka	…….	152
Figure 6.1	Methodology adopted for Land use / Land cover mapping	…….	222
Figure 6.1.A	Land use/land cover map of Hassan district -1996-97	…….	225
Figure 6.2	land use/land cover map of Hassan district -2001-02	…….	226
Figure 6.3	Land use/land cover map of NR 57C/04 -1996-97	…….	227
Figure 6.4	land use/land cover map of NR 57C/04 -2001-02	…….	228
Figure 6.5	Land use/land cover change assessment of Hassan district for the period 1996-2002	…….	229
Figure 6.6 & 6.7	Satellite data depicting urban changes of Hassan district for the year 1998 & 2002	…….	230

List of Maps / Plates

Map No.	Map Title		Page No.
Map 2.1	District Map of Karnataka	…….	18
Map 2.2	Agro Climatic Zones of Karnataka	…….	23
Map 2.3	Soil Types in Karnataka	…….	27
Map 2.4	Soil Erosion in Karnataka	…….	28
Map 2.5	(a) 1 250,000 Scale	…….	31
Map 2.5	(b) 1 50,000 Scale	…….	31
Map 2.6	Forest Types in Karnataka	…….	40
Map 2.7	Rainfall in Karnataka	…….	49
Map 2.8	River Basins in Karnataka	…….	50
Map 4.1	Selected Districts (in Green) for NTFPs ,Grazing and other Services	…….	76
Plate 6.1	Digital Mosaic of Karnataka State	…….	196
Plate 6.2	Land Use/Land Cover of Karnataka (1999-2000)	…….	197
Plate 6.3	Land Use / Land Cover System Adopted for the present study	…….	204
Plate 6.4	Land Use/Land Cover Change Map of Chitradurga District	…….	211
Plate 6.5	Land Use/ Land Cover Change Map of Davangere District	…….	212
Plate 6.6	Land Use/Land Cover Change Map of Shimoga District	…….	214
Plate 6.7	Land Use/Land Cover Change Map of Dharwad District	…….	215
Plate 6.8	Land Use/Land Cover Change Map of Kodagu District	…….	216
Plate 6.9	Land Use/Land Cover Change Map of Uttar Kannada District	…….	217
Plate 6.10	Land Use/Land Cover Change Map of Dakshina Kannada District	…….	218
Plate 6.11	Land Use/Land Cover Change Map of Udupi District	…….	219
Plate 6.12	Land Use/Land Cover Change Map of Hassan District	…….	221
Plate 6.13	Multi-date Remote Sensing for Land Use/Land Cover Change:Hassan District	…….	223

List of Boxes

Box No.	Box Title		Page No.
Box 2.1	Forest area versus forest cover	…….	28
Box 3.1	Summary of valuation methods for timber	…….	67
Box 4.1	NTFPs (Unrecorded) Share in GSDP of Karnataka	…….	89
Box 4.2	Estimated share of grazing land in forests to GSDP	…….	95
Box 4.3	Recreational value as % to GSDP	…….	109
Box 4.4	Estimated Share of Carbon Sequestration Value in GSDP	…….	119
Box 4.5	Unrecorded share of medicinal plant in GSDP	…….	128
Box 4.6	Estimated share of Sacred groves in GSDP	…….	133
Box 4.7	Share of Watershed in GSDP of Karnataka	…….	136
Box 5.1	Land–use classification in India	…….	147
Box 5.2	Accounting of land resources in SDP	…….	182

List of Charts

Chart No..	Chart Title		Page No.
Chart 1.1	Flows between the economy and the environment	…….	4
Chart 2.1	Total Economic Value of Forests	…….	47
Chart 3.1	Taxonomy of cost-based estimates	…….	62
Chart 3.2	Taxonomy of benefit/damage valuation techniques	…….	63
Chart 5.1	Structure of the land cover/land use accounts (SEEA 2003)	…….	145

EXECUTIVE SUMMARY

E.1 The study deals with a range of selected issues in the areas of natural resource accounting in land and forest sectors namely physical accounting and valuation issues which are imperative in conversion of physical accounts into monetary accounts and for the integration of the latter into the 'green' national/state income accounting.

E.2. The main thrust of the findings of this study is methodological. The methods suggested in the study are applied in the context of Karnataka. The data base is required in physical terms and in some cases also on the prices of the natural resources. The valuation of these resources into monetary terms tends to be difficult but not insurmountable. The markets do not reflect the true value of such resources due to the presence of externalities attached to these resources. This limits the use of reported prices. The formats for compilation of accounts for resources, in physical and monetary terms and in stocks and flows as per SEEA, 2003, have been provided in Chapter -1.

E.3 In Karnataka like that for India, the income originating from forestry and logging sector is included under NSDP/GSDP in a rather incomplete manner. The timber produce harvested on land under forest departments is taken care of in the flows of NSDP/GSDP. However, the other non-timber forest products/services are inadequately accounted for in the state domestic products and even in national income accounts.

E.4. In Karnataka, the area under forest cover has declined in 2003 as compared with 2001 and this decline has been caused by a severe decline in the dense forest cover, part of which has gotten converted into open forests. The decline in dense forests of Uttar Kannada district has been almost half of the decline in dense

forests of the Karnataka state as a whole. This has adverse implications for carbon sequestration benefits and also for enabling forests to perform their sink function.

Eight case studies were conducted to get an idea of the contribution of forests in Karnataka to the State Domestic Product of Karnataka. The main observations as based upon these case studies are presented below:

1. The study on value of NTFPs reveals that the unrecorded NTFPs is to the tune of 86 % of the reported SDP originating from forestry and logging sector and that this amount escapes from the accounting of SDP. ***This unrecorded value of NTFPs constituted about 1.45 percent of SDP of the state in 2002-03.***

2. Various types of forests of Karnataka provide grazing services to its livestock population **which amounted to about 0.50 percent of SDP** of Karnataka at current prices in 2002-03. However, the adjustments on the negative side have to be made for the expenses in running the forest department and also the degradation in land quality and productivity of land due to grazing of animals in forests.

3. Karnataka possesses a rich wild-life resources which are not properly accounted for. The case study on Dandeli Wild-life Sanctuary reveals that the recreational value of the sanctuary is more than the revenue earned by the state. The total **recreational value of forests in Karnataka constituted 0.02 % of GSDP at current prices for 2002-03.**

4. The study highlights the benefits of carbon sequestration of the forests in the context of Karnataka based on information available from secondary sources. **The estimated value of carbon content in the forests of Karnataka is about 14.6 % of GSDP at current prices in 2002-03. It may be noted that this benefit is a stock concept and hence, warrants inclusion only in the physical stock accounts, if they are prepared for forests and not to be adjusted in the GSDP of the state.**

5. The case study on the valuation of fuel wood used by the local industries amounted to about Rs. 49 lakhs. The sale of fuel wood by government depots is already accounted for in the SDP. Therefore, adjustments for fuel wood have not been made for the sheer fact of avoiding double counting.

6. Forest resources of Karnataka in particular and of India in general, are used for medicinal purposes, which is regarded as one of the most important sources of state domestic product with its backward and forward linkages. The case study on this aspect reveals that **the share of medicinal plants in GSDP for the year was to the extent of 0.01 percent for the year 2002-03.**

7. We estimated the **share of sacred groves in GSDP as 0.001 per cent for the year 2002-03 on the basis of the willingness to pay by the households.**

8. The case study on **watershed benefits of forests** based on the contingent valuation method using the willingness to pay for the preservation of watersheds revealed that the total value of such benefits was Rs 43.23 crore for Karnataka for the year **2002-03, which was 0.04 percent of GSDP.**

E.5 In order to assess the value of land resources (excluding Mining) for estimating its contribution to the SDP, the study made an attempt in this direction. Conversion of such resources in monetary terms requires the corresponding price matrix which is rather difficult to get due to the fact that land markets are rather thin and also the reported prices for land transactions vary from place to place. The replacement costs of restoration of land quality in Karnataka are high but these are not available for enabling people to fully appreciate the cost of economic growth in the state. We have identified the impacts of land degradation; both environmental and socio-economic, in a PASIR framework for the state. By using the physical accounting method (SEEA, 2003) we have developed the physical flow of accounts of land resources (Chap-5). As soil is one of the most important determinants of land quality for agricultural purposes, we have provided an

estimate of restoration of soil based on restoration cost approach. These estimates are used to estimate the **adjusted SDP in the agriculture sector of the state, which was 19.5 %** as against 20.3 % without adjustment of land degradation in 2002-03 at current prices.

E.6 Considering that the official data on land use is most often incomplete and unreliable, the study used **remote sensing** data for accurate asset accounting of the Land and Forestry sector, covering eight districts, viz., Davanagere, Dharwad, Chitradurga, Kodagu, Hassan, Shimoga, Uttar Kannada and Dakshina Kannada (Chap-6). This is a more reliable method as compared to the official land records. The reason is that the latter are just repeated in successive years, while the former are also based on ground truthing. However, this is just an demonstrative study conducted at a rather miniscule scale.

On the whole, the present study is a modest initiative to recognize the importance of various unrecognized or less explicitly recognized elements in the natural resources while estimating the state domestic product. The study can be considered as illustrative rather than conclusive. We have considered only selected items of natural resources for the purpose of this exercize of recognizing less explicitly recognized aspects. We hope that the present study would pave the way for more comprehensive studies in the field.

Chapter -1

NATURAL RESOURCE ACCOUNTING AND SUSTAINABLE DEVELOPMENT: AN INTRODUCTION

1.1 Introduction

Sustainable development of an economy depends on the continued availability of natural resources along with human and man-made capital. The traditional national income accounting ignores the contribution made by the factors of production that are not traded within the market orbit. This is particularly true of the natural resources and environmental inputs. The interaction between economic activity and environment takes place through products, natural resource inputs, ecosystem inputs and residuals (such as, gases). In this process of interaction natural resources get depleted and degraded affecting the potential growth in future.

Recognizing this possibility of a trade off between high growth at present and impoverishment in future, the urgency for making development process 'sustainable' was emphasized in the Brudtland Commission Report (WCED, 1987). The need to evolve the accounting processes which can capture sustainability of development process started almost three decades back and the procedures are being evolved on a continuous basis after identifying the gaps in the System of National Accounts (henceforth, SNA). The 1992 Rio Conference recommended development of a system of Integrated Environmental and Economic Accounting (IEEA). In 1993, the United Nations Statistical Division (UNSTAT) came up with the detailed methodology of a System of Environmental and Economic Accounting (United Nations, 1993) as a revised SNA. SEEA 1993 has been further revised and is known as SEEA 2003. The SEEA 2003 provides a useful framework for the empirical assessment of the concept of sustainability. It may be noted that SEEA also aims to provide a unified framework which can be adhered to by countries whilst preparing their national accounts that will be meaningful from the point of view of judging the sustainability of their development and also will have the advantage of enabling cross-country comparisons. The

major steps in the preparation of satellite accounts are: (i) identification of environmentally related sectors/economic activities; (ii) physical accounts of those sectors/activities (stocks, flows or changes in stocks, and factors affecting changes in stocks); (iii) monetary valuation of the changes in stocks and flows; and, (iv) aggregation of the monetary values.

1.2 Sustainability and Natural Resource Accounting

The concept of '***sustainability***' in the context of development process has been interpreted both in a ***weak*** and in a ***broad*** sense. The concept of weak sustainability permits for the depletion and/or degradation of natural resources, as long as such depletion is compensated by increases in the stocks of other forms of natural capital. The basic 'assumption' made whilst defining weak sustainability is that the various forms of natural capital are substitutable. Hence, if one form of natural capital stock degrades/depletes, it can be compensated by augmenting the other forms of natural capital. As against it, strong sustainability mandates that all forms of natural capital should be maintained, because different forms of natural capital are complementary to each other. The cautionary principle invoked for strong sustainability is that renewable resources should not be used in excess of their natural regeneration (assimilative capacity) and that the sink functions (receptacle of wastes) of these resources should not be used beyond their assimilative capacities. As regards the non-renewable resources, these should be used cautiously and efficiently so as to make the same available to future generations. Technological advancements and switching over to alternative renewable resources can be the guiding principles in this matter. Activities which cause deterioration in service functions are best avoided, if not then minimized.

The three most common interpretations of sustainability (SEEA, 2003) are: (i) the three-pillar approach; (ii) the ecological approach; and, (iii) the capital approach. The ***three-pillar approach*** to sustainable development emphasizes that sustainable development needs to simultaneously take care of economic, social and environmental needs. The ***ecological approach*** mandates protection and enhancement of the 'health' of ecosystems. This is to enable the resilience of ecosystems that is required for sustainability. Human activities exert pressure on ecosystems. Material and energy extraction, physical restructuring, human

appropriation of space and ecosystem productivity, *etc.*, are examples of pressure exerted on ecosystems by human activity. These pressures trigger responses to the human pressures. These responses can be classified into four types according to their description. These are: (i) the state of the ecosystem; (ii) the causes of changes in the state of the ecosystems; (iii) the likely changes in ecosystems in the face of known pressures; and, (iv) the capability of ecosystems to deal with imposed pressures. The ***capital approach*** views that as regards generation of income, the role of natural capital is similar to that of man-made capital. Sustainability of development hinges upon the maintenance of natural capital. Natural capital is classified into three categories, *viz*., natural resource stocks, land and ecosystems. Natural capital (NC) is viewed to perform three prime functions. These functions are as follows.

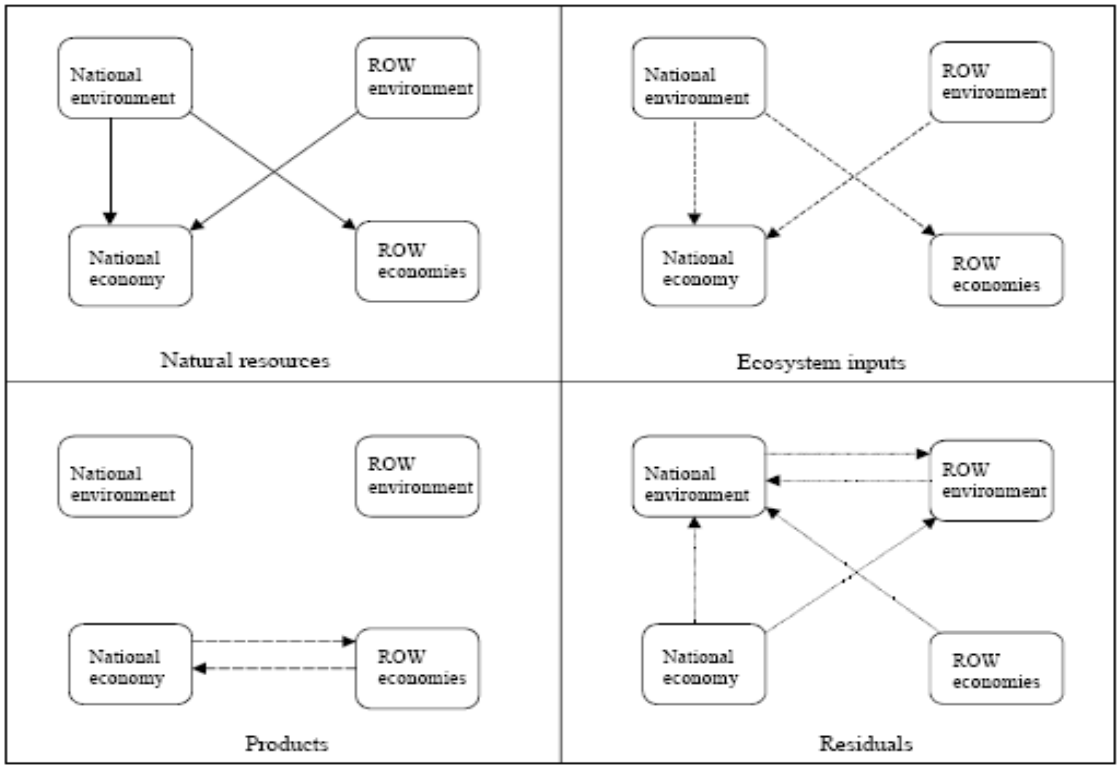
1. *Resource functions*: NC gets converted into goods and services for the benefit of mankind. NC in the form of mineral deposits, timber from natural forests, and deep sea fish, *etc*., can be deemed as performing the resource functions.

2. *Sink functions:* NC absorbs the unwanted by-products of production and consumption. Air, water (including sea water) and landfill sites function as sinks by absorbing the exhaust gases, filthy water used by people and waste generated by human activity, respectively.

3. *Service functions*: Service functions can be classified into two categories, *viz.*, survival function and amenity functions. The aspects of habitat provided by NC that are essential for survival of living organisms, such as, air to breathe and water to drink, are referred to as the survival functions of NC. If the quantity and quality of survival functions are diminished, biodiversity of species is threatened, not excluding the human species. NC also performs amenity functions by providing panoramic views for the pursuit of leisure. Though amenity functions improve the quality of life these need not be essential for survival as such.

The national income accounts cover only the boundaries of the economic activities. SEEA 2003, is essentially a satellite system of accounts. Satellite accounts enable expansion of the national accounts by including the selected areas of interest, while keeping intact the concepts and structure of the core national accounts. The satellite accounts provide details on a particular topic which is separate from, but yet linked to, the core national accounts. National accounts indicate the interaction between the national economy and the rest of the world (henceforth, ROW). SEEA 2003 includes environment of both the national economy and ROW. These interactions are depicted in Chart 1.1.

Chart 1.1: Flows between the economy and the environment



Source: *System of Environmental and Economic Accounting (SEEA) 2003.*

It can be seen from chart 1.1 that the linkages between national economy, ROW economies, national environment and the ROW environment are obtained through natural resources, ecosystem inputs and residuals are much more comprehensive than those which are captured merely through the interaction of products (lower left block of Chart 1.1). The global

sustainability of development requires that all the interactions between national economy, ROW economies, national environment and ROW environment should be taken into account in national income accounting. The national income accounting practices prevalent at present capture only the flows of products and only those natural resources which are traded in the markets between the national economy and the rest of the world. In other words, from sustainability point of view, the information provided by the national accounts of the countries is not only inadequate but misleading as well. This emphasizes the need for more comprehensive systems of accounting as compared to that provided by SNA.

1.3 An Overview of the SEEA (2003) Accounting System

As mentioned earlier, the SEEA is a satellite system of the SNA and it comprises four categories of accounts. These are: (i) Physical and hybrid flow account; (ii) Economic accounts and environmental transaction; (iii) Asset accounts in physical and monetary term; and, (iv) Extending SNA aggregates to account for depletion, defensive expenditure and degradation. We now discuss each of these accounts.

1.3.1 ***Physical and hybrid flow accounts***: It includes purely physical data relating to flows of materials and energy and presents them more or less according to the accounting structure of the SNA. The accounts also provide the flow data in physical and monetary terms that can be combined to produce so-called 'hybrid' flow accounts. SEEA uses four concepts in preparation of hybrid accounts. These are: (i) products; (ii) natural resources; (iii) ecosystem inputs; and, (iv) residuals. Products are produced with natural resources, ecosystem inputs and residuals. Some of these are in addition to the contribution of raw material inputs which are traded within market ambit and are accounted for within the SNA framework, *viz*., products. *Products* are goods and services produced and used within the economic sphere, *viz*., flows of goods and services between the national economy and the rest of the world. *Natural resources* encompass mineral and energy resources, water and biological resources. Here again, only those natural resources which are traded in market are accounted for in the SNA. Examples of *Ecosystem inputs* are water and other natural inputs (*e.g*., nutrients, carbon dioxide, *etc*.) needed by plants and

animals for their growth, and the oxygen necessary for combustion process. *Residuals* are the incidental and undesired outputs from the economy which generally have negligible economic value. Hence, these are either recycled or stored within the economy or discharged into the environment. 'Residuals' encompass solid, liquid and gaseous wastes. Physical flow accounts consist of merging accounts for products, natural resources, ecosystem inputs and residuals. Account for each of these is expressed in terms of 'supply' to the economy and 'use' by the economy. In Table 1.1 and Table 1.2 the format which can be adhered to for presenting the summary of physical flow accounts and supply and use table for all physical flows have been provided.

Table 1.1: Format for summary physical flow accounts

(Million tons)

	Production	Final consumption	Capital formation	Rest of the world	Total for the economy	Total for the environment
Supply						
Products						
Natural resources						
Ecosystem inputs						
Residuals						
Net accumulation						
Total supply						
Use						
Products						
Natural resources						
Ecosystem inputs						
Residuals						
Total use						

Source: *System of Environmental and Economic Accounting (SEEA) 2003.*

Table 1.2: A Simple Supply and Use Table for All Physical Flows *(Million tons)*

	Products	**Industries**	**Consumption**	**Capital**	**ROW**	**Residuals**	**Material Balance**
Products		Intermediate consumption	Consumption		Exports		
Industries	Production					From industry	
Consumption						From household	
Capital						From capital formation	
ROW						Residuals generated by non-residents	
Natural Resources	Imports	To industry			To ROW		
Ecosystem Inputs		To industry	To households		To ROW		
Residuals		To industry	To households	Waste to landfill site	To ROW		

Source: *System of Environmental and Economic Accounting (SEEA) 2003.*

A standard SNA supply and use table can be superimposed on the corresponding part of the physical table which gives a **hybrid flow account**. This consists of supply and use table where the columns contain values of products, the cost of labour and capital, physical inputs of natural resources and ecosystem inputs. The rows include values of products and physical measures of residuals. Such a hybrid table is particularly useful for relating the generation of residuals to the production of particular industries. One of the most useful and most frequently compiled examples concerns energy accounts and the associated emission generation.

Table 1.3: A Simple Hybrid Supply and Use Table *(Continued)*

		Economy						Total economy	Destination of Residuals		Material Balance	Total use
		Products		Industries	Consumption	Capital	ROW products		National	ROW		
		Physical	Monetary									
Economy	Products Physical *Monetary*			Products used by industry	Products used for consumption	Products used for capital	Products used by ROW exports					
	Industries	Products supplied by industry							Residuals generated by industry	Residuals generated by industry in ROW		
	Consumption								Residuals generated by consumption	Residuals generated by consumption in ROW	Net material accumulation by consumption	
	Capital								Residuals generated by capital		Net material accumulation by capital	
	ROW (products)	Products supplied by ROW							Residuals generated by non-residents		Net material accumulation by ROW economy	
	Value added Total economy											
Natural Resources	National Environment			Natural resources supplied to industry	Natural resources supplied to consumption		Natural resources extracted by ROW				Net accumulation of natural resources in the national environment	
	ROW origin			Natural resources supplied to industry	Natural resources supplied to consumption						Net accumulation of natural resources in the ROW	

Table 1.3: A Simple Hybrid Supply and Use Table *(Concluded)*

		Economy						Total economy	Destination of Residuals		Material Balance	Total use
		Products		Industries	Consumption	Capital	ROW products		National	ROW		
		Physical	Monetary									
Ecosystem inputs	National environment			Ecosystem inputs to industry	Ecosystem inputs to consumption		Ecosystem inputs to ROW economy				Net accumulation of ecosystem inputs in the national environment	
	ROW origin			Ecosystem inputs to industry	Ecosystem inputs to consumption						Net accumulation of ecosystem inputs in the ROW	
Residuals	National origin			Residuals re-absorbed by production		Waste to landfill sites				Cross boundary residual out-flows	Net accumulation of the residuals in the national environment	
	ROW origin								Cross boundary residual in-flows		Net accumulation of the residuals in the ROW	

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

1.3.2 Economic Accounts and Environmental Transactions*:* The second category of accounts selects transactions from the existing SNA which are relevant to the environmental management and make the environment-related transactions more explicit. An account of expenditures incurred by businesses, governments and households to protect the environment is an example of the accounts included in this category and presented in Table 1.4

Table 1.4: Supply and Use Table for Environmental Protection Services

Currency Units

	Government services	**Specialist services**	**Ancillary services**	**Cleaner and connected products**	**Total**
Output at basic prices					
Imports					
Taxes and margins					
Total supply at market prices					
Intermediate consumption					
Government consumption					
Household consumption					
Capital formation					
Total use at market prices					

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

1.3.3 Asset accounts in physical and monetary terms*:* The third category of accounts in the SEEA consists of accounts for environmental assets measured both in physical and monetary units. As this is a stock account, it consists of opening and closing stocks and the changes during the accounting period. As mentioned earlier, environmental assets are divided into three main categories, *viz*., natural resources, land and ecosystems. The classification of environmental assets can also be based on the following criteria: (i) whether these are renewable or non-renewable resources: (ii) whether these assets fall within the SNA or outside of it; and (iii) whether these assets are consumed by the economy (such as subsoil assets and biological resources) or not (as may be the case used for water and land used for transport purposes or *in situ* resources).

In the SNA an asset has to have two properties: (i) it has to be owned by an economic agent and ownership rights are enforced by some agency; and, (ii) the owner of the asset should benefit by using or holding the same over a period of time. The SEEA 2003, extends the asset boundary of the SNA by including all environmental assets which are of ***interest and measurable***. The environmental assets covered by the SEEA 2003 are grouped into the following major categories (sub-categories). These are:

- Natural resources
    - Mineral and energy resources
    - Soil resources
    - Water resources
    - Biological resources
- Land and associated surface water
- Ecosystems.

An illustrative physical account of environmental assets is provided in Table 1.5.

Table 1.5 : Illustrative Physical Asset Account

Opening stock
Increases during the year
New discoveries of minerals
Natural growth of plants and animals
Land reclamation
Decreases during the year
Extraction of minerals
Soil erosion
Loss of capacity of reservoirs due to silting
Harvesting of plants and animals
Natural death of plants and animals
Loss of animals due to drought
Closing stock

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

1.3.4 ***Extending SNA aggregates to account for depletion, defensive expenditure and degradation:*** The final category of SEEA accounts considers how the existing SNA might be adjusted to account for the

impact of the economy on the environment. Three sorts of adjustments are considered; those relating to depletion, those concerning so-called defensive expenditures and those relating to degradation.

Given the state of availability of data, it is just not possible to compile data in the formats provided in Tables 1.1 to 1.4 for the present study. *However we have made an attempt to compile the available data for land resources of Karnataka using the physical asset account (Table 1.5). To establish the linkages between domestic economy in terms of environment will be a distant dream. However, as a first step, the linkages between domestic economy and domestic environment can be modeled and a rather moderate task can begin in the form of compilation of an inventory of physical stocks and flows of some of the natural resources. Suitable valuation techniques can then be applied for valuing the selected resources and regions. In other words, a bottom-top approach can be adhered to arrive at the estimation of monetary value of degradation and depletion of resources at the national level. These estimates can be discussed and debated before arriving at a final decision about the magnitude of such adjustments in the National Income Accounting.*

1.4 Objectives of the Study

- To identify the major environmental-related issues in Karnataka for the Land & Forestry Sector (excluding Mining) and present them in the usual PASIR (Pressure-Activity-State-Impact-Response) framework;
- To prepare physical resource accounts of the selected sector;
- To explore and apply appropriate valuation techniques to study the extent and impacts of natural resource depletion/degradation in the Land (excluding Mining) and Forestry Sector;
- To adjust the State Domestic Product (SDP), wherever possible, for the changes in natural resource assets of the Land (excluding Mining) and Forestry Sector;

- To carry out sector-specific analyses to identify data gaps and suggest the necessary institutional structures/linkages for better data generation and management; and
- To use remote sensing data for accurate asset accounting of the Land & Forestry sector as the official data on land use is most often incomplete and unreliable.

In the above context, the present study makes a modest attempt to develop a Natural Resource Accounting framework for the state of **Karnataka**, specifically with reference to Land (excluding Mining) and Forestry Sector.

1.5 Methodology of the study

1.5.1 The Data, coverage and the sample: The study has used both secondary and primary data. The secondary data was collected mainly from Directorate of statistics and economics, Forest dept, Govt of Karnataka, Land revenue dept, Administration Report of Forest Department, Govt of Karnataka, Forest survey of India, National sample survey organization (NSSO), Central statistical organization (CSO), State pollution control board, National bureau of soil survey & land use planning, Directorate of Agriculture, Watershed department etc. The primary data was collected from selected 5 districts, viz., Tumkur, Chikkamagalur, Hassan, Dakshina Kannada, and Uttar Kannada which were purposively selected. We selected 10 villages and 500 households each for NTFP and Grazing services. For the study we covered fourteen (14), four(4), three(3) and two(2) villages for studying the benefits of fuel wood, medicinal plant, water shed and sacred groves, respectively, from the same 5 districts. For valuating recreational facilities we selected 300 visitors from Dandeli wild life sanctuary. Similarly 32 firms for fuel wood, 32 Households for watershed, 30 households each for medicinal plant and sacred groves were covered under the study. The details of sampling are discussed in Chap-4 (Table 4.1). The data sources, data requirements and data gaps of the study are presented in Appendix-I in detail.

1.5.2 The Methods:

We conducted 8 case studies in order to estimate the unrecorded value of NTFP, grazing service, and fuel wood for evaluating their contribution to SDP. We used *local market prices* for this purpose. For estimating the value of watershed benefits, value of sacred groves and medicinal plant, we used contingent valuation method based on the willingness to pay by the households. For estimating the recreational value, we used *the travel cost method* (TMC) based on the econometric model. The details of these methods are discussed in Chap- 4.

Land (excluding Mining) and forest resources are covered under the study. The study applied the **PASIR** (Pressure, Activity, State, Impact, and Response) framework to identify the key economic sectors/activities from which environment-related pressures are originating to have an impact on the resource base of the Land and Forestry sector (Chap-5). Physical accounts of land-use change are prepared using the **opening stock – closing stock approach** (as discussed earlier in this chapter) for different land-use categories, based on data from secondary sources. The contribution of land resources to SDP was estimated using the method of reclamation cost of soil. Considering that the official data on land use is most often incomplete and unreliable, the study used **remote sensing** data for accurate asset accounting of the Land and Forestry sector, covering Eight districts viz., Davanagere, Dharwad, Chitradurga, Kodagu, Hassan, Shimoga, Uttar Kannada and Dakshina Kannada (Chap-6).

1.6 Outcome of the study

(i) The physical accounts of land and forest resources are made in the present study which is likely to help the policy makers to prepare the land records more accurately.

(ii) The study has attempted to estimate the contribution of the unrecorded value of forests and land resources (excluding mining) to SDP adjustments. This would help to assess the amount of monetary flow escaped from the inclusion of SDP. The study helps to provide proper direction to the administrators and policy

makers to assess the green SDP by applying the methodology used in the present study or using the suggested methodologies as per SEEA,2003. In the absence of such a study at the state level, the present study is the first modest attempt in this direction.

(iii) The data base in respect of land (excluding mining) and forestry sector of the state has been provided by the present study which would not only help the researchers but also the policy makers to strengthen it more extensively.

(iv) Realizing the significant contribution of the natural resources to the state economy (SDP) which the present study has attempted, the government may initiate such an estimate to make the un recorded value of natural resources i.e. land and forestry to be accounted for and incorporated in the sate economy.

(v) It also provides a platform to the researchers/policy makers to discuss/debate on the methodology used in the study.

1.7 Limitations of the study:

(i) The size of the sample for the 8 case studies is relatively small and is purposively selected. The coverage of larger sample size and more districts may provide more accurate estimate of the natural resource accounting like land and forest.

(ii) Local market price method for valuing the NTFPs is used. Since prices vary widely from place to place and product prices also vary according to the season, the choice of local price seems to be arbitrary and indicates a minimal or conservative value of NTFPs. Similarly, it is difficult to consider the gathering time as an opportunity cost because, many times people remain unemployed and the quantity collected is not at all related to gathering time because of uncertainty.

(iii) In the case study of grazing, we have merely considered the contribution of grazing services of forests. However, there is also an adverse impact of grazing on land quality which needs to be incorporated for the completeness of forest accounts. Grazing and browsing by domestic cattle, goat, sheep, *etc*., is a major problem in the forest areas. Uncontrolled grazing in forests by livestock, often

beyond the carrying capacity of the land, may likely to affect adversely the regeneration status and regenerative capacity of the forests. Overgrazing also affects properties of soil which includes formation of small gullies, loss of topsoil, compaction of soil and reduction of porosity. In Karnataka, grazing was controlled/ regulated by Karnataka Forest Act till 1971, after which this regulation was withdrawn and grazing has become uncontrolled.

(iv) The study considered the travel cost method for estimating the recreational value of forests which was only for one year which may lead to bias in our estimation, if for instance, the particular year records highest number of tourists to the spot due to some reason or the other. Therefore one may consider the travelers for a period of time and different seasons in the year covering a larger sample.

(v) The conversion of land into monetary account and incorporation of the same in state domestic product was not attempted due to large variation in land prices.

1.8 Organization of the Report

The report contains seven chapters. Chapter-1 is the introductory chapter which discusses the statement of the problem, objectives, methodology in brief, outcomes and limitations of the study. Chapter-2 records the socio-economic and natural resources profile of Karnataka. Chapter-3 deals with the accounting frameworks for forest resources adhered to international (SEEA 2003) and in the National Accounts in India. It also tries to relate the uses and benefits of forests to the methodologies used in accounting for forests. Chapter-4 consists of the eight case studies pertaining to forests resources of Karnataka. Chapter-5 deals with the land resources and accounting in Karnataka. Chapter - 6 highlights the use of remote sensing for natural resource accounting. The last chapter (Chapter-7) presents summary and conclusions emanating from the first six chapters. There are two appendices. Appendix –I presents the methodological issues, data sources, data requirements and data gaps of the study. All the schedules used for the 8 case studies are presented in Appendix-II.

Chapter – 2

KARNATAKA: A PROFILE

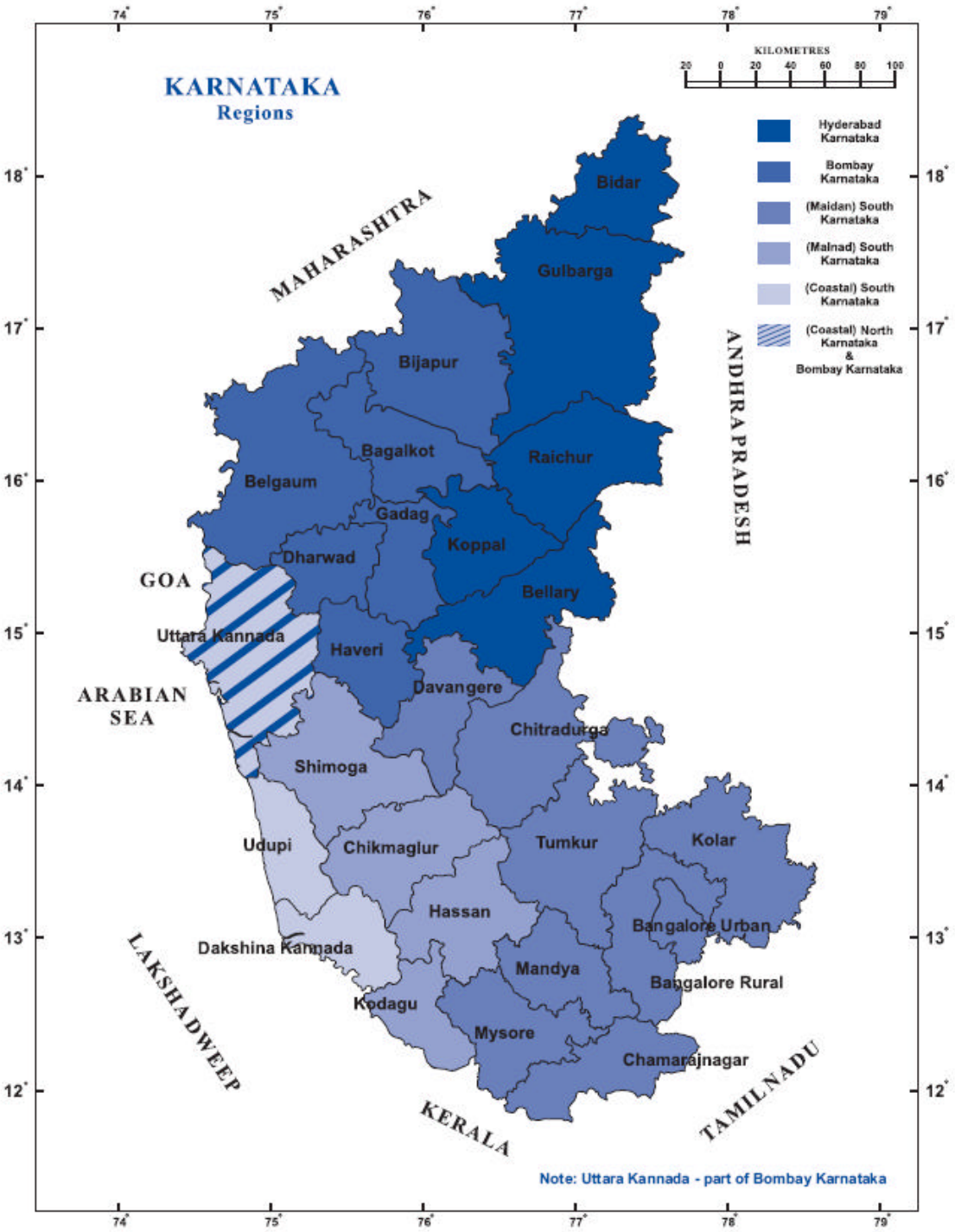
2.1 Introduction

The state of Karnataka is located in the southwestern part of the country. It covers total geographical area of 192 thousand sq. kms which is about 6.3 percent of the national geographical area. The state is divided into 27 districts which are further sub-divided into 175 talukas. The state has about 270 towns and more than 27 thousand inhabited villages. In other words, the state occupies a prime importance in the economy of the country. Being a hub for IT industry in the country the state has witnessed an influx of highly qualified information technology professionals in the recent past which has put pressure on the land and other infrastructure in the state. Map 2.1 presents the map of Karnataka indicating location of its various districts.

In this Chapter, we provide a profile of Karnataka and the pressures emanating from economic activity which are putting pressure on environmental resources of the state. As demographic factors and economic activity play crucial roles in determining the changes in stocks of environmental resources (such as, forests and land), it becomes necessary to have a bird's eye view of the various facets of the state.

This chapter is organized as follows. We provide an overview of demographic and socio-economic overview of the state in Section 2.2. In Section 2.3, we provide a profile of the natural resources (*viz*., land, soil, water and forest resources) of the state as well as for the country. The functions and benefits of forest resources are discussed in this section. In section 2.4 Economic Activity and Natural Resource Interactions in Karnataka are presented. The policy to protect Forest and Land Resources in Karnataka is discussed in section 2.5. The summary of the chapter is provided in the last section, i.e., section 2.6.

Map 2.1: District Map of Karnataka



Source: *Karnataka Human Development Report 2005.*

2.2 Demographic and Socio-economic Profile of Karnataka

The demographic features of Karnataka as per the Census 2001 are as follows: The state has a population of 52.73 million, *i.e.*, it accounted for about 5.1 percent of the India's population. The state had about 30.69 million livestock population (i.e, about 6.8 percent) of the livestock population of the country in 1997 (Economic Survey, 2003-04, Government of Karnataka). The human population in the state grew by 17.25 percent over the decade of 1991 to 2001. The proportion of urban population to the total population in the state was 34 percent, in comparison to the respective figure for India being 28 percent. The literacy rate of the state was 67.0 percent, i.e., marginally higher than that for India. Select demographic details of the state have been presented in Table 2.1.

Table 2.1: Demographic Profile of Karnataka

Population ('000)	Total	Persons	52,734
		Males	26,856
		Females	25,878
	Rural	Persons	34,814
		Males	17,619
		Females	17,195
	Urban	Persons	17,920
		Males	9,238
		Females	8,682
Literacy rate (Percent)		Total	67.0
		Males	76.3
		Females	57.5

Source: *ECONOMIC SURVEY, 2003– 04*, Government of Karnataka .

The figures for the state census show that out of the 52.7 million people, 23.5 million persons (*i.e.*, 44.6 percent of the total population of the state) are reported as workers. The workforce participation, which stood at 42.0 percent in 1991, has risen to 44.6 percent in 2001. Of the 23.5 million workers (36.7 percent of the total population) are main workers and the rest 7.9 percent are the marginal workers. A glance at the composition of workers reveals that the proportion of cultivators has declined from 35.4 percent in 1991 to 29.5 percent in 2001 and that of agricultural labourers from 29.9 percent to 26.4 percent at the state level. The

proportion of 'workers in household industry' and 'other workers' have increased from 1.9 percent in 1991 to 4.0 percent in 2001, and from 32.8 percent to 40.1 percent, respectively. The proportion of total workers engaged in non-agricultural activities accounts for more than 80 percent in the districts of Bangalore, Dakshina Kannada and Kodagu. The proportion of workers engaged in cultivation is as high as 55.0 percent in Hassan, whereas, that of agricultural labourers is 45.0 percent in Raichur district (Census, 2001). Unemployment among the urban youths in Karnataka is 10.5 percent, which is lower than all India figures of 15.4 percent (Economic Survey, 2003). Broad composition of workforce as main and marginal workers in Karnataka is presented in Table 2.2.

Table 2.2: Broad composition of Workers in Karnataka
(As a % percentages of total population)

Category of Workers	1991	2001
Total workers *(main and marginal)*	42.0	44.6
Main workers	38.5	36.7
Marginal workers	3.5	7.9
Non workers	58.0	55.4
Composition *(main and marginal)*		
Cultivators	35.4	29.5
Agricultural Labourers	29.9	26.4
Workers in household industry	1.9	4.0
Other workers	32.8	40.1

Source: *Census of India*, 2001.

Karnataka state has been maintaining fairly good economic growth rate, if considered in the national context. The growth rate achieved during the year 2003-2004 was 6.9 percent with the rate of inflation down to 5 percent (Government of Karnataka, henceforth GoK, website). This rate of growth was reached despite the hardships of global oil and steel prices and natural calamities like drought. The average rainfall in the state is about 1187 mms. During 2001 to 2003, the state received rainfall levels of 1005, 680 and 64 mms only. Thus, rainfall levels were not only below normal, but also declined drastically. Added to this was the problem of uneven distribution of rainfall across districts. Anticipated food grain production

(GoK, 2003) was reported to be 64 lakh tonnes as against the target of 104.05 lakh tones. The share of agriculture in state GDP declined by 3.5 per cent since 2001-02, industrial production increased by 8.4 per cent, electricity generation rose by 6.5 per cent, exports increased by 23.1 per cent and imports by 32.1 per cent. The economy saw growth of 8.9 percent in service sector. The data pertaining to The Gross State Domestic Product (GSDP) and per capita GSDP for Karnataka are presented in Table 2.3. The GSDP for the year 2002-2003, at current prices shows that 52.9 percent of the GSDP is contributed by tertiary sector, 23.8 percent by secondary sector and 23.2 percent by primary sector. The agriculture's contribution in the GSDP is about 20 percent. The contribution of forestry and logging ranges between 1.4 (2001-02) and 1.8 (2002-03) percent of GSDP. The corresponding figure for the Indian economy in both these years was 1.2 percent.

Table 2.3: Total and per capita GSDP of Karnataka

Sector	2001-02		2001-02		2002-03 (Q.E.)		2002-03 (Q.E.)	
	Current Prices		1993-94 Prices		Current Prices		1993-94 Prices	
	Rs Crore	% of Total GSDP	Rs Crore	% of Total GSDP	Rs Crore	% of Total GSDP	Rs Crore	% of Total GSDP
Agriculture	23027	21.8	16346	23.5	23174	20.3	15843	21.9
Forestry and Logging	1873	1.8	1089	1.6	1912	1.7	1041	1.4
Fishing	550	0.5	225	0.3	646	0.6	263	0.4
Mining and Quarrying	701	0.7	519	0.7	736	0.6	569	0.8
Primary Sector	**26150**	**24.7**	**18179**	**26.2**	**26468**	**23.2**	**17715**	**24.5**
Manufacturing	15456	14.6	10989	15.8	16730	14.7	11720	16.2
Registered	8884	8.4	6163	8.9	9647	8.5	6520	9.0
Un-registered	6572	6.2	4827	7.0	7083	6.2	5200	7.2
Construction	7112	6.7	5112	7.4	7628	6.7	5261	7.3
Electricity,Gas and Water supply	2966	2.8	1697	2.4	2794	2.5	1557	2.2
Secondary Sector	**25534**	**24.2**	**17799**	**25.6**	**27151**	**23.8**	**18537**	**25.6**
Trade, Hotels, Transport and	22846	21.6	15373	22.1	25090	22.0	16630	23.0
Financing, Insurance, Real	15703	14.9	9454	13.6	17732	15.6	10081	13.9
Community, Social & Personal	15424	14.6	8644	12.4	17488	15.3	9435	13.0
Tertiary Sector	**53973**	**51.1**	**33471**	**48.2**	**60310**	**52.9**	**36146**	**49.9**
Total GSDP	**105658**	**100.0**	**69449**	**100.0**	**113929**	**100.0**	**72399**	**100.0**
Per Capita GSDP(Rs.)	**19821**		**13028**		**21015**		**13354**	

Source: *www.mospi.nic.in*

2.3 The Natural Resource Profile of Karnataka State

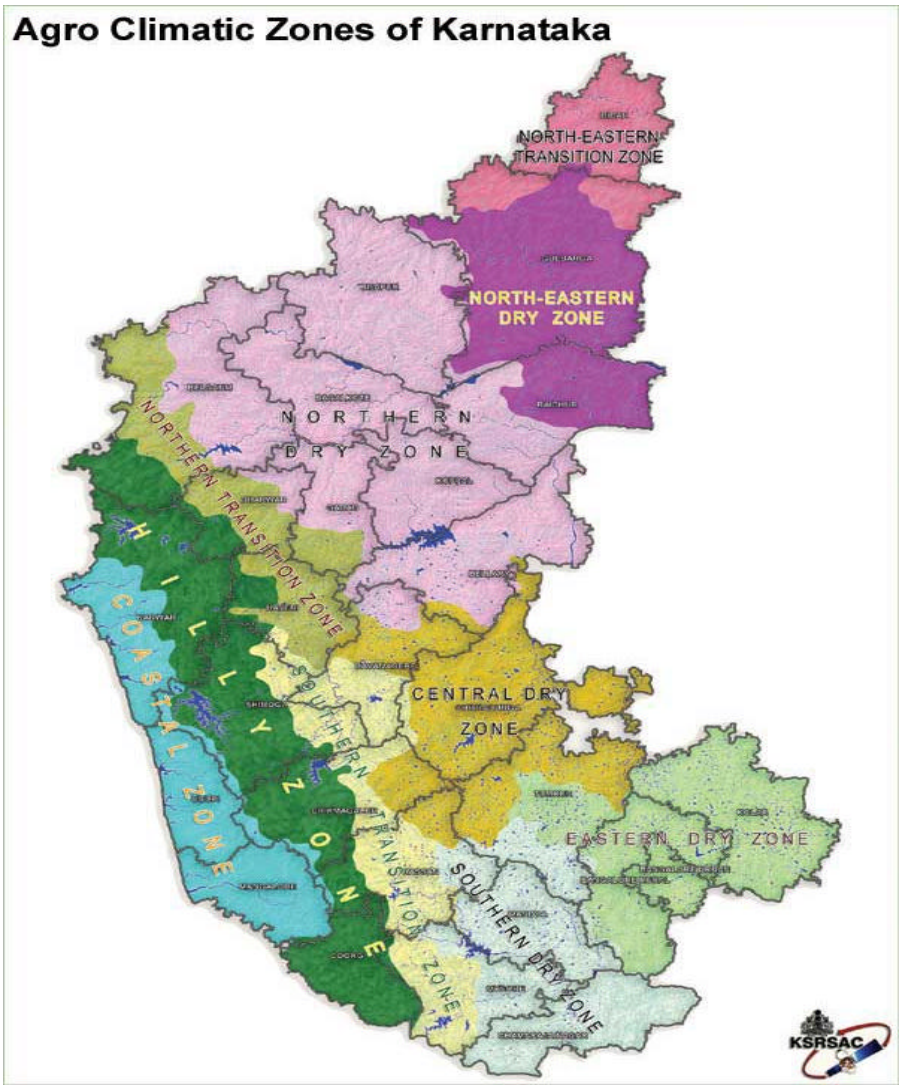
The natural resources of a region include the air, water, land, biodiversity and ecosystems, *etc.* The state of Karnataka is well endowed with many of these resources. Besides, the state has rich deposits of mineral wealth, distributed more or less evenly over its territory. These deposits contain asbestos, bauxite, chromite, dolomite, gold, iron ore, kaolin, limestone, manganese, ochre, quartz, silica sand, *etc.* Karnataka is the sole producer of felsite and leading producer of gold, moulding sand, and fuchsite quartzite.

2.3.1 Land Resources:

More than three fourths of the land in Karnataka is under rainfed cultivation. Cultivation practices involving the use of chemical fertilizers and pesticides affect the soil and water quality. The agro-climatic conditions are an important factor determining the use of natural resources in rural areas and availability of bioresources.

Regions with similar geographic, edaphic and meteorological characteristics are grouped and referred to as agro climatic zones. Karnataka state has been divided into 10 agro-climatic zones. We also profile the soil types, water resources (rainfall, river basins and use of groundwater) and forest resources of Karnataka in what follows. Map 2.2 provides a pictorial view of the agro climatic zones of Karnataka.

Map 2.2: Agro Climatic Zones of Karnataka



Source: *Karnataka State Remote Sensing Applications Centre (KSRSAC)*

We now discuss the characteristics of each of these agro-climatic zones, as reported in the Karnataka State Land Use Board (2001).

1. North eastern transition zone: the annual rainfall in this region varies from 830 to 890 mm. About 63% of the rainfall is received during the kharif season. The elevation ranges between 800 to 900 m in major areas. The soils are shallow to medium black, clay in major areas and lateritic in the remaining areas. The important crops grown are pulses, jowar, oilseeds, bajra, cotton and sugarcane. The total geographical area of this zone is about 0.87 million hectares (Mha).

2. North eastern dry zone: this zone covers and area of 1.76 Mha. The annual rainfall varies from 632 to 806 mm. About 55 percent rainfall is received during rabi season. The elevation ranges from 300 to 450 m in all the talukas. The soils are deep to very deep black clay in major areas and shallow to medium black in minor pockets. The principal crops grown are rabi jowar, bajra, pulses, oilseeds and cotton.

3. Northern dry zone: this zone covers an area of 4.78 Mha. The annual rainfall ranges from 465 to 785 mm and about 52% of the annual rainfall is received during rabi season. The elevation is between 450 to 900 m. The soils are shallow to deep black clay in major areas. The important crops grown here are rabi jowar, bajra, groundnut, cotton, wheat, sugarcane and tobacco.

4. Central dry zone: this zone covers an area of 1.94 Mha. The annual rainfall ranges from 453 and 718 mm, of which more than 55% is received during the kharif season. The elevation ranges from 450 to 900 m and the soils are red sandy loams in major areas, shallow to deep black in remaining areas. The principal crops cultivated in this area are ragi, jowar, pulses and oilseeds.

5. Eastern dry zone: this zone consists of an area of 1.81 Mha. The annual rainfall ranges from 680 to 889 mm. More than 50% of the rainfall is received during kharif season. The elevation is 800-900 m and the soils are red loamy in major areas, lateritic in the remaining areas. The main crops grown are ragi, rice, pulses, maize and oilseeds.

6. Southern dry zone: this zone extends over an area of 1.74 Mha. The annual rainfall ranges between 670 to 889 mm of which more than 50% rain is received in kharif season. The elevation is 450-900m and the soils are red sandy loam in major areas and red loamy in the remaining areas. The principal crops grown are rice, ragi, pulses, jowar and tobacco.

7. Southern transition zone: this zone comprises of an area of 1.22 Mha. The annual average rainfall from 612 to 1054 mm. About 61% rainfall is received during kharif season. Soils are red sandy loam in major areas and red loamy in remaining areas. The principal crops are rice, ragi, pulses, jowar and tobacco.

8. Northern transition zone: this zone comprises of an area of 1.19 Mha. The annual rainfall ranges from 619 to 1303 mm. About 61 % rainfall is received in kharif season. The elevation is 450-900 m and the soils are black clay and red sandy loam in equal proportions. The main crops grown are rice, jowar, groundnut, pulses, sugarcane and tobacco.
9. Hilly zone: this zone covers an area of 2.56 Mha. The annual rainfall received ranges from 904 to 369 mm. About 75% of it is received in kharif season. The soils are red sandy loam in major areas. The principal crops are rice and pulses.
10. Coastal zone: this zone comprises of an area of 1.17 Mha. The annual rainfall ranges from 3010 to 4694 mm, of which 80% falls in the monsoon season. The elevation is less than 300-800 m and the soils are red lateritic and coastal alluvial. The crops grown are rice, pulses and sugar cane.

Agriculture production in the state is spread over three seasons, viz., kharif (July to October), Rabi (October to March) and summer. These seasons account for nearly 70, 22 and 8 % of annual food grains production, respectively. In case of oilseeds, this ratio is in the order of 70, 15 and 15 %. The area covered under kharif, rabi and summer seasons is around 70, 30 and 6 lakh hectares, respectively. The total cultivable area of the state including net sown area (55.06 %), cultivable wasteland (2.28%), current fallows (6.66%), and other fallows (2.10 %) is 66.09 %. The total cropped land includes the net sown area plus the area sown more than once. The net sown area in the state was 102.38 million hectares in 1960-61 and declined to 100.31 million hectares in 2000-01. The respective figures for the gross cropped area in these two years were: 105.88 and 116.70 million hectares (website, GoK). In other words, the net sown area has declined but the gross cropped area, *i.e.*, land which is cultivated more than once a year, has registered an increase over this period. This indicates, inter alia, diversion of land to non-agricultural uses. Table 2.4 provides a synoptic view of agro climatic zone of Karnataka.

Table 2.4: Agro climatic zone of Karnataka

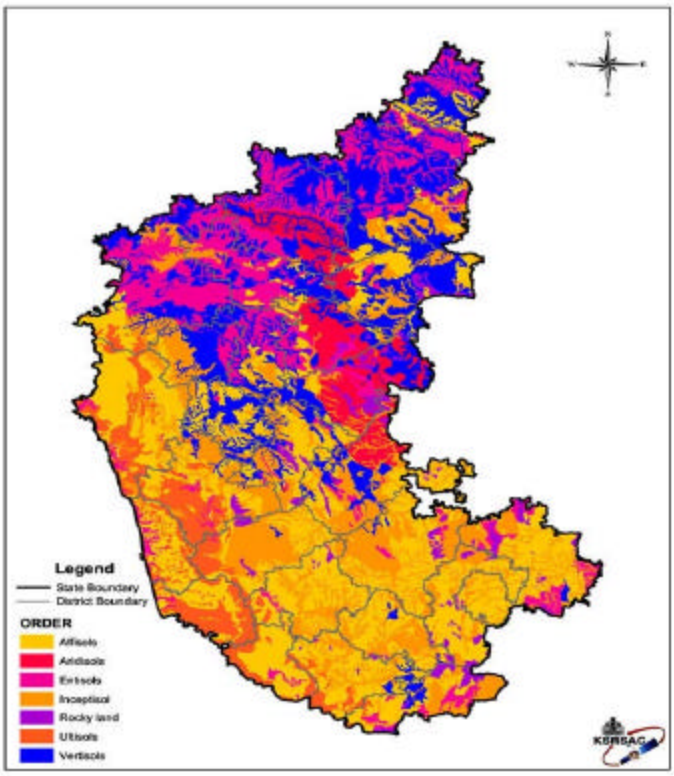
Sr No.	Agro-climatic Zone	Area (Million hactare)	Annual Rainfall mm	Elevation meters	Soil Type	Major Crops
1	North eastern transition	0.87	830 to 890	800 to 900	shallow to medium black, clay in major areas and lateritic in the remaining areas	pulses, jowar, oilseeds, bajra, cotton and sugarcane
2	North eastern dry	1.76	632 to 806	300 to 450	deep to very deep black clay in major areas and shallow to medium black in minor pockets	rabi jowar, bajra, pulses, oilseeds and cotton
3	Northern dry	4.78	465 to 785	450 to 900	shallow to deep black clay	rabi jowar, bajra, groundnut, cotton, wheat, sugarcane and tobacco
4	Central dry	1.94	453 to 718	450 to 900	red sandy loams in major areas, shallow to deep black in remaining areas	ragi, jowar, pulses and oilseeds
5	Eastern dry	1.81	680 to 889	800 to 900	red loamy in major areas, lateritic in the remaining areas	ragi, rice, pulses, maize and oilseeds
6	Southern dry	1.74	670 to 889	450-900	red sandy loam in major areas and red loamy in the remaining areas	rice, ragi, pulses, jowar and tobacco
7	Southern transition	1.22	612 to 1054		=”=	rice, ragi, pulses, jowar and tobacco
8	Northern transition	1.19	619 to 1303	450-900	black clay and red sandy loam	rice, jowar, groundnut, pulses, sugarcane and tobacco
9	Hilly	2.56	904 to 369		red sandy loam in major areas	rice and pulses
10	Coastal	1.17	3010 to 4694	300-800	red lateritic and coastal alluvial	rice, pulses and sugar cane

Source: *Karnataka State Land Use Board (2001)*

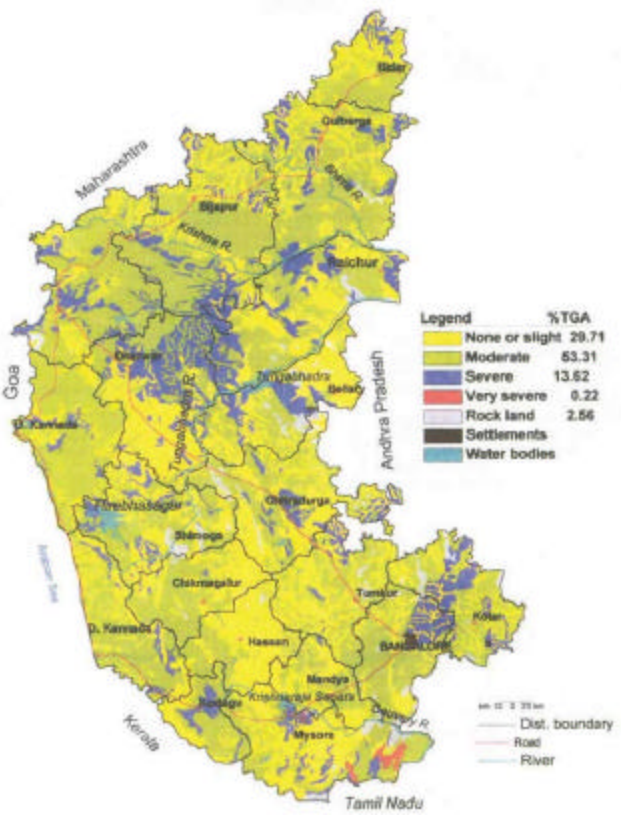
The soil profile, including its fertility and type determines the cropping pattern in the region. However, due to both natural and human activities, soil profile of a region can change due to erosion and degradation. This, more often than not, reduces the productivity of land. In this chapter, we merely introduce the resource positions, leaving the discussion about the same for the later chapters. Map 2.3 provides a synoptic view of the various types of soils in Karnataka. Map 2.4 provides the position of soil erosion (an important form of land

degradation) position of the state. Only about 30 percent of geographical area of land in the state does not suffer from soil erosion. More than half of the geographical area of the state is characterized by moderate soil erosion. Remaining area is either rocky area or suffers from severe to very severe soil erosion problem. This is worrisome especially in regard to agriculture and related activities, if considered from the point of view of productivity of land and income generation potential of these activities. Growth rates of primary sector in Karnataka in 2001-02 and 2002-03 were -15.8 and -3.1 %. This is a sector from which almost one-fifth of the state income is derived.

Map 2.3: Soil Types in Karnataka



Map 2.4: Soil Erosion in Karnataka



2.3.3 Forest Resources:

Before discussing the forest resources of Karnataka, it is necessary to highlight the distinction between the concepts of forest area and forest cover. In Box 2.1, we discuss these concepts.

Box 2.1: Forest Area *versus* Forest Cover

In India, forest area is defined by using the legal connotation. An area of land recorded as forest in revenue records or proclaimed to be forest under a forest law or Act is described as forest". In other words, 'forest area' is an area recorded as forest in the government records. This is different from the 'forest cover' which is based on the capability of remote sensing satellite sensor and is completely independent of the legality of land use or land ownership. This data is provided by the Forest Survey of India (FSI).

Forest area is further ***classified by the Forest Departments*** as follows:

(i) **Reserved Forest (RF,** an area notified under the provisions of Indian Forest Act or the State Forest Acts having full degree of protection. In Reserved Forests all activities are prohibited unless permitted);
(ii) **Protected Forest: (PF,** an area notified under the provisions of Indian Forest Act or the State Forest Acts having limited degree of protection. In Protected Forests all activities are permitted unless prohibited); and
(iii) **Unclassed Forest (UF,** an area recorded as forest but not included in reserved or protected forest category. Ownership status of such forests varies from state to state).

Forest cover consists of all lands having tree canopy density of more than 10 percent that can be interpreted from satellite data. The resolution and limitations of the sensor are crucial in estimation of area under forest cover. The various forms of forest covers as ***classified by the FSI*** are as follows:

(i) **Dense forest** -These Include all lands with a forest cover of trees with a canopy density over 40 percent;
(ii) **Open Forest**-All lands with a forest cover of trees with a canopy density between 10 to 40 percent;
(iii) **Non-forest**-includes all lands without forest cover, such as agricultural croplands, grasslands, wastelands, scrub, water bodies, riverbeds, snow-covered mountains and built up areas.

Dense forests have been further classified in FSR 2003 into **Very Dense Forest** (forest cover of trees with a canopy density higher than 70 %) and **Moderately Dense Forest** (forest cover of trees with a canopy density between 40 -70 %)

Non-forest cover is further sub-categorized into Scrub, non-forest and water bodies. S**crub connotes** land having bushes and/or poor tree growth with canopy density less than 10 percent.

The FSI has also been publishing data related to forest cover in State of Forest Report (SFR) since 1987. SFR is a biennial publication and the details of these data are provided in Table 2.5.

Table 2.5 Satellite Data for forest Cover Assessments as Provided in SFR (2003)

Assessment	SFR Year	Sensor	Data Period	Scale of Interpretation	Spatial Resolution	Spectral Resolution
I	1987	Landsat - MSS	1981-83	1: 1 million	80 m	4 Bands
II	1989	Landsat - TM	1985-87	1:250,000	30 m	7 Bands
III	1991	Landsat - TM	1987-89	1:250,000	30 m	7 Bands
IV	1993	Landsat – TM	1989-91	1:250,000	30 m	7 Bands
V	1995	IRS-1B LISS II	1991-93	1:250,000	36.25 m	4 Bands
VI	1997	IRS-1B LISS II	1993-95	1:250,000	36.25 m	4 Bands
VII	1999	IRS-1B LISS III	1996-98	1:250,000	23.5 m	4 Bands
VIII	2001	IRS-1B LISS III	2000	1:50,000	23.5 m	4 Bands
IX	2003	IRS-1D LISS III	2002	1:50,000	23.5 m	4 Bands

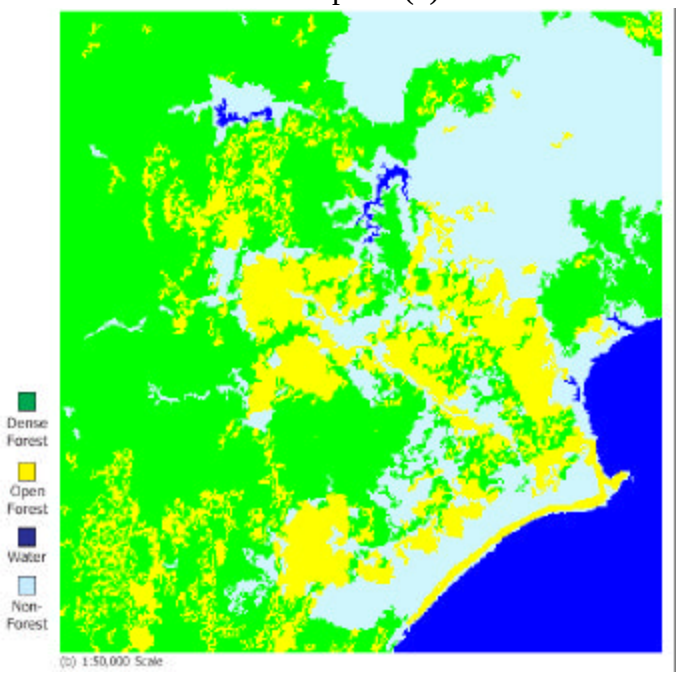
Source: *Forest Survey of India* (2003)

It can be seen from Table 2.4 that different sensors have been used to capture the images of forest types. Both the spatial and spectral resolutions have varied across the assessment years. The scale of interpretation also has been more detailed in the recent assessments. Hence, in Table 2.4, strict comparability across assessments has been indicated by the same colour, whereas, non comparability is indicated by shading with different colours. As we are more concerned with the integration of data on forestry in national accounts in the years to come, we will focus on the more recent trends and hence, we will compare SFR 2001 with SFR 2003 data both of which have a scale of interpretation of 1: 50,000. An example of the images of the same area with different scales of interpretation have been provided in Maps 2.5 (a) and 2.5 (b). The scale of interpretation in Map 2.5 (b) is able to capture more details as compared to that in Map 2.5 (a).

Map 2.5 (a)

(a) 1:250,000 scale

Map 2.5 (b)



Source: *Forest Survey of India* 2001 and *Forest Survey of India* 2003

We now discuss the forest area in Karnataka in national perspective, district-wise forest area in Karnataka and district-wise forest cover in Karnataka in the sub-sections that follow.

2.3.3.1 Forest Area/Cover in Karnataka in National Perspective

In Table 2.6, we present forest area in Karnataka in relation to the country as a whole and in relation to the other states of the Country.

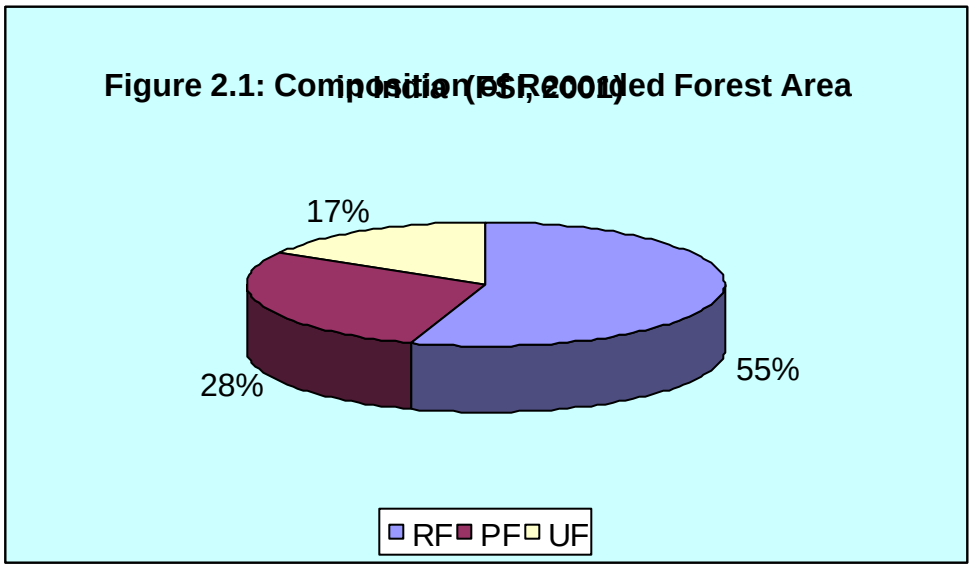
Table 2.6: Forest Area in Karnataka: An Inter-State Comparison (Area in sq kms)

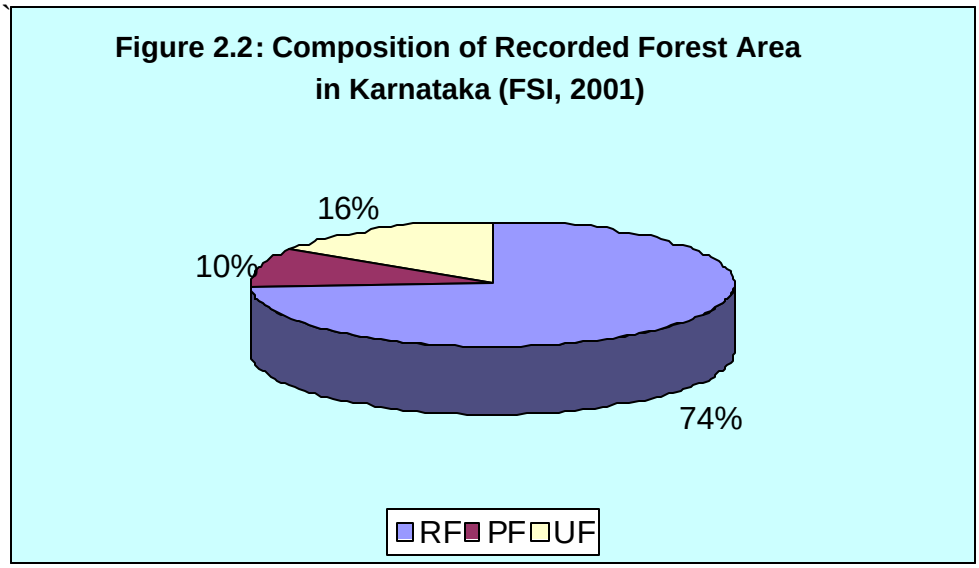
State/UT	Geographic Area (GA)	Reserved Forest	Protected Forest	Unclassed Forest	Recorded Forest	
					Area	(percent)
Madhya Pradesh	308245	58734	35587	900	95221	2.9
Andhra Pradesh	275069	50479	12365	970	63814	1.9
Maharashtra	307713	49217	8196	4526	61939	1.9
Chhattisgarh	135191	23966	31107	4212	59285	1.8
Orissa	155707	26329	15524	16282	58135	1.8
Arunachal Pradesh	83743	19880	0	31660	51540	1.6
Karnataka	191791	28611	3932	6181	38724	1.2
(As a % of GA of Karnataka)		14.9	2.1	3.2	20.2	
Himachal Pradesh	55673	1896	33043	2094	37033	1.1
Uttaranchal	53483	23827	10673	162	34662	1.1
Rajasthan	342239	11860	17658	2976	32494	1.0
Assam	78438	18060	0	8958	27018	0.8
Jharkhand	79714	4387	19185	33	23605	0.7
Tamil Nadu	130058	19325	2240	1306	22871	0.7
Jammu & Kashmir	222236	20230	0	0	20230	0.6
Gujarat	196022	13904	396	4699	18999	0.6
Manipur	22327	1467	4171	11780	17418	0.5
Uttar Pradesh	240928	11078	2425	3323	16826	0.5
Mizoram	21081	7127	3568	5240	15935	0.5
West Bengal	88752	7054	3772	1053	11879	0.4
Kerala	38863	11038	183	0	11221	0.3
Meghalaya	22429	1112	12	8372	9496	0.3
Nagaland	16579	308	508	7813	8629	0.3
Andaman & Nicobar	8249	2929	4242	0	7171	0.2
Tripura	10486	3588	509	2196	6293	0.2
Bihar	94163	693	5384	1	6078	0.2
Sikkim	7096	5376	285	104	5765	0.2
Punjab	50362	44	1112	1903	3059	0.1
Haryana	44212	249	1155	147	1551	0.0
Goa	3702	236	0	988	1224	0.0
Dadra & Nagar Haveli	491	198	5	0	203	0.0
Delhi	1483	78	7	0	85	0.0
Chandigarh	114	31	0	2	32	0.0
Daman & Diu	112	0	1	0	1	0.0
Lakshdweep	32	0	0	0	0	0.0
Pondicherry	480	0	0	0	0	0.0
Total India	**3287263**	**423311**	**217245**	**127881**	**768436**	**23.4**

Source: *FSI, 2001*

It can be seen from Table 2.5 that in India recorded forests account for about 23.4 % of geographic area. For Karnataka, this figure is about 20 %. Madhya Pradesh, Andhra Pradesh, Maharashtra, Chhattisgarh, Orissa and Arunachal Pradesh had higher recorded forest area (in absolute terms) as compared with that of Karnataka.

In Figure 2.1 and Figure 2.2, we indicate the classification of forest area in India and in Karnataka into various sub-categories, *viz*., reserved, protected and unclassed forests. We observe from these figures that the unclassed forest area in both India and Karnataka hovers around 16 to 17 per cent and remaining area is either reserved or protected forest area. In Karnataka, the proportion of reserved forests is as high as 75 % and for India this figure is much lower at about 55 % of the country's geographical area.





In Table 2.7, we provide a comparison of the recorded forest area and area under the forest cover in Karnataka and in India. It can be seen from Table 2.7 that these areas differ by about 1733 and 92898 sq kms for Karnataka and India respectively. It may be also mentioned that it is more appropriate to consider forest cover rather than the recorded forest area, as the latter can also include unwooded land.

Table 2.7: A Comparison of the Recorded forests and Actual Forest cover (area in sq.km)

State/Country	Geographic	Recorded forest *		Forest cover	
	Area	Area	Percent	Area	Percent
Karnataka	191791	38724	20.2	36449	19.0
India	3287263	768436	23.4	678333	20.6
Karnataka as a % of India	5.8	5.0		5.4	

Source: *Forest Survey of India* 2001

2.3.3.2: Forest Area in Karnataka

The area of the forests of the state by legal status is given in Table 2.8. The state has about 38,724 sq kms geographical area under the Karnataka State Forest Department. As can be seen from Table 2.8, the forests are classified as reserved (73.88 percent), protected (10.15 percent), unclassified (14.84 percent), village (0.32 percent) and private (0.80 percent). Of the total forest area nearly 75% of it suffers from an absence of regeneration. Almost four-fifths of area of forest is under the control of the forest department of the state. The encroachment on

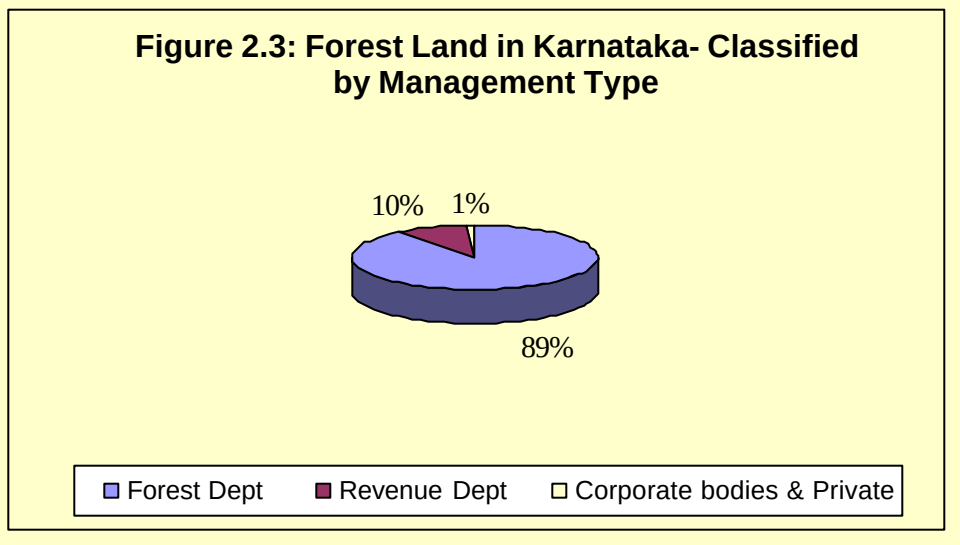
forest land and eviction in the state (up to May 2002) was 876 sq kms and encroachment evicted from forestland as on May 2002 was 200 sq kms. The existing encroachment on forestland in Karnataka as on May 2004 is 677 sq kms (Forests and Wildlife Statistics, India, 2004, in SOER, 2004).

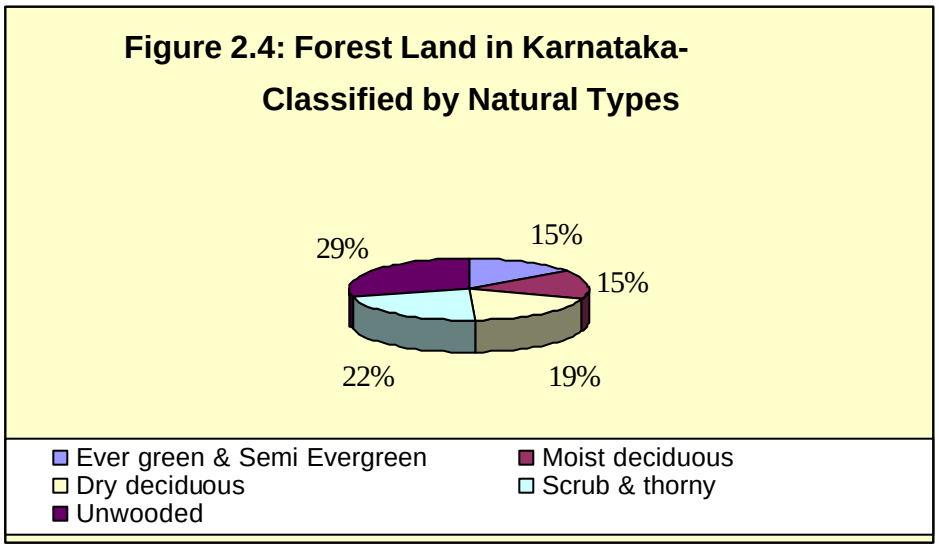
Table 2.8: Area of different forests in Karnataka

Forest Type	Area (sq.km)	Area (%)
Reserved forest	28611	73.88
Protected forest	3932	10.15
Village forest	124	0.32
Unclassed forest	5748	14.84
Private Forests	309	0.80
Total	**38284.30**	**100**

Source: *Forest Survey of India*, 2001

In brief, almost 85 % of forest area is classified as the reserved forests and protected forests. Figure 2.3 and Figure 2.4 indicate the data on the forest area in the state, classified by the management type.





Three facts emerge from these pie-charts and Table 2.8. These are:

First, forest area is predominantly reserved or protected forests. ***Second,*** almost 89 % of the forest area is under the management of the Forest Department and about 10 under the Revenue Department, leaving barely 1 percent of area under private and corporate management. ***Third,*** evergreen (EG) and semi-evergreen (SE) forests account for merely 15 % of the total forest area and so is the case with the moist deciduous forests (MD).

The proportion of forest area to geographical area in the state is less than the all-India average of about 23% and also much below the norm of 33% prescribed in the National Forest Policy. We now discuss the district-wise forest area in Karnataka.

We now provide a synoptic view of the forest area in Karnataka, district-wise in Table 2.9 and in Table 2.10. It can be seen from Table 2.8 that forest area in the state is about 20 percent of the gross area of the state. As mentioned earlier, Karnataka state is divided into 27 districts. Uttara Kannada, Dakshina Kannada & Udupi and Mysore & Chamarajanagara account for more than 10 percent of forest area of the respective districts.

It can be seen from the Table 2.9 that Uttara Kannada, Dakshina Kannada & Udupi, Mysore & Chamaraja Nagara, Shimoga, Belgaum and Chikmagalur districts account for almost two thirds of the forest area of the State.

Table 2.9: Forest Area in Karnataka: District-wise
(Area in hectares and Ratios in %)

Sr. No.	District/State	GAD	FAD	FAD/GAD	FAD/FAS
		(1)	(2)	(3) = (1)*100/(2)	(4)
1	Bangalore (U)	219000	7364	3.36	0.19
2	Bangalore(R)	581500	109438	18.82	2.86
3	Belgaum	1341500	224557	16.74	5.87
4	Bellary	841900	174353	20.71	4.55
5	Bidar	544800	48231	8.85	1.26
6 & 7	Bijapur & Bagalkot	1706900	82758	4.85	2.16
8	Chikmagalur	720100	217908	30.26	5.69
9 & 10	Chitradurga & Davanagere	1440600	156229	10.84	4.08
11& 12	Dakshina Kannada & Udupi	844100	518230	61.39	13.54
13, 14 &15	Dharwad, Gadag & Haveri	1373800	143673	10.46	3.75
16	Gulbarga	1622400	113785	7.01	2.97
17	Hassan	681400	54107	7.94	1.41
18	Kodagu	410200	125952	30.71	3.29
19	Kolar	822300	103941	12.64	2.71
20	Mandya	496100	27181	5.48	0.71
21& 22	Mysore & Chamaraja nagara	1195400	412962	34.55	10.79
23 & 24	Raichur & Koppal	1401700	65077	11.71	1.70
25	Shimoga	846500	327016	38.63	8.54
26	Tumkur	1059800	86517	8.16	2.26
27	Uttara Kannada	1029100	829151	80.57	21.66
Karnataka State		**GAS**	**FAS**	**FAS/GAS**	**FAS/FAS**
		19179100	3828430	19.96	100.00

Source: GOK, *Annual Administration Report of Karnataka Forest Department*, 2002-03.
Note: GA is gross area; FA is forest area; and, Suffix D and S denote that data are for district and state levels, respectively.

In Table 2.10, we provide a synoptic view of the forest area in various districts of Karnataka as classified by the legal status.

Table 2.10: District-wise Forest Area by Legal Status: 2002-03
(As a % of Total Area of the State)

Sl No	Districts	Reserved	Protected	Unclassed	Village	Private	Total
1	Bangalore (U)	0.12	0.07	0.00	0.00	0.00	0.19
2	Bangalore(R)	2.82	0.02	0.00	0.02	0.00	2.86
3	Belgaum	5.37	0.03	0.14	0.00	0.32	5.87
4	Bellary	3.23	0.00	1.25	0.00	0.08	4.55
5	Bidar	0.17	0.24	0.86	0.00	0.00	1.26
6	Bijapur	2.15	0.00	0.01	0.00	0.00	2.16
7	Bagalkot						
8	Chikmagalur	3.74	0.48	1.45	0.02	0.00	5.69
9	Chitradurga	2.50	0.01	1.55	0.01	0.00	4.08
10	Davanagere						
11	Dakshina Kannada	5.54	4.08	3.68	0.00	0.23	13.54
12	Udupi						
13	Dharwad	3.32	0.04	0.24	0.00	0.15	3.75
14	Gadag						
15	Haveri						
16	Gulbarga	0.90	0.00	2.05	0.02	0.00	2.97
17	Hassan	1.17	0.00	0.23	0.01	0.00	1.41
18	Kodagu	2.97	0.07	0.25	0.00	0.00	3.29
19	Kolar	2.29	0.11	0.16	0.15	0.00	2.71
20	Mandya	0.36	0.02	0.34	0.00	0.00	0.71
21	Mysore	10.12	0.01	0.66	0.00	0.00	10.79
22	Chamaraja nagara						
23	Raichur	0.87	0.24	0.59	0.00	0.00	1.70
24	Koppal						
25	Shimoga	5.08	3.37	0.06	0.04	0.00	8.54
26	Tumkur	2.03	0.06	0.16	0.00	0.02	2.26
27	Uttara Kannada	20.19	1.42	0.00	0.05	0.00	21.66
As a % of Karnataka State		**74.94**	**10.27**	**13.66**	**0.32**	**0.81**	**100.00**
Karnataka State (Sq. Kms)		**28689.96**	**3930.72**	**5231**	**124.2**	**308.42**	**38284.3**

Source: GOK, *Annual Administration Report of Karnataka* Forest Department, 2002-03

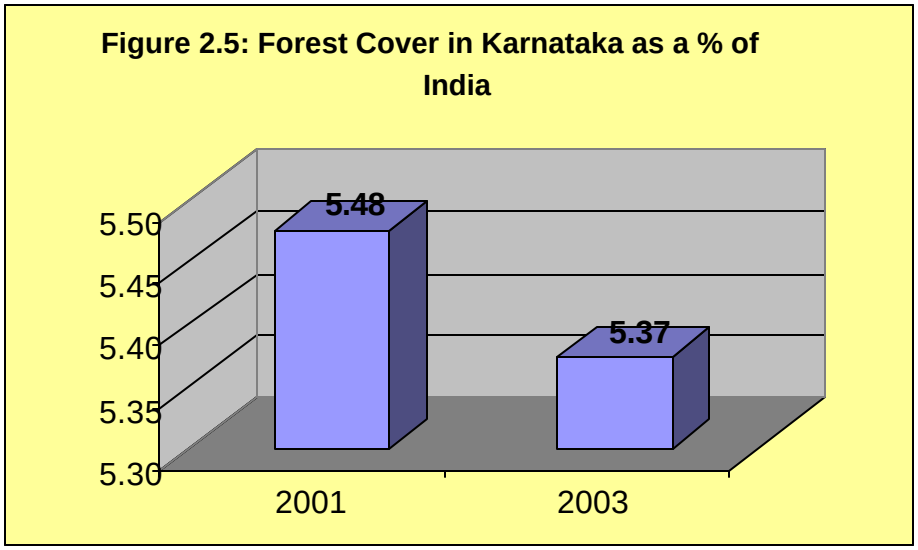
2.3.3.3: Forest Cover in Karnataka

In Table 2.11 and Figure 2.5, we provide information on forest cover in Karnataka in relation to that for India.

Table 2.11: Types of Forest Cover in Karnataka and India

Type of Area	Karnataka		India		Karnataka as % of India
	Area	% of Area	Area	% of Area	
1. Dense Forest	22461	11.7	390564	11.9	5.8
2. Open Forest	13988	7.3	287769	8.8	4.9
3. Mangrove					
Total Forest (1 to 3)	36449	19.0	678333	20.6	5.4
4. Scrub	3141	1.6	40269	1.2	7.8
5. Non-Forest	152201	79.4	2568661	78.1	5.9
Total (1 to 5)	**191791**	**100.0**	**3287263**	**100.0**	**5.8**

Source: *Forest Survey of India* 2001



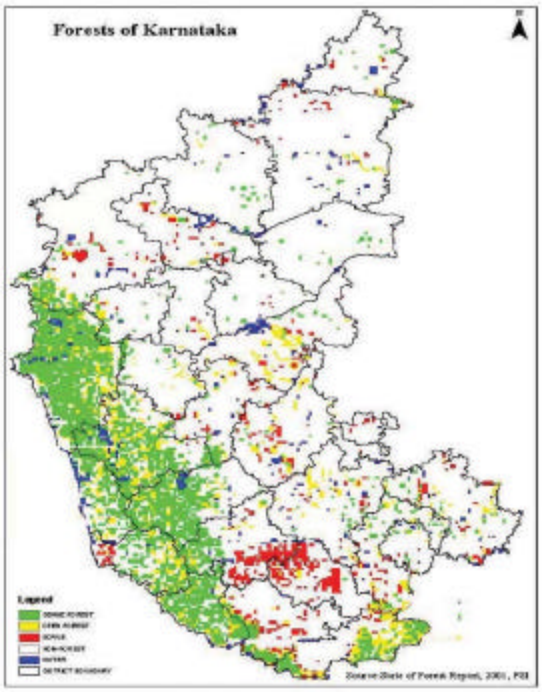
It can be seen from Figure 2.5 that the forest cover in Karnataka as a % of India has declined in 2003 in comparison to that in 2001. We observe that almost 81 percent of the area of the state does not have the forest cover. This needs to be judged against the forest policy which aims at bringing almost one-third of the geographical area under the forest cover.

The forest cover of Karnataka for the year 1999 was recorded as 32,467 sq. kms, whereas in 2001 it was assessed to be 36,991 sq. kms, which shows a positive difference of 4,524 sq. kms [FSI, 2001]. However, this positive difference could be due to the differences in methodologies used for data generation in these two surveys. The two most recent surveys, *viz*., FSI 2003 and FSI 2001 are comparable as the underlying methodologies used in these

surveys are the same. The latter indicates a decrease in total forest cover (by 542 Sq. kms.); this decline has been contained due to increase in open forest and non-forest area. In fact, there has been a severe decline in 'dense forest' to the extent of 3965 sq. kms. This is about 17 per cent of the area of the dense forest in 2001.

Map 2.6 is pertinent from the point of view of the physiography, climate control and the natural vegetation of the state, as these are related to the forest types. Ecologically five types of forests have been identified. These are Tropical dense evergreen forests, Tropical semi-evergreen forests, Moist deciduous forests, Dry deciduous forests and Tropical thorn forests. Most of the forests in Karnataka are situated in the belt running from Belgaum and ending at Mysore. The total growing stock of Karnataka's forests is 272 million cu.m. and the average volume per ha is 84 cu.m., which is 10 cu.m. more than the national average. The estimated increment of the forest produce in Karnataka is 5.5 cu.m., and the productivity is 1.45 cu m./ ha/ year for the whole area. The national average of productivity is 1.37 cu.m/ha.

Map 2.6: Forest Types in Karnataka

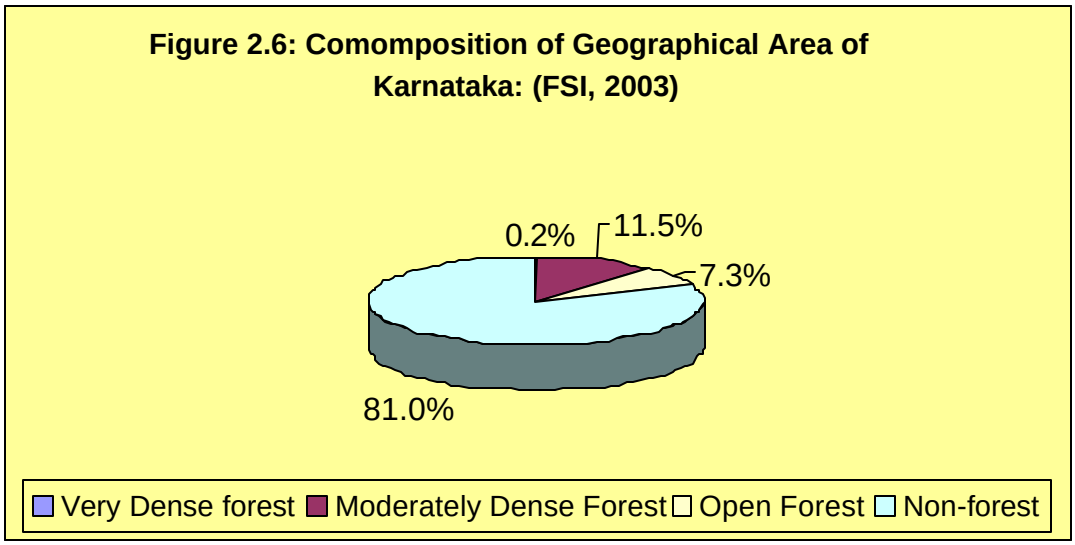


We now present the district-wise forest cover in Karnataka in Table 2.12.

Table 2.12: District-wise Forest Cover of Karnataka in 2001 (area in sq.kms.)

District/State	Geographic Area	Dense	Open	Total	Percent	scrub
Bagalkot	6575	225	159	384	5.84	222
Bangalore city	2190	109	53	162	7.40	28
Bangalore Rural	5815	338	498	836	14.38	261
Belgaum	13415	836	328	1164	8.68	328
Bellary	8450	215	646	861	10.19	224
Bidar	5448	128	28	156	2.86	18
Bijapur	10494	166	12	178	1.70	5
Chamrajanagar	5101	1098	1470	2568	50.34	197
Chickmaglur	7201	3068	486	3554	49.35	51
Chitradurg	8440	131	303	434	5.14	473
Davengeri	5924	394	378	772	13.03	257
Dharwad	4260	272	132	404	9.48	25
Gadag	4656	65	105	170	3.65	68
Gulbarga	16224	299	174	473	2.92	50
Hassan	6814	1053	272	1325	19.45	96
Haveri	4823	213	237	450	9.33	52
Kannad Dakshin	4560	2969	1078	4047	88.75	2
Kannad Uttar	10291	6502	1305	7807	75.86	0
Kodagu	4102	2608	400	3008	73.33	2
Kolar	8223	189	386	575	6.99	281
Koppal	7189	43	2	45	0.63	34
Mandya	4961	361	155	516	10.40	134
Mysore	6854	809	340	1149	16.76	43
Raichur	6827	112	0	211	3.09	14
Shimoga	8477	3117	1356	4473	52.77	36
Tumkur	10597	281	417	698	6.59	206
Udupi	3880	555	115	670	17.27	0
Karnataka	**191791**	**26156**	**10835**	**36991**	**19.29**	**3245**

Source: *Forest Survey of India* 2001



In Table 2.13, we present the forest cover change matrix in Karnataka for the year 2001 and 2003.

Table 2.13: Forest Cover Change Matrix of Karnataka in 2003 (Area in sq.kms)

Type of Land	2003 Assessment				Total 2001	Change in 2003 over 2001
	Dense Forest	Open Forest	Scrub	Non-Forest		
Dense Forest	22219	3266	1	670	26156	-3695
Open Forest	179	10565	9	82	10835	3153
Scrub	14	23	3092	116	3245	-104
Non-Forest	49	134	39	151333	151555	646
Total 2003	22461	13988	3141	152201	191791	

Source: *Forest Survey of India* 2003

It can be seen from Table 2.13 that the decline in forest cover has been most severe in dense forest. It seems likely that the dense forests have gotten converted into open forests which could be due to forestry and logging activities. The trend in the change in composition of forest cover in Karnataka is very similar to that witnessed for the country as a whole (refer Table 2.14).

Table 2.14: Forest Cover Change Matrix of India
(Area in sq.kms)

Type of Land	2003 Assessment				Total 2001	Change in 2003 over 2001
	Dense Forest	Open Forest	Scrub	Non-Forest		
Dense Forest	332928	55640	420	27821	416809	-26245
Open Forest	46177	194401	1366	16785	258729	29040
Scrub	749	4217	34703	7649	47318	-7049
Non-Forest	10710	33510	3780	2516407	2564407	4254
Total 2003	**390564**	**287769**	**40269**	**2568661**	**3287263**	

Source: *Forest Survey of India* 2001

In Table 2.15, we provide the area under forests of different types for each of the district of the state and also total forest cover in relation to the geographic area of the district. Chamrajanagar, Chickmaglur, Kannad Dakshin, Kannad Uttar, Kodagu Shimoga and Udupi have almost half of their geographic area under the forest cover. Kannad Uttar, Shimoga, Chickmaglur, Kodagu, Chamrajanagar, Udupi, and Kannad Dakshin account for more than 1000 sq kms of land under dense forests. In brief, Table 2.15 provides us with physical stock account of forest resources of the state. However, the physical flow accounts could be construed as changes in the physical stock of land under forest to be complemented with the flow accounts of the forest produce and forest services of each of these types of forests. These physical stocks and flow accounts can then be used to prepare the monetary accounts of forest resources.

Table 2.15: District-wise Forest Cover of Karnataka as per 2003 Assessment (sq kms)

District/State	Area under Forest Cover (FC)				As a % of GA Percent
	Geographic Area	Dense	Open	Total	
Bagalkot	6575	32	182	214	3.25
Bangalore city	2190	45	123	168	7.67
Bangalore Rural	5815	166	692	858	14.75
Belgaum	13415	722	390	1112	8.29
Bellary	8450	138	757	895	10.59
Bidar	5448	20	42	62	1.14
Bijapur	10494	1	37	38	0.36
Chamrajanagar	5105	1097	1523	2620	51.32
Chickmaglur	7201	2857	640	3497	48.56
Chitradurg	8440	49	396	445	5.27
Davengere	5924	342	417	759	12.81
Dharwad	4260	235	182	417	9.79
Gadag	4656	23	150	173	3.72
Gulbarga	16224	91	239	330	2.03
Hassan	6814	855	447	1302	19.11
Haveri	4823	182	282	464	9.62
Kannad Dakshin	4560	1095	1302	2397	52.57
Kannad Uttar	10291	6359	1483	7842	76.20
Kodagu	4102	2622	425	3047	74.28
Kolar	8223	82	500	582	7.08
Koppal	7189	11	35	46	0.64
Mandya	4961	146	375	521	10.50
Mysore	6854	642	503	1145	16.71
Raichur	6827	20	87	107	1.57
Shimoga	8477	3075	1401	4476	52.80
Tumkur	10597	111	595	706	6.66
Udupi	3880	1443	783	2226	57.37
Karnataka	**191791**	**22461**	**13988**	**36449**	**19.00**

Source: *Forest Survey of India* 2003

In Table 2.16, we provide the data regarding the change in stock of various forest types in each of the district of Karnataka. This can be viewed as the difference between the opening and closing stock of various types of forests across districts of Karnataka.

Table 2.16: Change in Forest Cover in Karnataka
(Area in Sq. Kms)

District/State	Dense	Open	Total
Bagalkot	-193	23	-170
Bangalore city	-64	70	6
Bangalore Rural	-172	194	22
Belgaum	-114	62	-52
Bellary	-77	111	34
Bidar	-108	14	-94
Bijapur	-165	25	-140
Chamrajanagar	-1	53	52
Chickmaglur	-211	154	-57
Chitradurg	-82	93	11
Davengere	-52	39	-13
Dharwad	-37	50	13
Gadag	-42	45	3
Gulbarga	-208	65	-143
Hassan	-198	175	-23
Haveri	-31	45	14
Kannad Dakshin	-1874	224	-1650
Kannad Uttar	-143	178	35
Kodagu	14	25	39
Kolar	-107	114	7
Koppal	-32	33	1
Mandya	-215	220	5
Mysore	-167	163	-4
Raichur	-92	87	-104
Shimoga	-42	45	3
Tumkur	-170	178	8
Udupi	888	668	1556
Karnataka	**-3695**	**3153**	**-542**

Source: *Forest Survey of India* 2001

2.3.3.4 Functions and Benefits of Forest Resources

Functions of Forest resources:

As highlighted by SEEA 2003, forest can be treated as a form of natural capital and these can be viewed to perform three functions. These functions are: (i) Resource functions; (ii) Sink functions; and, (iii) Service functions. Whilst performing the *resource function*, the natural capital enables itself to be converted in the form of goods. Use of trees for furniture making is an example of this kind. Forests provide '*sink*' when trees and plants break down Carbon dioxide (CO_2) during the photosynthesis process, absorb carbon dioxide, release oxygen and store the carbon. Thus, forests prevent accumulation of CO_2 in the atmosphere, by absorbing carbon and release oxygen necessary for survival of living organisms. This process

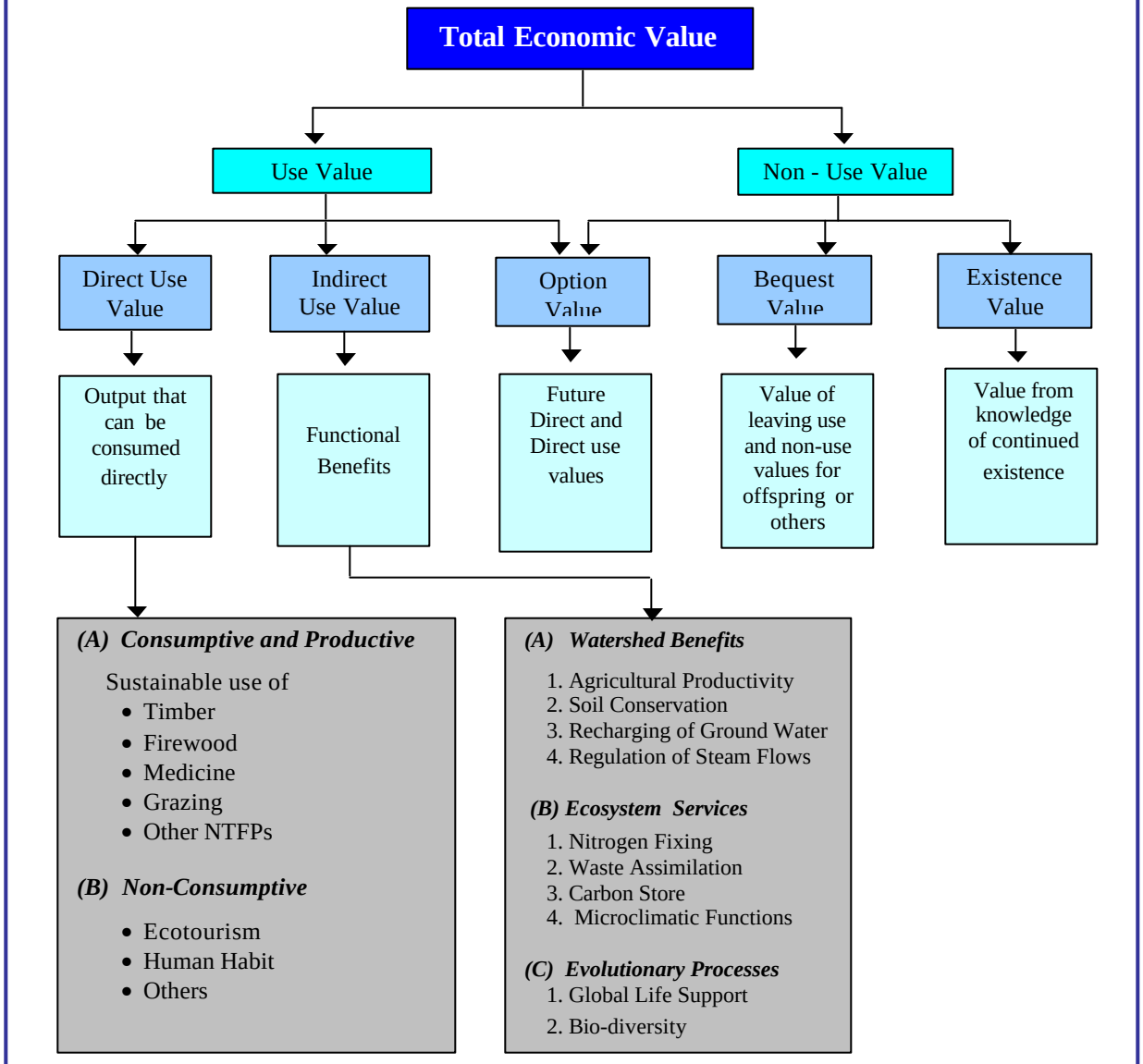
of 'carbon sequestration' is considered to be the 'sink' function of forests. In general, the sink function of a resource emanates from the fact that it absorbs the unwanted/harmful by-products of production and consumption activities. Forests also perform '*service function*' by providing habitat for living beings including mankind. This function can further be classified into the *survival function* (which is linked to ecological balance necessary for living being to survive) and *amenity function* (such as, providing scenic beauty).

More often than not, the use of one function of natural capital conflicts with the some other function, either at present or at some future date. The types of competition among environmental functions have been classified into three types: (i) spatial; (ii) quantitative; and, (iii) qualitative. Spatial competition takes place when the amount of space available is inadequate to satisfy existing or expected future wants. For example, space for forest may be at the expense of cultivable land. Quantitative competition occurs when the quantity of natural resource goes below the level that is required for ecological balance, *e.g*., decline in the forest cover. Qualitative competition takes place when changes in the 'type of species or substances' of a resource undergo a change and this can cause other possible uses. An example of this, in the context of forest resources, would be change in species of trees and plants which can alter the habitat for animals/human beings. Valuation of forest will be related to nature of changes in above-mentioned environmental functions.

Benefits from forest resources

The value of forests will also be dependent on the benefits emanating from forests and these can be classified into two broad types, *viz*., use and non-use values, which in turn, can be further sub-divided into various types (Chart 2.1).

Chart 2.1 - Total Economic Value of Forests



(Source: Chopra and Kadekodi, 1997**)**

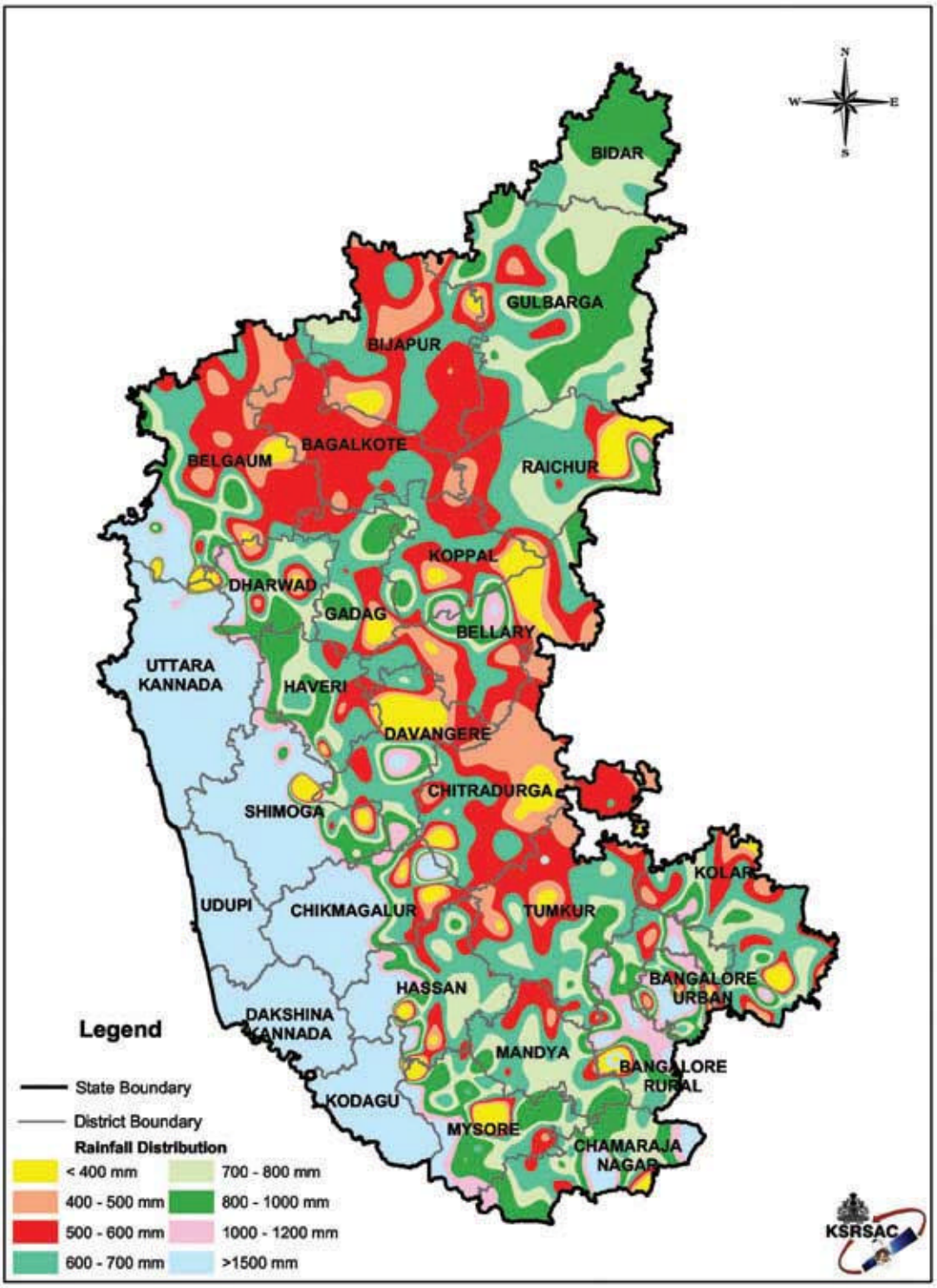
SEEA (2003) provides a format for classification of benefits emanating from natural capital and this methodology can also be applied to forests. ***Use value or benefits*** include both direct and indirect benefits. ***Direct use benefits*** include the use of forests as sources of materials, energy or space for input into human activities. ***Indirect use value or benefits*** do not change the physical characteristics of the forests and are sometimes described as being

non-consumptive benefits. The amenity benefit of landscape is one such example. Use benefits also include option and bequest benefits. ***Option benefits*** are those derived from the continued existence of elements of forests that may provide benefits in future to those currently living. ***Bequest value or benefits*** are also derived from the continued existence of forests because they may provide benefits to future generations. An example of these types of benefits is that derived from maintaining a rain forest to protect future sources of genetic material for drugs or hybrid agricultural crops. In addition to these use benefits, forests may simply have an ***existence value*** *or* ***existence benefit***. That is, without any prospect of the forests being of use to humans now or in the future, it is desirable to maintain the existence of forests. Before the estimation of benefits emanating from forests in Karnataka, we have a synoptic picture of the forest cover in the state that is juxtaposed in the national perspective, as and when deemed necessary.

2.3.4 Water Resources:

The most significant amongst bio-resources is the water. Karnataka accounts for about 6 percent of the country's surface water resources of 17 lakh million cubic metres (Mcum). About 40 percent of this is available in the east flowing rivers and the remaining from west flowing rivers. There are seven river basins with which their tributaries feed the State. The river basins of the state are: Krishna, Cauvery, Godavari, West flowing rivers, North Pennar, South Pennar, and Palar. Map 2.7 provides a summary view of the normal rainfall water position in Karnataka. It can be seen from this map that the coastal regions are well fed by rain water, whereas, some of the northern/ interior parts of Karnataka are not well endowed with rain water resources. According to the Drought Monitoring Cell of GoK, in 2001, 2002, 2003 and 2004, the state has faced the deficits in the rainfalls to the tune of 12 %, 24 %, 23 % and 4 %, respectively, in relation to the normal rainfall. In 2004, when the average deficit rainfall for the state was merely 4 percent, 100 out of 175 talukas has registered either negative normal (-19 to -1 %) or deficient rainfall (-59 to – 20 %). The former were 72 in number, whereas, the latter were 28. In 2003, the talukas with deficient rainfall were as high as 122.

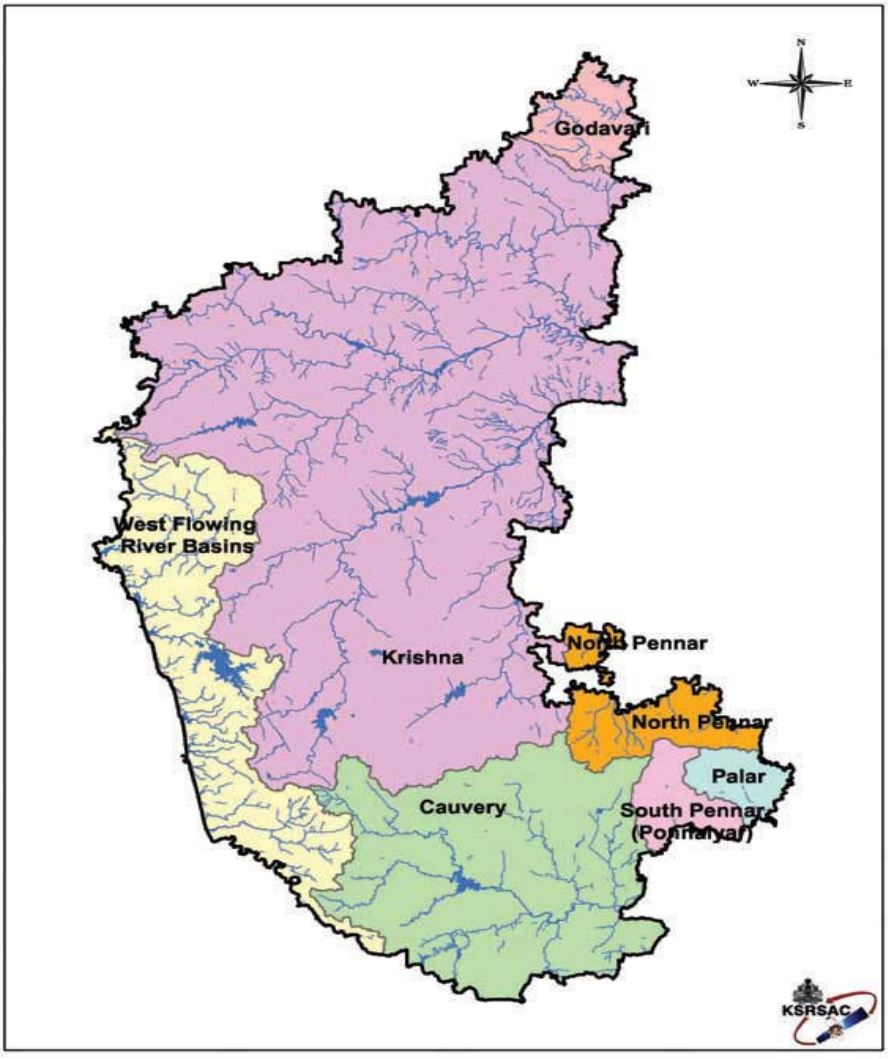
Map 2.7: Rainfall in Karnataka



Source: *Karnataka State Remote Sensing Applications Centre (**KSRSAC**)*

In Map 2.8, the river basins of the state have been displayed. The state is relatively better endowed with river basins as compared to some other neighboring states like Tamil Nadu and this often has been the cause of conflict emanating from river water distribution across the states.

Map 2.8: River Basins in Karnataka



Source: *Karnataka State Remote Sensing Applications Centre (**KSRSAC**)*

The inability to meet the water needs from rain and river water leads to utilization of groundwater. Table 2.17 indicates the groundwater utilization status in Karnataka.

Table 2.17: Groundwater Position in Karnataka
(As on March 1998-Provisional)

Sl. No	District	Grey Blocks	Dark Blocks	Over-Exploited Blocks
1.	Bangalore	1.Ramanagaram 2.Doddaballapur	1.Bangalore(S) 2.Chennapatna	1.Anekal 2.Bangalore(N) 3.Devana halli 4.Hoskote
2.	Belgaum	1.Chikodi 2. Hukkeri	1. Raibagh	
3.	Bijapur	1. Sindhigi	1.Indi	
4.	Chitradurga	1. Molakalmur		
5.	Dakshina Kannada	1.Bantwal 2. Sulya		
6.	Kolar	1.Chikballapura 2.Gauribidanur 3.Sidlaghatta	1.Mulbagal	1.Kolar 2.Malur
7.	Mysore		1. Kollegal	
8.	Tumkur	1.Gubbi 2.Madhugiri	1. Tiptur 2. Tumkur	
		13 Blocks	**8 Blocks**	**6 Blocks**

Note: Grey and Dark blocks indicate Semi-Critical and Critical groundwater positions. More intense is the problem of Over-Exploited blocks.
Source: http://cgwbswr.kar.nic.in/groundwater.htm

2.4: Economic Activity and Natural Resource Interactions in Karnataka

The main problems arising due to human activity as it impinges on forest and land resources in Karnataka (SOER, 2004) are as follows:

- Excessive livestock grazing in forests
- Excessive fuel wood removal from forests
- Encroachment of forest areas
- Diversion of forest areas for commercial purposes and destruction of natural habitat
- Unsustainable land management practices and mismanagement of common property resources
- Wildlife poaching and smuggling of animal products
- Soil and water erosion due to unsustainable practices resulting in loss of farmland productivity
- Land degradation caused by excessive irrigation and faulty water regimes
- Soil and water contamination due to use of chemical fertilizers
- Degradation of land due to mining and quarrying activities

A resource activity impact matrix summarizes impacts on natural resources due to specific human activity in the state of Karnataka (Table 2.18).

Table 2.18: Resource-Activity impact matrix

Resources	Industrial Pollution	Mining & Quarrying	Trans port	Urban Planning	Water Supply and Sanitation	Waste Mana-gement	Energy	Forestry	Agriculture
Water	H	L	L	M	H	M	M	H	H
Land	H	H	L	H	H	M	L	H	H
Forests	M	H	L	L	L	L	H	H	M
Air	M	L	H	M	L	M	M	L	M
Biodiversity	M	H	L	L	L	L	L	H	M
Coast	H	H	L	H	H	H	M	M	L
Health	H	H	M	M	H	H	H	L	L

Note: H, M and L indicate High, Medium and Low pressure impacts of the activity on resources.
Source*: GoK, State of Environment Report SOER* (2004)

It can be seen from Table 2.18 that mining and quarrying, energy production and forestry have high impacts on forest resources. Industrial and agricultural activities have exerted medium pressure on the forest resources of Karnataka. Energy production seems to have the maximum adverse impact on forest resources. The forests in Karnataka besides being the source of livelihood to many people are also known for functioning as "carbon sinks" (SOER, 2004). Forests in Western Ghats are listed as one of the 18-mega biodiversity hotspots in the world. However, there continues to be loss of forests and biodiversity due to anthropogenic pressures. Despite concerted efforts to address issues like removal of trees for firewood, grazing in the forests and also to meet development demands for hardwood, pulpwood, bamboo, canes, and medicinal plants, forests are still losing on their biota. In Karnataka state, non-commercial energy consumption is about 53.2 percent and is being met mainly by sources like firewood, agricultural residues, charcoal and cow dung. The share of commercial energy is 46.8 percent which is met mainly by electricity, oil, coal, *etc.* In view of the urgency to arrest the adverse socio-economic and ecological impacts, it is interesting to have a view of the priority matrix (Table 2.19) which can be used for policy purposes. More or less all the problems highlighted in Table 2.19 are equally severe. However, from the point of view of the adverse impacts, ecological impacts are rather severe and the effects of these would be evident in the long-run. There is also an urgent need to protect the vulnerable

sections of society as these do depend to a large extent on the natural resources for their livelihoods.

Table 2.19: Priority Matrix

Problems	Adverse Impacts on							Total
	Public health	Biodiversity	Vulner-able group	Productivity	Critical Eco-systems	Irreversibility /Reversibility	Urgency of the problem	
Livestock grazing	3	5	4	4	5	4	4	**29**
Fuel wood removal	4	4	4	4	4	4	4	**28**
Encroachment	2	5	4	5	5	4	3	**28**
Land fragmentation and habitat destruction	3	4	4	4	4	4	4	**27**
Absence of regulatory mechanisms for CPRs	3	4	5	4	4	4	3	**27**
Total	**15**	**22**	**21**	**21**	**22**	**20**	**18**	**139**

Note: *Rankings are on a 5 point scale with 1 as the lowest and 5 as the highest rank in terms of adversity of the problem.*
Source*: GoK, State of Environment Report SOER* (2004)

The state normally receives an average annual rainfall of 1138 mm ranging from 569 mm in the eastern part of the state to 4029 mm in the western part of the state (State of Environment Report, Karnataka, 2004). Nevertheless, the inequalities and inefficiencies in the distribution systems lead to shortage of water supply in both rural and urban areas. The increasing pollution of water bodies due to rapid urbanization, current agricultural techniques, industrialization and sanitation practices, is of grave concern. Discharge of industrial organic pollutants, municipal effluents and sewage into water bodies, leaching of fertilizers and pesticides into the groundwater, crop violations and ineffective watershed management especially in the upstream of command areas have degraded the water resources of the state. More than 14 districts in the state have fluoride concentration beyond permissible limits of 1.5 microgram per milliliter of water, which affects about 10 to 67 percent of habitations in these districts. Also 13 districts are affected by brackishness, there is excess nitrate in 8 districts and excess iron in 12 districts. Groundwater in the districts close to industrial areas has been reported to exceed permissible limits of total dissolved solids (TDS).

The coastline of Karnataka extends up to 320 kms and is characterized by lagoons, bays, creeks, spits, sand dunes and long beaches. Mining of sand near estuaries, removal of clay from riverbanks, has accelerated topsoil removal, which results in water logging. Coastal and marine ecosystems are under threat due to occupational pressures, salinity intrusion, siltation, water pollution and marine fishery activities.

The encroachment on forest land and eviction in the state (up to May 2002) was 876 sq kms and encroachment evicted from forestland as on May 2002 was 200 sq kms. The existing encroachment on forestland in Karnataka as on May 2004 is 677 sq kms (Forests and Wildlife Statistics, India, 2004, in SOER, 2004). The areas that have been cleared and diverted for non-forestry purposes from 1980 to 1996 are given in Table 2.20.

Table 2.20: Areas cleared and diverted for non-forestry purposes

S. No.	Purpose	Area (ha)
1	Irrigation projects	692.65
2	Hydroelectric project	5183.6
3	Mining	502.2
4	Roads	10.93
5	Transmission lines	317.04
6	Railway lines	348.88
7	Others	19445
	Total	**26500.35**

Source: *Forest Survey of India*, 2001

2.5 Policy to Protect Forest and Land Resources in Karnataka

The SOER 2004, details the state initiatives which have been meant to manage forest and land resources in a better manner. These are as follows. The state government has afforested about 1.2 million hectares of land in about last 25 years. Apart from this, it has also distributed more than 700 million seedlings to maintain greenery in the state. The state has also initiated the Joint Forest Planning and Management Programme and it covers about 2.5 lakh hectares of degraded forest with the help of about 3700 village forest committees which ensure the grass root participatory approach to sustainable development. The state has also amended the Karnataka forest Act of 1963. The essence of this amendment is more market friendly approach to sandalwood cultivation and ensuring market prices to the owners of sandalwood trees. For tribal community which is more forest dependent, a liberal view has

been taken for collection of minor forest produce by them and such scheme cover about 21 tribal societies, covering more than 27 thousand tribal families. The estimated income generation for these families is about Rs. 60 lakhs per annum. About 17 % of the state's forest area has been brought under the national parks and 21 wildlife sanctuaries so as to protect the rich biodiversity of the state. Project Tiger and Project Elephant are also highly appreciated initiatives towards the wildlife conservation by the state. This has also the advantage of promoting wilderness tourism, i.e., combining income generation with preservation of natural resources. Also the initiative of conservation of medicinal plants in the state is built on the same ideology.

As regards improving the quality of land resources, the state has implemented National Watershed Development Programme (in operation since 1989-90) in 27 districts which includes reclamation of alkaline and saline land and afforestation The Agriculture Department of the state has been providing green manure seeds and bio agents to the farmers. The drip irrigation schemes have been promoted in horticulture for sustainable water use.

2.6 Summary

Karnataka state accounts for about 5.1 percent of the India's human population and about 6.8 percent of the livestock population of the country. The proportion of urban population to the total population in the state is 34 percent, in comparison to the respective figure for India being 28 percent. The contribution of forestry and logging ranges between 1.4 was about 1.8 % of GSDP. The corresponding figure for the Indian economy is about 1.2 percent.

Karnataka state has been divided into 10 agro-climatic zones which have considerable diversity and hence leading to diverse profile of production and economic activities. The state suffers from moderate to severe problem of soil erosion, which is to the extent of 70 % of its geographical area.

Forest area in the state is about 1.2 % of the geographical area of the country and about 20 % the geographical area of the State. The reserved (protected) forest area as a proportion of

the total forest area in the state is about 74 % (10 %) in comparison to that for India which stands at about 55 % (28 %). About 89 % the forest area in the state is managed by Forest Dept.

The state accounts for about 5.8 % of forest cover of the country. Dense forests in Karnataka and India about 11 % of their respective geographical area. The state has about 19.3 % of its geographical area s forest cover, whereas, the corresponding figure for India is 20.6 %. Uttara Kannada, Dakshina Kannada & Udupi, Mysore & Chamaraja Nagara, Shimoga, Belgaum and Chikmagalur districts account for almost two thirds of the forest area of the State. Uttara Kannada, Dakshina Kannada & Udupi and Mysore & Chamarajanagara account for more than 10 percent of forest area of the respective districts. Forest cover in Karnataka as a % of India has declined in 2003 in comparison to that in 2001. In fact, there has been a severe decline in 'dense forest' to the extent of 3965 sq. kms. This is about 17 per cent of the area of the dense forest in the state in 2001. The districts with almost half or more than half of the forest cover in the state are: Chamrajanagar, Chickmaglur, Shimoga, Udupi, Kannad Dakshin, Kannad Uttar, Kodagu. Severest decline in dense forest cover in Kannada Dakshin which was compensated though to a lesser extent by a rather sharp increase in dense forest cover in Udipi. Other districts, viz., Bagalkot, Bijapur Gulbarga Raichur have suffered substantial reduction in the dense forest cover.

Chapter - 3

ACCOUNTING FOR FOREST RESOURCES

3.1 Introduction

The accounting frameworks for Natural Resources in general and for forest resources in particular, as laid down in SNA 1993 and SEEA 2003 need detailed discussion mainly due to the following reasons: (i) very often the question of boundaries to be drawn between various resources becomes pertinent in the process of valuation; and, (ii) the forest resources can be incorporated in national income accounting framework which do not find their rightful place in official statistics.

The rest of this chapter is organized as follows: In section 3.2, we provide the asset boundaries of SNA, 1993 and SEEA, 2003, within which the forest resources can be incorporated in national income accounting framework. In section 3.3 and 3.4, we highlight some of the valuation methods that are commonly used in valuation of environmental resources and products in general and in the context of forest resources, respectively. In section 3.5, we highlight the methodology which can be used for a greater inclusion of resources of forests in both national income accounting and natural resources accounting in India. In section 3.6, we present summary of the chapter.

3.2 Boundaries and Definitions of Environmental assets and forest resources

In Table 3.1 and Table 3.2, we provide the asset boundaries of SNA, 1993 and SEEA, 2003, within which the forest resources can be incorporated in national income accounting framework. In SNA 1993 (Table 3.1), the environmental assets are divided into two main categories, *viz.*, produced and non-produced assets. In this framework forest resources can be included in the form of forested land (AN.2112), other land and associated surface water (AN.2119), and non-cultivated biological resources (AN.213). Forested land in SNA 1993 is classified with other land under cultivation (AN.2112). Cultivated forests can be included

under item AN. 11142. The wooded land can also be included in the residual category of SNA or can be completely excluded from the SNA boundary, if the location of the land is so remote and/or so protected that economic value is not expected to accrue even in the 'foreseeable future' (SEEA, 2003).

SEEA 2003, which aims to provide a more comprehensive framework for natural resource accounting includes forest resources under 'wooded land and associated surface water' (EA.23 in Table 3.2). It defines forested land as "….land under cultivated or non-cultivated stands of trees of a size of more than 0.5 hectares with crown cover of more than 10 per cent and on which trees are able to grow to a height of 5 meters or more at maturity. Other wooded land is defined as land either with a tree crown cover of 5-10 per cent of trees able to reach a minimum height of 5 meters or with a crown cover of more than 10 per cent of trees not able to reach a height of 5 meters" (SEEA, 2003). The forest produce can be included in timber output (EA.141). The value of the ecological functions provided by wooded land could also be captured by the value of forest ecosystems (EA.313), depending upon the feasibility of such estimation.

Table 3.1: Environmental Assets in SNA 1993

AN.1 Produced assets
AN.11 Fixed assets
AN.111 Tangible fixed assets
AN.1114 Cultivated assets
AN.11141 Livestock for breeding, dairy, draught, etc.
AN.11142 Vineyards, orchards and other plantations
AN.112 Intangible fixed assets
AN.1121 Mineral exploration
AN.12 Inventories
AN.122 Work in progress
AN.1221 Work in progress on cultivated assets
AN.2 Non-produced assets
AN.21 Tangible non-produced assets
AN.211 Land
AN.2111 Land underlying buildings and structures
AN.2112 Land under cultivation
AN.2113 Recreational land and associated surface water
AN.2119 Other land and associated surface water
AN.212 Subsoil assets
AN.2121 Coal, oil and natural gas reserves
AN.2122 Metallic mineral reserves
AN.2123 Non-metallic mineral reserves
AN.213 Non-cultivated biological resources
AN.214 Water resources
AN.22 Intangible non-produced assets
AN.222 Leases and other transferable contracts

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

Table 3.2: SEEA 2003 Asset Classification

EA.1 Natural Resources
EA.11 Mineral and energy resources (cubic meters, tons, tons of oil equivalents, joules)
EA.12 Soil resources (cubic meters, tons)
EA.13 Water resources (cubic meters)
EA.14 Biological resources
EA.141 Timber resources (cubic meters)
EA.142 Crop and plant resources, other than timber (cubic meters, tons, number)
EA.143 Aquatic resources (tons, number)
EA.144 Animal resources, other than aquatic (number)
EA.2 Land and surface water (hectares)
EA.21 Land underlying buildings and structures
EA.22 Agricultural land and associated surface water
EA.23 Wooded land and associated surface water
EA.24 Major water bodies
EA.25 Other land
EA.3 Ecosystems
EA.31 Terrestrial ecosystems
EA.32 Aquatic ecosystems
EA.33 Atmospheric systems
Memorandum items: Intangible assets related to environmental issues (extended SNA codes)
AN.1121 Mineral exploration
AN.2221 Transferable licenses and concessions for the exploitation of natural resources
AN.2222 Tradable permits allowing the emission of residuals
AN.2223 Other intangible non-produced environmental assets

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

Table 3.3: Links between SNA and SEEA classifications

	SNA (1993) classification	Produced			Non-produced							
		Livestock, etc.	Vineyards, etc.	Work in progress on cultivated assets	Land under buildings	Land under cultivation	Recreational land	Other land	Subsoil assets	Non-cultivated biological assets	Water resources	Not within the SNA asset boundary
SEEA (2003) classification		AN.11141	AN.11142	AN.1221	AN.2111	AN.2112	AN.2113	AN.2119	AN.212	AN.213	AN.214	
Natural Resources	EA.11 Mineral and energy resources								x			x
	EA.12 Soil resources				(x)	(x)	(x)	(x)				(x)
	EA.131 Surface water					(x)	(x)	(x)				x
	EA.132 Groundwater										x	x
	EA.141 Timber resources		X	x						x		x
	EA.142 Crop and plant resources		X	x						x		x
	EA.143 Aquatic resources	x		x						x		x
	EA.144 Other animal resources	x		x						x		x
Land and Surface water	EA.21 Land under buildings				x		x					
	EA.22 Agricultural land					x	x					
	EA.23 Wooded land		X?			x	x	x		x?		x
	EA.24 Major water bodies						x				x	x
	EA.25 Other land						x	x				x
Eco-systems	EA.3 Ecosystems	(x)	(x)	(x)		(x)	(x)	(x)		(x)	(x)	

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003
(x) Not separately valued
x? May appear in this box only because of the difficulty of separating it from another asset

3.3 Valuation of Environmental Assets

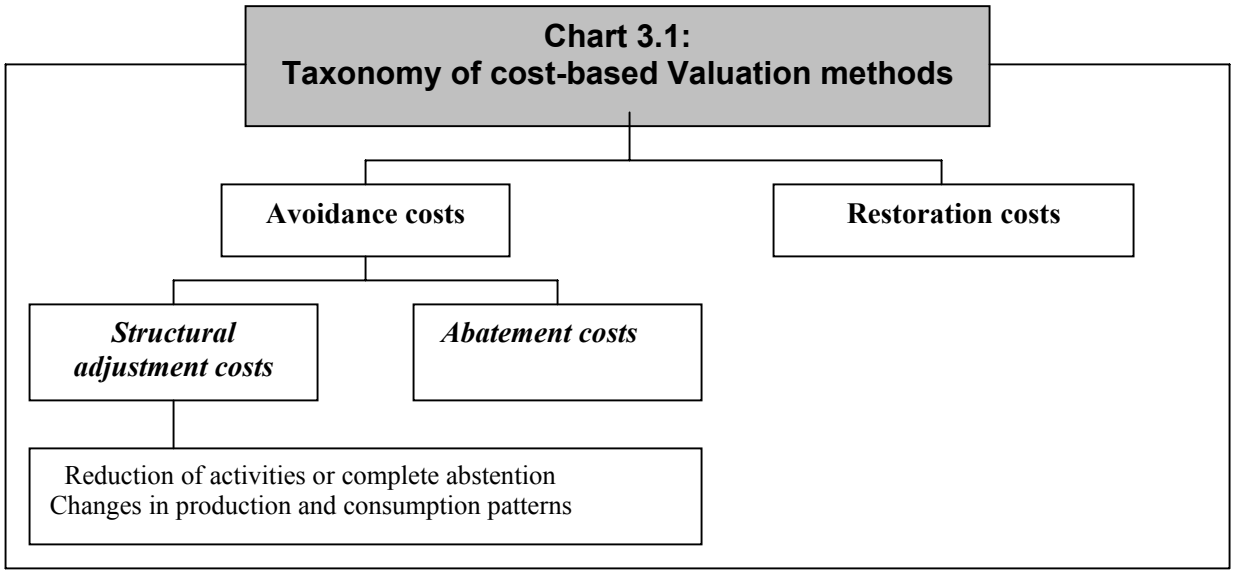
It may be mentioned at the outset that it is important to first ascertain what is being measured. For integrating national income accounts with environmental gains/losses depletion and degradation of natural resources and ecosystems are pertinent. In order to measure the depletion of a specific environmental asset, we need to measure the stock of the asset at the start of an accounting period and account for all the changes that take place during that period to give the stock level at the end of the period. For natural resources, quantity measurements

may suffice. However, for ecosystems, the qualitative changes are expected to predominate. The details (see Chapter -1) about the opening and closing stocks are part of the asset account.

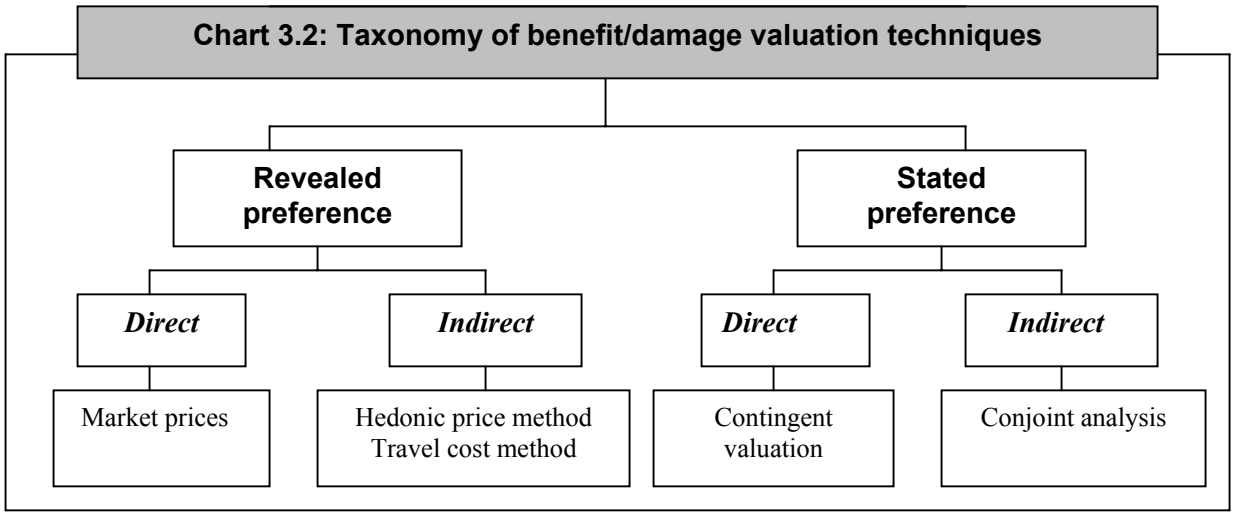
3.3.1 Methods of valuing degradation of Environmental Assets

Though the physical information on the degradation of ecosystem inputs is necessary to measure valuation on degradation, establishing monetary values for degradation is rather complex and controversial as compared with the task of valuing depletion. The preferred method of valuing assets is by using market prices but these prices, more often than not, are not available for environmental assets. Besides measuring the value of degradation and depletion of environmental assets, defensive expenditures that are incurred towards prevention or rectification also assign monetary value to environmental damage.

There are two major approaches to measurement of valuation of degradation of environmental assets (SEEA 2003). These are: (i) Cost-based valuation methods; and, (ii) Damage-based valuation methods. Taxonomy of these two methods is provided in Chart 3.1 and Chart 3.2.



Source: Based on SEEA 2003



Source: Based on SEEA 2003

There are three ways in which environmental degradation can be checked (SEEA 2003). These are: (i) by avoiding the degradation, either by refraining from the activity or by substituting less damaging inputs and outputs; (ii) by checking degradation and making it less harmful; and, (iii) by restoring the environment by clean-up activities. The two approaches within this approach are: (i) revealed preference; and, (ii) stated preference. In the former case, a market for environmental asset in direct or indirect form exists, whereas, in case of the latter, preferences have to be elicited by setting up a hypothetical market. Among the direct methods under the revealed preferences, market prices are used for valuation of environmental assets/products. The hedonic price approach assumes that the price of an asset/good depends on a number of characteristics and if these characteristics are independent, it is possible to ascribe what part of the price is due to each identifiable characteristic. This method requires not only large amounts of quality data on all relevant characteristics but also a high degree of statistical expertise as the valuation is highly sensitive to the model specification. Travel cost method estimates a money value that people actually pay, both in terms of money and time to avail of satisfaction from natural beauty. The three components of the travel costs that can be directly observed are: (i) the direct travel costs such as fuel costs, entrance fees, if any, (ii)the time-costs to the individuals as a proxy for the opportunity cost that has been forgone so as to visit the site; and (iii)the number of visits an individual will make to a site is regarded as a function of such factors as the distance to the site, accessibility

to the site, the income of the visitor, the alternative sites that can be visited, etc. Statistical methods are used to arrive at the relationship between travel and time costs and the number of visits made to the site. From this relationship, the average value per visit is estimated and used for calculating a monetary value for the recreational value of the site. In order to value a change in the environmental quality of the site, the value of the site after the change must has to be re-estimated. The method can be applied to value recreational land and sites of natural beauty. The details of estimates are discussed in Chapter 4.

Stated preference methods are used essentially when the ecosystem services are not traded in markets. Hence, the willingness to pay cannot be reflected through market prices. In these cases, surveys are used to ask people directly what they are willing to pay, based on a hypothetical market scenario. These methods include contingent valuation (direct method) and conjoint analysis (indirect method). Stated preference methods, unlike revealed preference techniques, can elicit information about both use and non-use values. The contingent valuation method presents hypothetical situations to a representative sample of the relevant population so as to generate the data regarding willing to pay for specific environmental services. An alternative to this is to ask people for the amount of compensation they would be willing to accept if they were to give up specific environmental services. Conjoint analysis valuation methods differ from contingent valuation as in the case of the latter, the values are inferred from the hypothetical choices or trade-offs that people opt for. The respondent is asked to state a preference between one group of environmental services or characteristics at a given price and another group of environmental characteristics at a different price. In this approach, basically the choices are involved.

3.3.2 Strength and Weaknesses of different techniques

SEEA 2003 has assessed the various pricing techniques adopted in valuation of environmental resources and products. Though market prices are conceptually preferable, it is difficult to use such prices in situations where normal markets do not exist particularly in case of environmental assets. The strength and weakness of different techniques are presented in Table 3.4.

Table 3.4: The strength and weakness of different techniques

Methods	Strengths	Weakness
Direct Market price	conceptually preferable as it provides the money value of the assets	The presence of externalities and imperfect markets render it difficult to use such prices for products which are to be used by future generations.
Travel cost and Hedonic price	This can be used to value environmental services and assets if the underlying assumptions are valid based on stated preferences	Since these are based on stated preferences, these can be applied only to 'limited, local and relatively small environmental questions'. For the estimation of environmentally adjusted national income figures the estimates of the values of all the various environmental services need to be aggregated to a national level is a stupendous task. Further it requires expertise in statistics and econometrics.
The contingent valuation* Conjoint analysis valuation**	*The willing to pay for specific environmental services can be collected from the respondents on the basis of household survey. **The respondent is asked to state a preference between one group of environmental services or characteristics at a given price and another group of environmental characteristics at a different price. In this approach, basically the choices are involved.	*This is also a hypothetical situation where the preference pattern of people depends on various other characteristics. It is very tedious to collect the information as it is subject to value judgment. *Contingent valuation* method involves a 'complicated, lengthy, and expensive process'. ** The values are inferred from the hypothetical choices or trade-offs that people opt for. It is difficult to value the respondent's choice/ preference between one group of environmental services or characteristics at a given price and another group of environmental characteristics at a different price.

3.4 Valuation of Forest Resources

As detailed in SEEA (2003), the asset classification of the SEEA (2003) and the SNA (1993), forest land and standing timber are classified as two separate assets. Land is a non-produced asset, while standing timber is a produced asset if the forest is cultivated and a non-produced asset if it is non-cultivated. In principle, the value of timber and the value of

forest land need to be separated. However, in practice it is difficult to separate the two components as the forested land may not be available for other purposes due to its location, soil type, administrative restrictions, *etc*. Viewing from the point of view of sustainability of forests, both the area and the standing timber (canopy) are of importance. The composite of land with timber is called a 'forest estate'. It also includes forest-related environmental assets of the forest estate. A range of methods has been developed and tested to value forest estates as well as land and standing timber separately.

3.4.1 Forest Estates

A simple method for valuing forest estates is to multiply the unit price of forest to the area under forest. Average prices for various types of forests can be obtained from the register of transactions regarding land transfers. The major problem encountered in this method is that the markets for forests may be very thin and may be influenced by 'hunting rights' and 'pure forestry motivations'. The use of transaction prices data may not be suitable unless used with critical assessment. Heterogeneity of forests may be captured by using the criterion of productivity of the land, species and age structure of the standing timber, the existence of hunting rights, *etc*.

Complementing the data on recorded transactions, the value of forest estates can also be estimated as a function of the above-mentioned characteristics using a hedonic pricing model. Yet another method that can be used to value forest estates is the net present value (NPV) of the future forest resource rent. The resource rent is estimated as the value of output in the forestry industry minus all costs of production. A comparison of the estimates of value of forests based on the transactions method and the NPV method can provide insights regarding the discount rate used and the biases in observed transaction prices.

3.4.2 Forested Land

If the price of bare forest land is available, it can be used or alternatively this can be approximated by the price of comparable land (*e.g*., price of marginal agricultural land). If the estimates of value of forest estates and of timber (it is possible to have alternative

assumptions, *viz*., no regeneration of timber or sustained timber production) are available then the value of forested land could be obtained by subtracting the latter from the former.

3.4.3 Valuation Methods for Timber

In box 3.1, a summary of the valuation method for timber has been provided.

Box 3.1: Summary of valuation methods for timber

This box provides formulae for the valuation of standing timber according to the methods described in this section. In each case the value is a product of the area of the forest (A) with the quantity of the timber in terms of cubic metres per hectare (Q) and the average stumpage price per cubic metre (p).

Stumpage value method

This is the simplest formulation; no discrimination is made for the age of the timber at the valuation date.

Using the stumpage value method the value of standing timber, S, is given by:

$$S = ApQ$$

Consumption value method

The consumption value method requires data for different age classes from 1 to n. The area, quantity and price for timber of age t are shown by a subscript t.

Using the consumption value method the value of the stock of standing timber, S, is given by:

$$S = \sum_{t=1}^{n} A_t p_t Q_t$$

Simple net present value method

In the simple version of the net present value method only receipts from harvesting mature timber are included; other receipts (from thinning) and costs are ignored. It is assumed the receipts are only realised when the timber reaches maturity at age T. At this point the price realised and quantity to be harvested have subscripts T. To reach the net present value, discounting using a discount rate of r for each of the (T-t) years until harvest must be applied.

Using the net present value method the value of standing timber, S, is given by:

$$S = \sum_{t=1}^{n} \frac{A_t p_T Q_T}{(1+r)^{T-t}}$$

Allowing for management costs

Suppose information on the management costs per hectare is available. This might be in the form of a simple average, c, for the whole forest or more refined information showing the costs for trees of a given age, c_t, might be available.

The total costs under the stumpage value method will be Ac. Under the consumption value method they will be $\Sigma A_t c_t$. Under the net present value method they will be: $\sum_{t=1}^{n} \frac{A_t c_T}{(1+r)^{T-t}}$

Each of these, if available, needs to be deducted from the formulae for S given above.

If estimates of the revenue from thinnings are available, additions to the value of the standing timber can be made to each of the formulae in a similar way:

$$S = \sum_{t=1}^{n} \frac{A_t (p_T Q_T + s_T)}{(1+r)^{T-t}}$$

Source: *System of Environmental and Economic Accounting (SEEA)*, 2003

As will be detailed later, the value of timber is included in official estimates of national income accounting. Timber felling from declared forest area is undertaken by the forest departments of the various states including that in Karnataka and later sold to the private sector or other government agencies. Thus, the value of such timber is already accounted for by the national income estimates. Hence, we refrain from estimating the value of timber in the present study.

3.4.4 Valuation Methods for Ecosystems

Ecosystems are less acquiescent to economic measurement and valuation due to their characteristics. Hence, economic accounting could be misleading and controversial. There are several difficulties in the way in which the ecosystem should be treated collectively as a complete system. Moreover, there are multiple interactions of various constituents of ecosystem. Due to the difficulties in capturing these intricacies, few attempts have been made to prepare the asset accounts for the ecosystems (SEEA, 2003). *Nevertheless, it is possible and necessary to prepare physical and\or monetary accounts for at least some of the components of ecosystems, e.g., ecological services provided by forests.* This would necessitate estimation of the amount of carbon dioxide absorbed by a country's forests during a given period and estimating the value of this service to the population. The amenity service of the environment can be measured in monetary terms either through 'willingness to pay' measured directly by entrance fees to a national park or through travel contingent valuation method (*i.e*., by constructing hypothetical market). Hence, at least for a few services of ecosystems, monetary accounts may be prepared, leaving others merely at the physical level. The details of tree and animal species (including their age structure) in the forests can be incorporated into forest accounts. Due to year-to-year climatic variations, it is advisable to estimate forest growth and harvest over a multi-year period or using moving averages. The stock of forests can increase /decrease due to afforestation/deforestation, natural expansion, degradation, change in use or status (reclassification), catastrophic events (fires, storms, avalanches, *etc*.), *etc.*

3.5 Forest Resources Incorporated in National Income Accounting in India

It may be instructive to begin the discussion regarding inclusion of forests within the National Accounts Statistics for India, by comparing the current series with 1993-94 as the

base with earlier series with 1980-81 base. In the 1980-81 series, the NAS estimates of gross value added (GVA) from the forestry and logging sector was obtained by using the 'production approach'. The estimates of gross value added (GVA) were derived by subtracting the value of various inputs at purchasers' prices from the value of output at factor cost. The economic activities included under the forestry and logging were: (i) forestry (*e.g*., planting and conservation of forests, collection of forest products, charcoal burning in forests); (ii) logging (*e.g*., felling and rough cutting of trees, hewing or rough shaping of poles, blocks, *etc*.) and transportation of forest products to the sale depots/assembly centers; and, (iii) farmyard wood (industrial wood and fuel-wood collected by the primary producers from trees outside regular forests). The forest produce was classified into two broad groups: (a) major products comprising industrial wood (timber, round wood, match and pulpwood) and fuel-wood (firewood and charcoal wood); and, (b) minor products that consist of a large number of heterogeneous items such as bamboo, fodder, lac, sandalwood, honey, resin, gum, tendu leaves, *etc*.

As reported by the CSO, the current series of national accounts statistics in India, with base year 1993-94, is more comprehensive as compared to the earlier series as regards the forestry and logging sector are concerned. The current series includes "Fuel wood" as estimated by using 'Consumption Approach', rather than 'Production Approach' used earlier. This is due to the fact that reliable estimates of production of fuel wood are not directly available. Due to this revision in methodology for valuation of fuel wood, the estimates of GDP in the forestry sector increased by Rs. 380 crore in 1993-94 (CSO, 1999).

The estimated value of fuel wood is based on three components: (i) household fuel wood consumption; (ii) agriculture byproducts used as fuel wood (this amount is subtracted from the total consumption of fuel wood by the households, since it is already included in agricultural sector as by-products); and, (iii) fuel wood consumed by industries and on funerals. In the old series, the estimates for (i) were worked out on the basis of NSS 32nd and 38th rounds results. For (ii) a norm of 10 per cent was assumed and a norm of 12.5 per cent was assumed for (iii). The main changes in the new series are: (a) use of data on household fuel wood consumption, as available from the Quinquennial Surveys of Consumer

Expenditure in the NSS 43rd (1987-88), and the 50th (1993-94) rounds; (b) deduction of the actual estimates of value of output of agricultural byproducts used as fuel (*e.g.*, cotton sticks, arhar sticks and jute sticks, and those agricultural byproducts whose value of output is already included in the agriculture sector from the household total consumption of fuel wood); and, (c) estimating afresh the consumption of firewood in the industry and on funerals as given below:

(A) The estimate ***of consumption of firewood in the industries*** for the year 1993-94 has been based on the estimates obtained from the Enterprise Surveys conducted on various activities by the CSO and the NSSO. The various industries that consume fuelwood are broadly grouped into 7 industry groups: (1) food products; (2) beverage, tobacco and related products; (3) textiles; (4) paper and paper products; (5) structural clay products; (6) hotels and restaurants; and, (7) others. For the subsequent years, the estimates of inter-industry consumption have been moved in accordance to that the fuel consumption in the unregistered manufacturing sector. However, for the hotels and restaurants, the indicator used is the growth of GVA of the sector.

(B) The ***consumption of firewood on funerals*** has been estimated making use of the data on: (i) distribution of population by different age groups; (ii) mortality rates of different age groups and different religions; (iii) population projections; and, (iv) consumption of firewood per funeral. Estimated deaths of only non-Muslim and non-Christian persons and those above the age of 10 years have been used for deriving the estimated consumption of firewood on funerals. Since the household consumer expenditure surveys are conducted only once in 5 years, the annual estimates of consumption of fuel wood by the households are not available. For deriving the estimates for the subsequent years after 1993-94, the compound growth rate observed between 1987-88 and 1993-94 (separately for rural and urban) in respect of per capita consumption has been used. The projected population figures are obtained from the Office of the Registrar General of India.

The National Forest Policy (1988) targets at bringing one-third of the geographic area under forests and tree cover. In the mountainous and hilly regions, this proportion has been targeted at the two-thirds of the geographic area. The data on forests can be obtained from three sources: (i) Ministry of Agriculture (land-use statistics based on revenue records); (ii) Ministry of Environment and Forests (based on the data provided by the State Forest Departments and primarily classified by the legal status of the land); and, (iii) Forest Survey of India (classified according the canopy cover and compiled by using the satellite imageries using remote sensing technology). There are discrepancies in the data obtained from the three different sources. There are also problems of comparability of data across the various assessment rounds, from the same sources due to the changes in definition of categories in which the data are recorded.

3.6 Summary

In this chapter, we have mainly discussed the accounting frameworks for forests and the associated issues in the methodologies. We have linked the uses and benefits of forests to the methodologies so as to link the same to the valuation methods. The methodologies actually used by this study in conducting the case studies have been elaborated in the respective chapters. This is due to the fact that the assessment of methodologies has to be done in the specific contexts in which these methodologies have to be applied. In this chapter, we have indicated the SEEA 2003 framework for accounting for forests. However, at present, the data at the state level do not permit us to follow SEEA 2003.

Chapter - 4

CASE STUDIES ON VALUATION OF SELECT FORESTS PRODUCTS AND SERVICES IN KARNATAKA

4.1 Introduction

As regards the area under forest cover, Karnataka ranks 4th among all the states and UTs of India, Forests constitute around 20 percent of the total geographical area of the state, including some of the most magnificent forests like: evergreen (EG) forest, semi-evergreen (SE) forest, moist deciduous (MD) forest, dry deciduous (DD) forest, and thorny forests.

In this chapter, the various case studies dealing with the valuation of select forest produce and forest services have been attempted. Eight case studies have been carried out in this context. These studies pertain to valuation of: (1) non-timber forest products (henceforth, NTFPs[1]) by households; (2) grazing services; (3) eco-tourism (Dandeli Park); (4) carbon sequestration; (5) fuel wood use by local industries; (6) medicinal plants; (7) watershed benefits; and, (8) sacred groves.

The chapter is organised as follows: The sampling design and brief methodology is discussed in the second section (4.2). The third section (4.3) presents estimates of valuation of NTFPs (excluding grazing) along with the profile of the villages covered under the study, the review of literature in respect of different methodologies and its strength and weakness. Section 4.4 discusses the case study methods of valuating the grazing services, and conclusion emanating from the case studies. In section 4.5, Recreation and Tourism Services on the basis of A Case Study of the Dandeli Wildlife Sanctuary is presented in great detail. The Case Study on Carbon Sequestration in Forests of Karnataka is presented in section 4.6. In section 4.7 the Case Studies on Fuel Wood Used by Local Industries is presented. The case studies on,

[1] According to the terminology currently accepted, NTFPs are defined as all biological material other than wood, which are extracted from natural forests for human use. These products are usually extracted with simple, traditional techniques causing little damage on ecosystems (Lescuyer and Guillaume, 1996).

Medicinal Plants, Sacred Groves and Watershed Benefits are presented in section 4.8, 4.9 and 4.10 respectively. The last section summarises the main findings of the chapter.

4.2 Sampling and Methodology

Of the eight case studies, the field surveys for the case studies 1 and 2 were conducted during November 2004 to January 2005. For the case study on eco-tourism, the field survey was conducted in January 2005. Carbon sequestration case study is primarily based on the secondary data combined with the forest types in the study region. Case studies 5 to 8 were carried out in the second phase of the study, i.e., in July 2005. The study area for case studies 1 and 2 were the same and hence we will profile the study area for these case studies together

4.2.1 Criterion for selection of Sample districts for NTFPs in the present study

Availability and accessibility of NTFPs varies in different type of forest. Therefore, districts with different forest types have been selected. As mentioned earlier, the selected districts are: Tumkur, Chikkamagalur, Hassan, Dakshina Kannada, and Uttar Kannada. These districts are relatively well endowed as regards forest resources are concerned. In this sense, the sampling of districts is purposive. After the selection of the districts, the forest ranges in each district have been selected. The ranges with high area of forests have been selected.

4.2.2 Selection of Villages

The same criterion has been used for selection of villages from the ranges. The selected villages belong to five districts of the state, as mentioned earlier. We selected 10 villages for NTFPs and grazing services. A total of 14 villages were selected for studying the benefits of fuel wood. We selected four (4), three (3) and two (2) villages for medicinal plants, watershed and sacred groves, respectively, from the same districts. The villages were selected adhering to the purposive sampling framework. However, this is not expected to bias the results as the adjustment for the state will be made depending on the forest area and forest types. This will be elaborated during the discussions of the respective case studies.

4.2.3 Selection of the Households and Other Details

In each of the selected villages 50 households (HHs) have been selected to get the information regarding the quantity and value of NTFPs collected. Thus, the total sample size is 500 (Table 4.1). The household schedules mainly include information about the collection of NTFPs, quantity collected, selling price and selling costs, *etc*. There are seasonal variations in the production of NTFPs. Thus, we have incorporated wide variation in quantity collected and price. Therefore, we have taken average value for all seasons, *i.e*., rainy, winter and summer (from Kharif 2003 to Rabi 2003-04). We selected 50 households in each selected village. The selection of the households was random so as to cover all types of HHs.

For valuating the recreational facilities, a sample of 300 visitors was selected from the Dandeli wild life sanctuary. Similarly, we selected 32 Industries for fuel wood and 32 households for valuing the benefits of watersheds. In order to study the benefits of forests derived from medicinal plants and sacred groves we selected 30 households for each of the case studies.

Table 4.1 provides a description of the valuation method adopted and select details of the sample for each of the case studies. The sample selection procedures have been detailed in the relevant sub-sections.

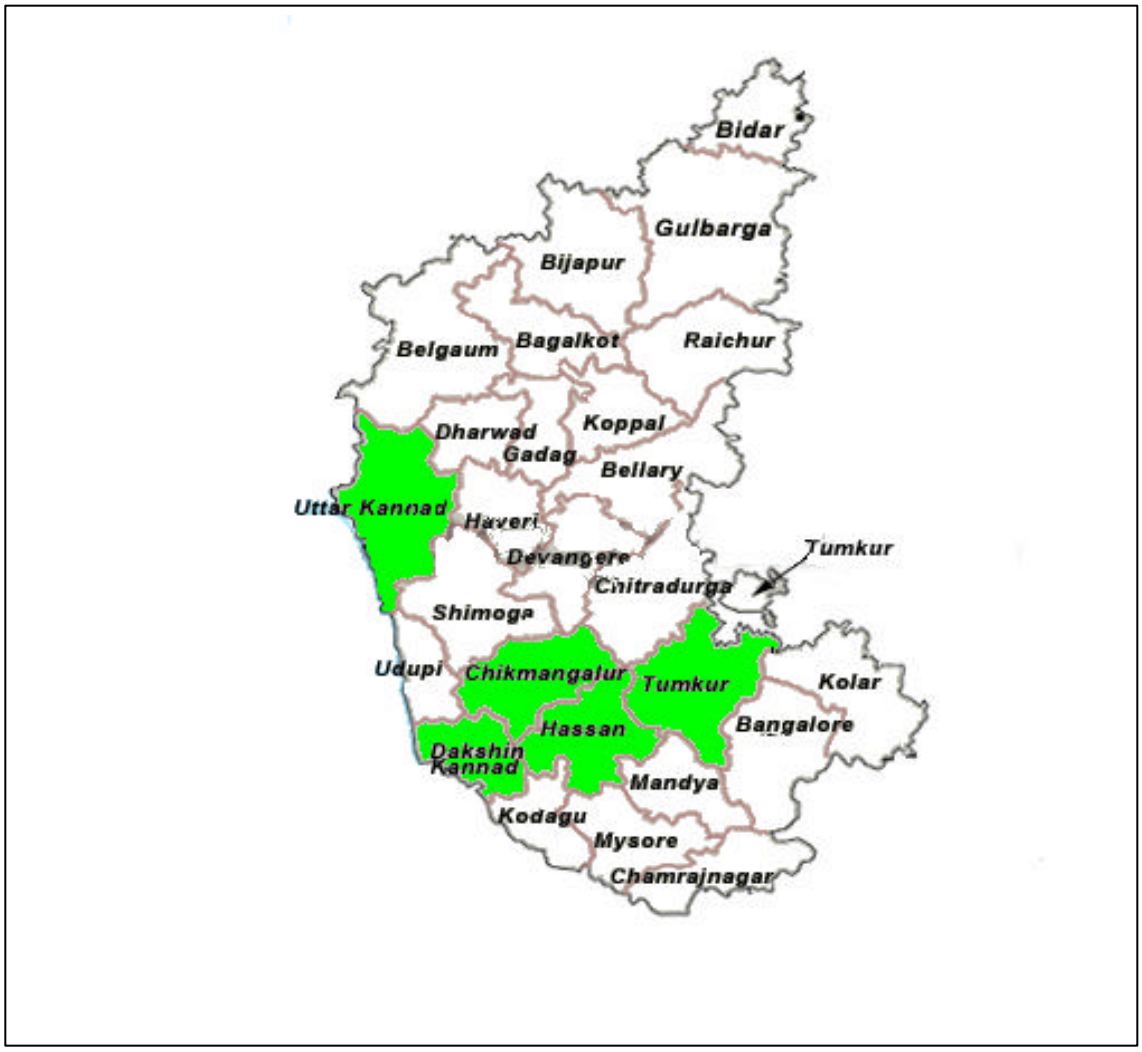
Table 4.1: Valuation Methods Used and Select Details of the Sample

Sr..No.	Case Study	Valuation methods	Districts/Taluks	Villages	No. of Units in the Sample
1.	NTFPs	Market prices	Uttar Kannada, Chikmanglur, Hassan, Dakshin Kannada, Tmkur	10 villages	500 Households
2.	Grazing	Market prices	Uttar Kannada, Chikmanglur, Hassan, Dakshin Kannada, Tumkur	10 villages	500 Households
3.	Dandeli Wildlife Sancury	Travel Cost Method	Uttar Kannada,	Not applicable	300 visitors
5	Fuel wood	Direct consumptive use value	Uttar Kannada dist and talukas: Sirsi, Honnavar, Bhatkal	14 villages	32 firms
6	Medicinal Plants	Direct consumptive use value	Uttar Kannada dist and talukas: Sirsi	Hunasehalli, Niranalli, Saunda, Vasegadde	30 Households
7	Sacred Groves	Non-use contingent valuation Method	Siddapur	Hittalgoppa, Kavanchur	30 Households
8	Watershed	Non-use contingent value	Sirsi	Kadabal, Sadakali, Nirnahalli	32 Households

Note: Case study No. 4 on Carbon sequestration did not involve collection of primary data and hence does not feature in this table.

In Map 4.1 we highlight the districts from which the sample villages and households were drawn for the case studies.

Map 4.1: Selected Districts (in Green) for NTFPs ,Grazing and other Services



4.3 Case Study on Valuation of Non-timber Forest Products (NTFPs)

Non-timber forest products are important forest products. In Karnataka, forests play an important role in the socio-economic development of the state. Forests help in maintaining a stable environment conducive to sustained development of agriculture. Forests meet a large share of the energy needs of the population, more so in the rural areas. A significant portion of the fodder needs of the vast cattle population is also met from the forest. Forest products, in addition to contributing to the state's income, also play a very important role in the rural and tribal economy. Many of the forest products, including non-timber forest products (NTFPs), provide sustenance to the rural and tribal people, who collect a large part of their daily

necessities, including food and medicines, from the forests. Most of these products represent a direct subsidy to the rural poor, and constitute an integral element of the factors alleviating their poverty. For landless and marginal farmers living in the vicinity of forests, forest-related activities generate their primary source of income.

In Karnataka, collection of non-timber forest produce is being entrusted to Tribal Societies wherever these exist. There are 19 such Tribal Societies in Karnataka. Wherever the societies do not exist the NTFP collection leases are granted through tender-cum-auction sales. Firewood is sold at fixed rates at the depots for domestic consumption. Canes and bamboos are provided by the department on payment basis against the quantity allotted to private artisans (Govt of Karnataka, 1996). *These officially extracted NTFPs are included in the estimation of the state domestic product. The value of NTFPs collected by the local population is not included in the estimation of SDP*. Failure to take these resources into account means neglecting a considerable source of wealth, at least locally. This also prevents optimal resource allocation. In this section, an attempt has been made to estimate the value of NTFPs collected by local people. In the following sub-sections, we briefly present the literature review, methodology used for this case study, estimates of valuation of NTFPs (excluding grazing).

4.3.1 Literature Review on Valuation of NTFPs

In Table 4.2, the studies dealing with the valuation of NTFPs have been presented.

Table 4.2: Studies on Valuation of NTFPs (continued)

Study (Year)	Methodology	Findings
1. Lal (1990)	Used market prices to value NTFPs available in India.	Value of wood Rs.118.8 billion per year. Fodder Rs. 22 billion per year. Other NTFPs Rs. 10.9 billion per year.
2. Chopra (1993)	Estimated the value of NTFPs for tropical deciduous forests in India. Used various valuation techniques to estimate the value of NTFPs. Following methods are used for valuation. **Fuelwood**: substitute good approach (price of soft coke) and labour input-cost of time spent in collection. **Fodder**: Market value of fertilizer and milk output from cattle feeding on established pasture and schubland. **Other forest products**: Labour inputs –cost of time spent in collection.	The direct use value is US$220 per hectare per year.
3. Gunatilake & Others (1993)	Study area: Knuckles National Wilderness Area in the Kandy and Matale districts of Sri Lanka. Direct use values of NTFPs are calculated excluding illegal extraction of wildlife, poles and ratten or products collected irregularly. Market prices of products or prices of close substitutes are used to value the NTFPs.	NTFPs provided 16.2 % and 5.3 % of total and cash income of the household per year. The value of NTFP extraction is US$92 per hectare per year.
4. Howard (1995)	Valuation of NTFPs is under taken as a part of financial and economic CBA with regard to Uganda's protected area system.	Direct use of wood and NTFPs by local communities is estimated at about US$74 million per year.
5. Lescuyer & Guillaume (1996)	An attempt has been made to estimate monetary valuation of all nutritious NTFP extracted by a rural village population in the East Cameroon. Three economic valuation techniques have been used for NTFPs, i.e., local market prices, the market price of the substitute of the non-marketed NTFP, and NTFP value by knowing the time spent in forest for its collect by the gatherer. Market price method and market substitute's method have produced results. But their application and results are questionable.	The value of NTFP extractions in Goute is FF 17945 for one year.

Table 4.2: Studies on Valuation of NTFPs (concluded)

Study (Year)	Methodology	Findings
6. Emerton & Mogaka (1996)	Used participatory method for valuation of forest resources in Aberdares, in Kenya. They used pictures to value forest use.	By using this method, timber, medicines, honey, building materials, wild foods, hunting, grazing, charcoal, fuelwood are valued. This exercise demonstrates how it is possible to link local categories of value and find a common 'currency' which can bridge the gaps between commercial and subsistence activities.
7. Chopra & Kadekodi (1997)	Estimated value of NTFPs based on the market price in two representative watersheds of the Yamuna river basin.	Value of NTFPs found quite high when compared to timber output.
8. Adger , et al (2002)	Estimates value of NTFPs in Mexico. These estimates are based on the shadow prices.	It is found that the use value of NTFPs is likely to be relatively high compared to other values, and possibly very high in certain regions.

4.3.2. Strengths and Weakness of the methods

The strengths and weaknesses of the methods used in the literature are presented in table 4.3

Table 4.3: Strengths and Weaknesses of the methods used in the literature

Valuation Method	Strengths	Weaknesses
Local market Price method	The resulting value estimates are derived from true household choices, facing prices that are 'real'. They reflect local demand and supply conditions.	Prices vary widely according to the place. Market transaction takes place in an oligopsony contest and not in pure perfect competition. NTFP economic value is diminished because it is the price of the first transaction that is chosen for the valuation. In general, the valuator is free to set the price. Product prices also vary according to the season. Often, the valuation use a low price set when supply exceeds demand. This choice is arbitrary and indicates a minimal or conservative NTFP value is sought. Application of this valuation technique implies a preliminary choice of the valuator as to the level of value he wants to set.
Valuation using substitute of the non-marketed NTFP	Substitute goods approaches may be used whenever close market substitutes for non-timber benefits exist.	Using a market substitute to give a value to a gathered product is difficult. Accepting the word of the villagers concerning their food substitutes is one thing; imputing a monetary value to these products is another. Furthermore, they are substitutable as food, but not economically or monetarily. It is not sure that a gatherer is willing to exchange his NTFP harvest against an equivalent non-market substitute harvest, even if he obtains the same satisfaction in consumption. It can be said that, in an economy where currency is rare, values of use do not correspond to values of exchange.
Travel Cost	This method recognizes that for some goods or services the consumer may have to incur substantial costs (in time or money), to obtain the particular good or service. For example, a recreation experience may involve considerable travel expenses; and gathering free fuel wood may require a considerable amount of time. It assumes that the value to the consumer is at least equal to the travel costs the consumer is willing to incur to obtain the desired good or service.	Quantity of NTFP collected and the time spent in gathering are required to value the resources. Similarly, it is difficult to consider gathering time as an opportunity cost. Because, many times people remain unemployed. Many time, quantity collected is not at all related to gathering time because of un certainly. In dry regions, people collect fuel wood from forests. In case of necessary products it is difficult to assign a value based on the transport cost.

4.3.3 Valuation of NTFPs in the present study

The growing awareness about organic products, herbal medicine and natural way of life have helped to develop markets for existing as well as new NTFPs in Karnataka. Almost all NTFPs have market value. Therefore, the present study makes an attempt to estimate the value of NTFPs collected by local people using 'local market prices' using the primary data collected from the Households.

Households collect the NTFPs for self-consumption, sale and for occupation. Collection of NTFPs depends upon several factors such as, availability of NTFPs in the forest, accessibility to the forest, availability of these products in the private lands, and fear of wild animals, *etc.*

4.3.3.1 Profiles of the Selected Villages of the Study Area for Case Studies on NTFPs

In Table 4.4 we provide information relevant from the point of view of NTFPs collection in the villages surveyed.

Table 4.4: Relevant Information about Selected Villages (continued)

Village Name	Sankaranahalli	Bellaru	Kundur	Marle	Urubage
Total population	1244	2166	2257	2611	811
Forest Area (Ha)	724	325	2050	533	897
Type of forest	Tropical Thorn	Deciduous	SE & MD	Throny scrub	Evergreen
NTFPs collected	Fuelwood, Fodder Magadiberu Nelli	Fuelwood, Fodder, Nelli,Tumri leaves, Honey, wax, Medicines	Fuelwood, Fodder Kadumallige, honey, Nelli	Fuelwood, fodder, muttal leaves	Fuelwood, fodder, Honey Mango
Occupations	Agriculture, Agri-labour	Agriculture, Agri-labour	Agriculture, Agri-labour	Agriculture, Agri-labour, Casual lab	Agriculture Agri-labour
Major crops	Coconut Ragi Tur Paddy	Ragi Paddy Jawar Coconut	Coffee, Cardamom Banana Paddy, Dalchinni Sunthi and Menasu	Paddy Jawar and Tur	Coffee Cardamom Banana, Paddy Dalchinni Sunthi, Menasu
Districts	Hassan	Tumkur	Chikkamagalore	Chikkamagalore	Chikkamagalore
Ranges	Arasikere	Bukkapatna	Aldur	Chikkamagalore	Mudigere

Table 4.4: Relevant Information about Selected Villages (concluded)

Village Name	Heggadde	Nekkiladi	Madappadi	Subramanya	Jagalbet
Total population	2466	1815	1640	3447	2059
Forest Area (Ha)	3600	80	4595	2915.5	9096
Type of forest	Evergreen	Dry deciduous	MD	SE & MD	SE & MD
NTFPs collected	Fuelwood, fodder, tumre leaves	Fuelwood	Fuelwood, fodder, Honey	Fuelwood, honey, wax, tumre leaves	Fuelwood, Fodder, Nelli Sigekai, Honey
Occupations	Agriculture, Agri-labour	Agriculture, Agri-labour & trade & business	Agriculture, Agri-labour	Agriculture, Agri-labour Casual labour and trade & business	Agriculture Agri-labour
Major crops	Paddy, Menasu Coffee, Sunthi Yalakki, Dalchinni	Dalchinni, Giniya Hunde, huli, Coco (for chocolate) Honne (seed oil for medicinal purpose)	Yalakki, Menasu Sunthi Paddy	Yalakki Menasu Sunthi Paddy	Paddy
Districts	Hassan	Dakshina Kannada	Dakshina Kannada	Dakshina Kannada	Uttara Kannada
Ranges	Sakkeshpur	Puttur Range	Sullia	Subramanya	Jagalbet

4.3.3.2 Number of HHs engaged in NTFP Collection

On an average, more than half of the households who live in the vicinity of the forest in the selected villages of the study area collect NTFPs. Table 4.5 provides the number of sample HHS collecting NTFPs in the study area.

Table 4.5: Sample of HHs Collecting NTFPs

Type of Forest	Total No of HHs in the Sample	No. of HHs Collecting NTFPs	Col 3 as a % of Col 2
1	2	3	
Evergreen (EG)	100	36	36.0
SE & MD	200	137	68.5
Dry Deciduous (DD)	100	59	59.0
Tropical Thorny (TT)	100	44	44.0
Total	**500**	**276**	**55.2**

4.3.3.3 NTFPs collected per HH per month

In the selected villages households collect fuel wood, fodder, muttal leaves, honey, nelli, magadi beru, kada bike hannu, gum, tumbare leaves, wax, tupra furit, medicinal leaves, seegekai, gaaliaubhadi balli, geru, malli balli, otae, vate, *etc.* Most of these Households depend on the forest mainly for their fuel wood and fodder requirements. The rural population prefers to gather the fuelwood as they have less purchasing power. Only in certain situations Households purchase fuelwood. In certain areas fuelwood gathering is a source of livelihood. Gathering of fuelwood is mainly a female activity. Table 4.6 shows average quantity of NTFPs collected per month. It shows that fuel wood and fodder are the main items collected by the rural households. The monthly seasonal average has been calculated as a weighted average of the monthly collection across various forest types, where weights are proportional to the number of households in the sample provided in Table 4.6.

Table 4.6: Collection of NTFPs* in Selected Villages per Household per Month

NTFP	Season	Evergreen	SE & MD	Dry Deciduous	Tropical Thorn	Monthly seasonal Average
Fuel wood (Quintal)	Rainy	0.5	1.1	1.0	0.8	0.9
	Winter	0.9	1.7	1.4	1.0	1.4
	Summer	1.2	3.4	1.6	1.1	2.1
Fodder (Quintal)	Rainy	0.2	2.1	0.2	2.3	1.4
	Winter	0.1	0.1	2.3	2.3	1.0
	Summer	0.1	0.1	2.1	0.2	0.5
Muttal Leaves (Quintal)	Rainy	0.0	0.0	0.0	0.0	0.0
	Winter	0.0	0.0	0.0	0.0	0.0
	Summer	0.0	0.0	0.0	20.1	4.0
Honey (Kg)	Rainy	0.1	0.0	0.0	0.0	0.0
	Winter	0.1	0.2	0.0	0.0	0.1
	Summer	0.2	4.1	0.1	0.0	1.7
Nelli (Kg)	Rainy	0.0	0.0	0.0	0.0	0.0
	Winter	0.0	0.1	10.5	0.1	2.2
	Summer	0.0	0.0	0.0	0.0	0.0
Tumbare Leaves (Kg)	Rainy	16.0	0.3	16.8	0.0	6.7
	Winter	15.9	0.3	16.4	0.0	6.6
	Summer	1.0	0.3	6.3	0.0	1.6
Seegekai (Kg)	Rainy	0.0	0.0	0.0	0.0	0.0
	Winter	0.0	5.0	0.0	0.0	2.0
	Summer	0.0	0.0	0.0	0.0	0.0

* Main products only

Source: *Based on field survey, CMDR*

4.3.3.4 Value of NTFPS collected by the sample HHS

In selected villages almost all the NTFPs are locally sold and hence market prices for all these products are available. Table 4.7 shows the prices of various NTFPs in the selected villages of Karnataka. NTFPs are available in the particular season and in that season these are collected and marketed. It is found that fuel wood is collected and marketed throughout the year. The selling price of fuel wood varies in different seasons. However, we have included the average local price of fuel wood in this study.

Table 4.7: Local Price of NTFPs in Selected Villages of Karnataka

NTFPs	Price (Rs / Unit)	NTFPs	Price (Rs)
Fuelwood (Quintal)	92	Tupra Fruit (Kg)	30
Fodder (Quintal)	60	Dindan Wax (Kg)	80
Muttal Leaves (Quintal)	165	Medicine (Kg)	50
Honey (Kg)	42	Seegekai (Kg)	26
Nelli (Kg)	40	Gaali Aubhadi Balli (Kg)	20
Magadi Beru (Kg)	25	Geru (Kg)	180
Kada Bikke Hannu (Kg)	10	Malli Balli (Kg)	10
Gum (Kg)	100	Otae (Kg)	25
Tumbare Leaves (Kg)	18	Vate (Kg)	25
Wax (Kg)	80	Cane (Nos)	15

Note: Obtained from discussion with the villagers

The value of NTFPs is obtained by multiplying the quantity of NTFPs collected, the details of which are provided in Table 4.6 and the price matrix generated by using information provided in Table 4.7. The value of NTFPs is presented in Table 4.8.

Table 4.8: Value of NTFPs Collected in Selected Villages (per Household per month, Rupees)

NTFP	Season	Evergreen	SE & MD	Dry Deciduous	Tropical Thorny
Fuel wood (Q)	Rainy	45.1	104.9	94.2	69.1
	Winter	82.3	160.6	133.3	88.2
	Summer	105.8	317.0	143.4	96.8
Fodder (Q)	Rainy	11.4	126.6	12.0	136.8
	Winter	4.2	6.0	135.6	135.0
	Summer	3.0	5.4	126.0	9.0
Muttal Leaves (Q)	Rainy	0.0	0.0	0.0	0.0
	Winter	0.0	0.0	0.0	0.0
	Summer	0.0	1.7	0.0	3319.8
Honey (Kg)	Rainy	2.1	0.0	0.0	0.0
	Winter	3.4	7.1	0.0	0.0
	Summer	6.7	172.6	4.2	0.0
Nelli (Kg)	Rainy	0.0	0.0	0.0	0.0
	Winter	0.0	4.4	419.6	2.0
	Summer	0.0	0.4	0.0	0.0
Tumbare Leaves (Kg)	Rainy	287.6	5.4	302.0	0.0
	Winter	285.8	4.5	294.8	0.0
	Summer	17.6	4.5	113.0	0.0
Seegekai (Kg)	Rainy	0.0	0.0	0.0	0.0
	Winter	0.0	130.0	0.0	0.0
	Summer	0.0	0.0	0.0	0.0

4.3.3.5 Value of NTFPs collected and sold by the sample Villages

Most of the households collect NTFPs for their home consumption. It is observed that mainly landless and marginal farm households are engaged in collection and sale of these products. Fuel wood is the main item sold and other items are sold in small quantities. The trading of NTFPs takes place mostly within the village or in the nearby village. Land less and marginal farm households collect fuel wood and sell it to the rich households in the village (medium, large farm households and salaried people). Thus, these sellers do not incur any cost of selling. Table 4.9 shows the value of NTFPs collected, consumed and sold in the selected villages.

Based on the information regarding the value of NTFPs collected per household and total number of households residing in the forest vicinity, we have calculated value of NTFPs collected per hectare. It is found that value of NTFP collected/Ha is more in case of tropical

thorny and dry deciduous forests. Though there are abundant forests in and around the villages in evergreen and SE & MD types of forests; the value of NTFP collected by the villagers is rather small. This is mainly due to two reasons. First, HHs depend on the private land for their biomass requirements and second, forest department imposes various restriction of on collection of NTFPs in these areas.

Table 4.9: Total Value of NTFPs Collected in the Selected Villages (Rs/Month).

Item	Season	Evergreen	SE & MD	Dry Decidious	Tropical Thorn
Total Value of NTFPs Collected	*Rainy*	34622	47385	40820	20589
	Winter	37574	62525	98330	22518
	Sumer	13316	100311	38662	342563
Total Value of NTFP Sale	*Rainy*	27420	2740	29136	0
	Winter	28340	6364	71836	276
	Sumer	3392	13508	13434	333084
Total Value of NTFP Consumption	*Rainy*	7202	44645	11934	20589
	Winter	9174	31084	28344	23167
	Sumer	11033	83248	30238	9479

Source: *Based on field survey*

Table 4.10 presents the estimates of value of NTFPs per HH collected, sold and consumed per month.

Table: 4.10: Per HH Value of NTFPs Collected & Sold in the Selected Villages (Rs/HH/Month)

Item	Season	Evergreen	SE & MD	Dry Decidious	Tropical Thorn
Per HH Value of NTFPs Collection	*Rainy*	346	237	474	408
	Winter	376	313	625	983
	Sumer	133	502	1003	387
Per HH Value of NTFP Sale	*Rainy*	274	14	27	291
	Winter	283	32	64	718
	Sumer	34	68	135	134
Per HH Value of NTFP Consumption	*Rainy*	72	223	446	119
	Winter	92	155	311	283
	Sumer	110	416	832	302

Note: Value of NTFPs per household has been obtained by dividing the total value of NTFPs collected in the village by the number of households in the sample in the selected forest type.

The value of NTFPs collected in the selected villages per year is obtained by multiplying the monthly average of seasons by 12 (No. of months per year). This is given in Table 4.11. The last row of Table 4.11 is transposed in Table 4.12 (Col.4 of Table 4.12)

Table 4.11: Yearly Average Value of NTFPs collected per HH in Selected Villages (Rs)

	Evergreen	SE & MD	Dry Decidious	Tropical Thorn
Rainy	346.2	236.9	408.2	205.9
Winter	375.7	312.6	983.3	225.2
Summer	133.2	501.6	386.6	3425.6
Monthly Average	285.0	350.4	592.7	1285.6
Yearly Average	3420	4204	7113	15427

4.3.3.6 Estimated value of NTFPs per Hectare across Forest types:

(i) Using the yearly average value of NTFPs we estimated the total value of NTFPs by multiplying the number of households in the study region so as to get the total value of NTFPs in the study area. (ii)Value of NTFPs per hectare is obtained by dividing the total value of NTFPs by the forest area in the study region. (iii) Total value of NTFPs in Karnataka is obtained by multiplying total area under forests in Karnataka by total value of NTFPs collected locally in Karnataka. Table 4.12 shows the value of NTFPs in Karnataka state as a whole.

Table 4.12: Estimated Value of NTFPs per Hectare Across Forests Types

Type of Forest	Forest Area (Ha)	Total No of HHs	Value of NTFP/HH/Year	Total Value of NTFP	Value of NTFP Collected / Ha
1	2	3	4	5	6
Ever Green	4497	655	3420	2240414	498
SE & MD	18657	1881	4204	7908537	424
Dry Deciduous	405	796	7113	5661553	13979
Tropical Thorny	1257	771	15427	11894075	9462
Average	24816	4103	6752*	27704579	1116

Note: Value of NTFP is in rupees.

* obtained by dividing the total value of NTFPs in the study area by the total households in the study area.

4.3.3.7 Estimates of Value of NTFPs for Karnataka

In order to arrive at the total value of NTFPs for Karnataka, we use the estimates of the value of NTFPs per hectare (from Table 4.12) and multiply the same by the total forest area in Karnataka. As the field survey was conducted in 2004-05, these figures are for this particular year. We need to derive these values for 2002-03, (the latest SDP figures are not available for the state), as we wish to juxtapose these estimates against the SDP of the state for that year. As mentioned in the profile of Karnataka, the state has witnessed an inflation rate of about 5 % per annum in the recent years and we use this inflation rate to deflate the value of NTFPs and arrive at the value of NTFPs for 2002-03. This adjustment yields the value of all NTFPs collected to be equal to Rs 1685.0 crore. The recorded value of NTFPs for the state for 2001-02 is Rs. 33.6 crore. This has to be inflated for 2002-03 by a factor of 5 %. In other words, the estimate of recorded value of NTFPs for the state becomes Rs. 35.3 crore and that of unrecorded NTFPs is Rs 1649.7 crore for the year 2002-03 (Table 4.13).

Table 4.13: Estimates of NTFPs in Karnataka for 2002-03

Forest Types	Value of NTFPs Collected / Ha By HHs in Selected Villages (Rs)*	Total Forest area in Karnataka (Ha)	Total Value of NTFPs in Karnataka (Rs. crore)*	Total Value of Recorded NTFP (Rs. Crore)**	Total Adjusted Value of NTFP in Karnataka (Rs. crore)***	Total Adjusted Value of Recorded NTFPs (Rs. Crore)***	Total Adjusted Value of NTFPs Unrecorded : Rs. crore)***
Evergreen	498.0	435000	21.7	NA	19.6	NA	19.6
Semi-evergreen	424.0	145000	6.1	NA	5.6	NA	5.6
Moist deciduous	424.0	578000	24.5	NA	22.2	NA	22.2
Dry deciduous	13979.0	727000	1016.3	NA	921.8	NA	921.8
Thorn Forests (Scrub)	9462.0	834000	789.1	NA	715.8	NA	715.8
Total	1116.0@	3828400	1857.7	33.6#	1685.0	35.3	1649.7

@ is average and not total
* Value in 2004-05
** Value in 2000-01
***Adujsted value in 2002-03, with assumed inflation rate of 5 % in 2002-03, 2003-04 and 2004-05.
#Recorded value of NTFP for the state for 2001-02 is Rs33.6 crore (Directorate of Economics and Statistics, Bangalore).

The Box 4.1 explains the share of NTFPs in GSDP of Karnataka

Box 4.1: NTFPs (Unrecorded) Share in GSDP of Karnataka

The unrecorded value of NTFPs (Rs 1649.7 crore) is about 47 times that of the recorded value (Rs 35.3 crore) for 2002-03. The SDP originating from forestry and logging in 2002-03 is reported to be Rs 1912 crore. In other words, about 86 % of unrecorded NTFPs (to the reordered value) is escaped from the national income accounting of GSDP originating from forestry and logging sector. **This unrecorded value of NTFPs constituted about 1.45 percent of GSDP of the state at current prices in 2002-03.**

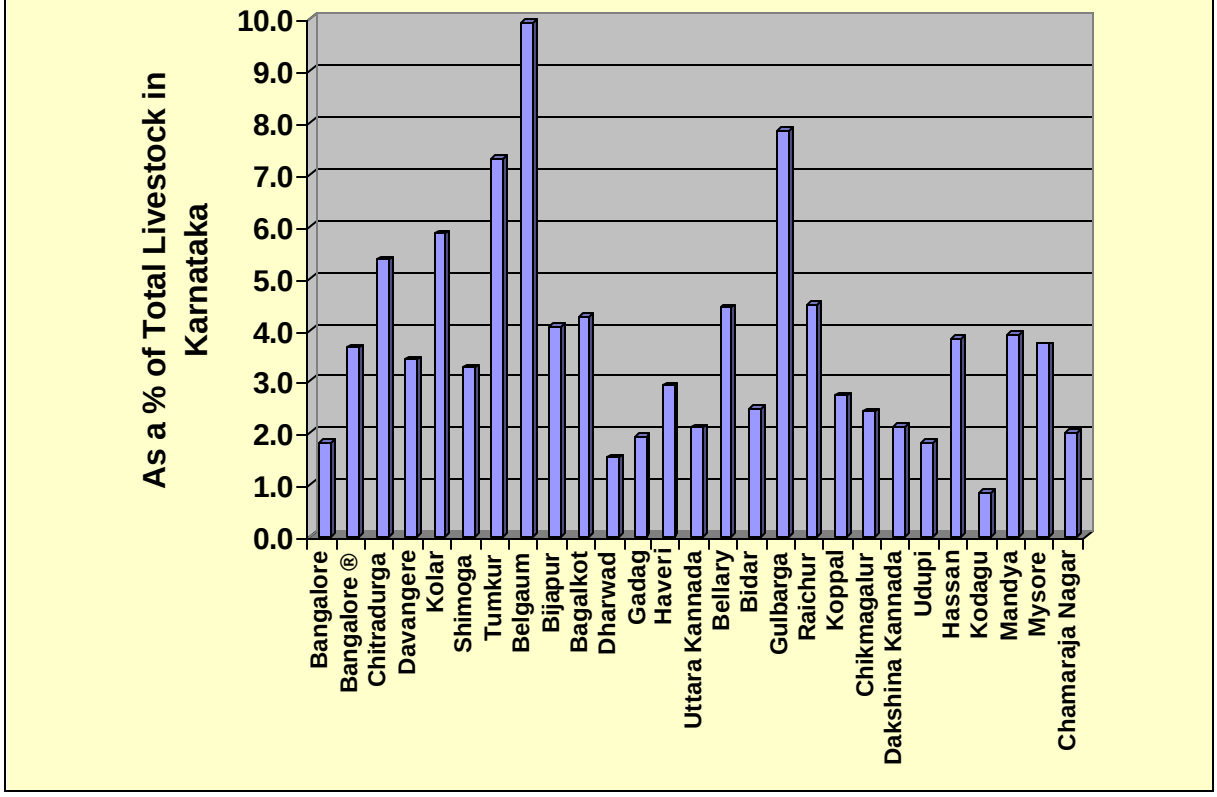
4.4 Case Study on Valuation of Grazing Services of Forests

In Karnataka, forests are an important source of supply of fodder for the livestock. In Karnataka, the fodder needs are met by cutting and collecting it from forests, sending livestock to graze in forest and non-forest areas, stall feeding, collecting fodder from non-forest sources and market purchases. We have already estimated the quantity and value of fodder, which is cut and collected by the local people. In this section, an attempt has been made to value the grazing service of the forests of Karnataka.

4.4.1 Livestock position in Karnataka

The total number of livestock in Karnataka, as per the livestock census in 1997 and 2003 are 30988062 and 28311742, respectively. Thus, there has been a decline in the number of livestock in 2003 as compared with that in 1997. In Figure 4.1, we provide the district-wise distribution of livestock in Karnataka.

Figure 4.1: District-wise Livestock in Karnataka (2003 provisional)



It can be seen from Figure 4.1 that each of the following districts, *viz*., Chitradurga, Kolar, Tumkur, Belgaum and Gulbarga account for more than 5 % of livestock of the state. For the case study on grazing, we have selected five districts (see Map 4.1). Tumkur is the district which is common in both the lists. The fodder requirements depend on the number of livestock as well as their type.

4.4.2 Livestock position in study districts

In Table 4.14, we indicate the type of livestock in the selected districts for the field study. These data have also been presented in Figure 4.2 for obtaining a synoptic view.

Table 4.14: Composition of Livestock in Selected Districts of Karnataka

Livestock Type	As a % of Total Livestock in Karnataka (2003)					
	Tumkur	Uttara Kannada	Chikmag-alur	Dakshina Kannada	Hassan	Selected Districts
Cattle	5.3	3.5	3.8	3.6	5.7	21.9
Buffaloes	5.4	2.7	2.7	0.7	4.9	16.3
Sheep	12.2	0.2	0.9	0.0	2.1	15.4
Goat	7.2	0.3	1.1	0.4	2.2	11.1
Others	4.8	3.9	3.3	7.1	3.3	22.4
Livestock in selected districts	**7.3**	**2.1**	**2.4**	**2.1**	**3.8**	**17.8**
Total Livestock (number)	**9538967**	**3990931**	**7255931**	**4483776**	**3042137**	**28311742**

Source: *Livestock Census* 2003

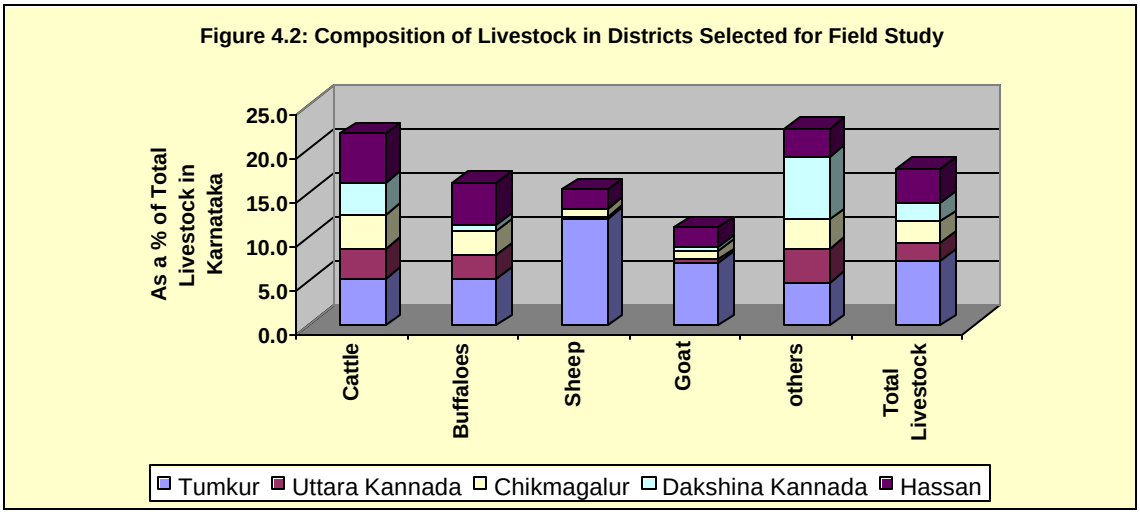


Table 4.14 (Figure 4.2) shows that 18% percent of households own livestock in Karnataka. The fodder requirements of cattle and buffaloes are higher than those of other livestock varieties. It can be seen from Figure 4.2 that the selected districts account for almost 22 % of cattle population and about 16 % of buffalo population.

4.4.3 Livestock position of the sample Households

It is reported that on an average 4.18 tonnes of fodder per year per livestock is required (Govt of Karnataka, 1996). In the selected villages livestock are allowed to graze in the forest

for 5 to 6 hours a day. Households provide rather scanty quantity of fodder to livestock in their houses. Thus, livestock depends more or less entirely on forest for their fodder requirements. For our estimation we have assumed that 75 percent (lower side) of the fodder requirement of the live stock (*i.e.*, 3.14 ton out of total requirement of 4.18 ton) is met from the grazing facilities of the forest.

In Table 4.15, we present the number of household who own livestock in the sample of 500 households. It can be seen that on an average 40 percent of the sample households own livestock. There is also significant variation (ranging from 29 % to 63 %) in the number of households who own livestock across the villages and forest types.

Table 4.15: Sample of HHs Owning Livestock in the Selected Villages

Types of Villages	Total No of HHs in the Sample	HHs owning Livestocks in the Sample	% of HHs owning Livestocks
Evergreen	100	39	39.0
SE & MD	200	68	34.0
Dry Decidious	100	29	29.0
Tropical Thorn	100	63	63.0
Total	**500**	**199**	**39.8**

4.4.4 HHs depend on Livestock for grazing

For feeding their livestock, households adopt different practices. Table 4.16 presents the number of households who depend on forest for grazing their livestock. It shows on an average 45 percent of the livestock owning households fully depend on forest for grazing their livestock. These households do not use other sources of fodder.

Table 4.16: HHs Depending on Forest for Grazing Livestock

Types of Villages	No of HHs Owning Livestocks	No of HHs sending livestock to forest for Grazing	Col (3) as a % of Col (2)
(1)	(2)	(3)	(4)
Evergreen	39	18	46.2
SE & MD	68	26	38.2
Dry Decidious	29	12	41.4
Tropical Thorn	63	33	52.4
Total	**199**	**89**	**44.7**

4.4.5 Estimation of animal units grazing across various seasons

Table 4.17 presents the livestock of the sample households grazing in the forest area during different seasons.

Table 4.17: Number of livestock grazing in forest during various Seasons in the Study area.

RAINY SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	51	69	21	46	187
Buffalo	20	28	7	24	79
Cow	41	76	24	72	213
Calf	14	36	8	33	91
Goat	0	0	10	37	47
Sheep	0	0	625	20	645
Total	**126**	**209**	**695**	**232**	**1262**
WINTER SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	41	27	14	30	112
Buffalo	6	21	6	17	50
Cow	27	53	46	79	205
Calf	10	24	4	11	49
Goat	0	0	10	37	47
Sheep	0	0	625	20	645
Total	**84**	**125**	**705**	**194**	**1108**
SUMMER SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	32	23	10	27	92
Buffalo	6	17	7	16	46
Cow	31	49	44	70	194
Calf	8	24	4	11	47
Goat	0	0	10	36	46
Sheep	0	0	625	20	645
Total	**77**	**113**	**700**	**180**	**1070**

Table 4.18: No of Animal Units* Grazing in Forest during Various Seasons in the Study area

RAINY SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	51	69	21	46	187
Buffalo	20	28	7	24	79
Cow	41	76	24	72	213
Calf	7	18	4	16.5	46
Goat	0	0	2	7.4	9
Sheep	0	0	125	4	129
total animal units	**119**	**191**	**183**	**170**	**663**
WINTER SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	41	27	14	30	112
Buffalo	6	21	6	17	50
Cow	27	53	46	79	205
Calf	5	12	2	5.5	24.5
Goat	0	0	2	7.4	9.4
Sheep	0	0	125	4	129
total animal units	**79**	**113**	**195**	**143**	**530**
SUMMER SEASON					
Livestock Type	EG	SE & MD	DD	TT	Total
Bullocks	32	23	10	27	92
Buffalo	6	17	7	16	46
Cow	31	49	44	70	194
Calf	4	12	2	5.5	23.5
Goat	0	0	2	7.2	9.2
Sheep	0	0	125	4	129
total animal units(TAU)	**73**	**101**	**190**	**130**	**494**

* Note: Conversion of livestock into animal units has been obtained by equating One animal unit = 1 bullock = 1 buffalo = 1 cow = 2 calf = 5 goat = 5 sheep. This conversion rate was borrowed from Jodha N S (1992): Common property resources and rural poor in dry regions of India" in Managing India's planning Vol-II. Edited by S N Chary and Vinod Vysulu. Printwell Publishers. Jaipur, P-366.

In Table 4.19, we have provided information regarding the animal units grazing in the forests of villages of the study area. On the basis of this, we have calculated the grazing intensity.

Table 4.19: Total animal units (TAU) grazing in the forest area

TAU_Season	**EG**	**SE & MD**	**DD**	**TT**	**Total**
TAU_Rainy	119	191	183	170	663
TAU_Winter	79	113	195	143	530
TAU_Summer	73	101	190	130	494
Average	**90**	**135**	**189**	**148**	**562**

4.4.6 Grazing Intensity across various seasons

Table 4.20 provides the information on grazing intensity (Animal Units per HH) in forests of selected villages of the study area.

Table 4.20: Grazing Intensity (Animal Units per HH) in Various Forests of Villages of Study Area

Season	EG	SE & MD	DD	TT	Average
TAU_R	1.19	0.96	1.83	1.70	1.33
TAU_W	0.79	0.57	1.95	1.43	1.06
TAU_S	0.73	0.51	1.90	1.30	0.99
Average	**0.90**	**0.68**	**1.89**	**1.48**	**1.12**

4.4.7 Estimated Share of grazing lands in forests to GSDP in Karnataka

Using the average grazing intensity in different types of forests, we have estimated the animal units grazing in various types of forests of Karnataka. As mentioned earlier, assuming that each animal units consumes about 3.14 tons of fodder per year from the forests, the fodder requirements of animals dependent on forest grazing has been estimated for the state. The average price of fodder in the market is about Rs. 600 per ton (as per local price). Using this information, we estimate the fodder supplied by various forest types in the state to be of the magnitude of about Rs. 635 crore in 2003-04. All these details have been provided in Table 4.21. Assuming an inflation rate of 5 % in 2003-04 and 2004-05, the contribution of grazing services provided by various types of forests of Karnataka amounts to about 0.50 percent of SDP of Karnataka at current prices in 2002-03.

Box 4.2: Estimated share of grazing land in forests to GSDP

The contribution of grazing services provided by various types of forests of Karnataka amounts to about 0.50 percent of GSDP of Karnataka at current prices in 2002-03.

Table 4.21: Estimation of Value of Grazing Services Provided by Various Types of Forests in Karanatka State									
Data and Estimates for Sample Villages						Estimates for Karnataka			
Type of Forest	Forest Area (Ha)	Total No of HHs	Animal units / HH	Total animal units in the village	Animal units/ Ha in selected villages	Forest Area in Karnataka (Ha)	Animal Units in Grazing in Forests of Karnataka	Fodder Requirements in Tons@	Value of Fodder (Rs. Crore)
1	2	3	4	(5) = Col (3) * Col (4)	(6) = Col (5) / Col (4)	7	(8) = (7)* (2)	9	10
Ever Green	4497	655	0.9	590	0.13	435000	57023	179052	10.74
SE & MD	18657	1881	0.68	1279	0.07	723000	49567	155641	9.34
Tropical Thorny	1257	771	1.89	1457	1.16	727000	842782	2646336	158.78
Dry Deciduous	405	796	1.48	1178	2.91	834000	2425972	7617553	457.05
Total	24816	4103	1.12	4595	0.19	2719000	3375344	10598582	635.91
Note: @ = Assumption: Fodder required/ animal unit is 3.14 ton per year									

4.4.8 Limitations

In this case study we have merely considered the contribution of grazing services of forests. However, there is also an adverse impact of grazing on land quality which needs to be incorporated for the completeness of forest accounts. Grazing and browsing by domestic cattle, goat, sheep, *etc*., is a major problem in the forest areas. Uncontrolled grazing in forests by livestock, often beyond the carrying capacity of the land, has adversely affected the regeneration status and regenerative capacity of the forests. Overgrazing also affects soil properties adversely. The adverse effects on soil include formation of small gullies, loss of topsoil, compaction of soil and reduction of porosity. In Karnataka, grazing was controlled/ regulated by Karnataka Forest Act till 1971, after which this regulation was withdrawn and grazing has become uncontrolled.

4.5 Recreation and Tourism Services: A Case Study of the Dandeli Wildlife Sanctuary

Many natural resource systems, such as, lakes, rivers, streams, sanctuaries, estuaries, forests, national parks, wildlife reserves, trekking area and beaches provide a variety of recreational services (both tangible and intangible) to people. However, from economic viewpoint, these services provided by nature have two important dimensions. First, economic value of these services is largely dependent upon a set of quality characteristics inherent in the natural resource systems under consideration. Second, since access to such resources for recreational services are not allocated through proper market mechanism, the capacity to

generate a perpetual stream of income through such ecological services mostly remains undermined. However, precise knowledge of the economic value (price) implicit in the services provided by nature is important at least for two reasons, a) taking appropriate decisions regarding proper management and sustainability of the natural resource system and b) correct valuation 'for individuals' consumption of such non market environmental goods. The travel cost approach is an extension of the conventional household production function (HPF) model, instrumented to derive an indirect mechanism for evaluating individual preferences for and consumption of non-market ecological goods. The method was first suggested by Hotelling in 1947 and subsequently it was developed by, Trice and Wood (1958). Since then this methodology has been widely used in numerous studies for valuing non-market goods. The approach uses cost of traveling to a non-market recreational site as a *proxy/surrogate* price in order to estimate the value (that includes consumers surplus) of recreational services rendered by the site. This method involves on-site survey in which a questionnaire is designed to collect data on visitants place of residence, necessary demographic and attitudinal information, frequency of visit to the site under study and other substitute sites; trip information such as purpose, distance traveled for availing recreational benefit and other associated costs etc. From this data visit costs can be estimated and related with other relevant factors that are most likely to influence the visitation rate. The travel cost method (TCM) is usually used to estimate the cost of travel as a function for generating visits: visit rate is a function of the cost of travel incurred by individuals to the site, travel cost to substitute sites and other socio economic characteristics of the visitors. TCM studies have consistently shown an inverse relationship between access prices (cost of travel) and visit rate to site. Valuing recreational benefit through travel cost method has two variants: 1) the zonal travel cost method (ZTCM) and 2) the individual travel cost method (ITCM). However the ITCM enjoys relatively advantageous position over its counterpart because of its built-in flexibility as follows.

a) ITCM is individual specific where as ZTCM uses zonal aggregate data.
b) Estimations based on individual observations instead of zonal aggregate data are statistically more efficient.
c) Estimation of the visit generating function based on ITCM requires a smaller number of observations than the ZTCM, hence more cost effective.

4.5.1 Theoretical framework:

The individual travel cost function can be deduced from the Household Production Function (HPF) model where it is assumed that consumer's utility depends on the total number of visits *(r)* to a recreational site, the quality characteristics of the site *(q)* and consumption of a composite good *(X)*. The utility function is specified as:

$$U = U(X, r, q) \qquad (4.1)$$

Where U = Utility

X = Quantity of consumption of other (composite) good

r = Number of visits to the recreational site

q = Quality index of the recreational site

The price of composite good is normalized to take value equal to unity. The consumer's income is comprised of two distinct components: an *exogenously given income Y* (income from other than wage earnings) *and a wage* component $p_w.t_w$. It is assumed that the consumer spends his entire income, of which a portion is spent on the consumption of a composite good and the rest for availing recreational service. The consumer's budget constraint is given by:

$$Y+P_w.t_w=X+ C_T.r \qquad (4.2)$$

Where

Y = Exogenous income

P_w=Wage rate

t_w = Hours of work

C_T = Monetary cost involved in a trip

In addition to the above budget constraint, the consumer also faces a time constraint as mentioned in (3).

$$t^* = t_w + (t_1+t_2).r \qquad (4.3)$$

Where

t^* = Total discretionary time at individual's disposal

t_1 = Round trip travel time

t_2 = Total time spent at the site

Substituting the term t_w from (3) in to (2) and rearranging, we obtain a time budget as given below.

$$Y + P_w.t^* = X + r[C_T + P_w (t_1 + t_2)] \qquad (4.4)$$

The equation implies that the individual spends his total income on the composite good and for availing recreation at the site. Here the consumer's expenditure includes the cost of composite commodity and the cost of recreation. The bracketed term associated with *r* is the price of recreation, p_r which includes the *monetary cost of travel to the site the time cost of travel to the site and the cost of time spent at the site, i.e.*, $P_r = C_T + P_w (t_1 + t_2)$. Further the monetary cost of travel has two distinct components: the *admission fee (f)* to the recreation site and the *monetary cost* incurred for adopting a particular type of conveyance mode $(p_d.d)$, Where P_d is the per kilometer cost of travel and *d* is the distance traveled.

Thus the constrained utility maximization problem of the consumer can be represented as,

$$Max: U (X, r , q^*) \qquad (4.5)$$

$$s.t.\ Y + P_w.\ t^* = \quad X + r\ [f + P_d.\ d + P_w\ (t_1 + t_2)] \qquad (4.6)$$

The environmental quality parameter *q* appearing in the consumer's Utility function is assumed to be constant (at q*). Which means the consumer operates in a given environmental quality.

The Lagrangian function associated with the constrained Utility maximization problem is given by:

$$L=U(X, r ,q^*)+ l\ \ [Y+p_w.t^* - \{X+r[f+p_d.d+p_w(t_1+t_2)]\}] \qquad (4.7)$$

The first order necessary conditions of the utility maximization problem are:

$$\partial U/\partial X = l \qquad (4.8)$$

$$\partial U/\partial r = l \ [f + p_d.d + p_w(t_1 + t_2)] \qquad (4.9)$$

$$Y + p_w.t^* = X + r\ [f + p_d.d + p_w\,(t_1 + t_2)] \qquad (4.10)$$

Where,

l = Marginal utility of money income.

The systems equation (4.8) is suggestive of consumer's rational behavior with respect to the arguments in his utility function. This equation implies that the consumer continues to purchase the composite commodity *X* up to a point where her marginal utility from consumption equals to the marginal utility of money income times the price of *X* (Unity). Similarly equation 4.9 is indicative of consumer's decision regarding the number of visits to the recreational site that maximizes his utility function. The utility maximizing consumer chooses the number of visits to a recreation site at the point where marginal utility of the visit equals the full price *(Pr)* of recreational times the marginal utility of money income. Equation 4.10 equates the consumer's income to his expenditure. Now solution to the above set of equations provides the consumer's demand function for recreation. The demand function for the number of visits can be represented as:

$$r = (p_r, Y, q^*) \qquad (4.11)$$

$$\text{Where } P_r = f + P_d.d + P_w\,(t_1 + t_2) \qquad (4.12)$$

4.5.2 Econometric Model for estimation of demand function for environmental service

Before going for an econometric estimation of recreational demand, the first step involves identifying the relevant explanatory variables (factors) and then specifying a functional relationship between visitation rates (number of visits) and the selected explanatory factors. However, the economic theory does not suggest any particular functional form for TCMs. The most commonly used functional forms are: *Linear; Log-linear; Double-log; and, Negative exponential.* Assuming a linear demand relationship between individuals' number of visits to the site and factors, such as travel cost, time spent in traveling, income of the

household, visitor's highest level of education (in number of years), family size, age, sex, residence, site quality and employment status, the travel cost model may be specified as follows:

$r_i = b_o + b_1$ *travel cost* $+ b_2$ *household income* $+ b_3$ *age of visitor* $+ b_4$ *visitor's highest level of education* $+ b_5$ *household size* $+ b_6 D_1$ *(gender dummy)* $+ b_7 D_2$ (residence dummy) $+ b_8 D_3$ (park quality dummy) $+ e_I$ *(4.13)*

However, in our analysis we have specified the demand function as:

$r_i = f(TCi, INCi, AGEi, EDNi)$ *(4.14)*

Where r_i = the number of visits made by the individual 'i', to the park per time period.

TC = round trip total cost from an individual's residence to and from the site.

INC = monthly income

AGE = Age

EDN = Education

Estimation of the b coefficients using the ordinary least squares (OLS) technique would provide important insights about how individuals' decision regarding the number of visits (per period) to the site is influenced by a vector of explanatory variables. Table 4.22 summarizes the variables and postulated hypotheses.

Table 4.22: Variables Used, Notations and Hypotheses to be Tested

Variables		***Notation***	***Expected signs of the b coefficients***	***Hypotheses***
Explained	*No. of Visits*	*VIS*		
	Log of VIS	*LV*		
Explanatory	Travel cost	TC	-	The number of visits to a recreational site is inversely related to travel cost.
	Household income	INC	+	Number of visit to a site is positively related Household income.
	Age	AGE	-	Number of visit is negatively related to the age of the individual.
	Years of education	EDN	+	Number of visit is positively related to the level educational attainment of the individual.

4.5.3 Methodology:

The procedure for carrying out a study with the ITCM is given as follows:

a) ***Identification of the site:*** A clear description of the site to be surveyed is essential for interviewees and interviewers to know what they are asked to value.

b) ***Definition of the environmental good/services to be valued:*** In order to avoid any ambiguity, the goods or services to be valued should be clearly defined. The services or goods to be valued could be exhaustive in nature or may cover select ones. Here an attempt has been made to value only the recreational services provided by the national park.

c) Identification of the type of visits

i. *Visitors, declaring a visit of less than one day:* visitors belonging to this category are considered as if they have devoted the whole day for the visit. For these visitors the travel cost and time have been totally allocated to the visit.

ii. *Visitors who declared that they were spending the whole day for the visit:* Here also the trip time and cost were fully attributed to the visit.

iii. *Visitors planned to spend more than one day at the site:* For visitors falling under this category, the cost of travel and time have been divided by the number of days spent at the site.

iv. *Visitors who had a one-day return trip with multiple destinations:* Here the travel cost and time had been attributed proportionally to the time devoted to the visit.

v. *Visitors declared to spend more than one day in the site and planning to visit multiple sites:* Here also travel costs and time costs were allocated proportionately to the share of the total time spent in the site.

d) Types of visitors

Types of visitors could be classified as follows.

1. *Individual visitors:* visitors coming alone to the place for recreation.
2. *Individuals coming with family members.*
3. *Individuals coming in a group.*

e) Questionnaire design

The questionnaire basically aims at collecting information on the consumer's behaviour towards the recreational service. The information collected has been subdivided into compulsory and non- compulsory information. Compulsory information includes the origin of the visitors, the mode of conveyance to reach the site and other related information, which facilitates estimation of the cost of travel. The non-compulsory information includes individual socioeconomic features such as income, age, profession, number of family members and education, etc. Also few questions were included to investigate the level of environmental concern and awareness of the visitors. Finally, the information collected through administering the questionnaire has been used to derive the demand curve for the Dandeli Park.

f) Sample selection

There are many ways to determine the sample of respondents. However the visitors should be selected in such a way that each of them has the same probability of being selected. A random sample of visitors during the peak season is deemed to be adequate, as it can be

representative of the total number of visits undertaken in an year. The sample size plays a crucial role for reliable estimation of the economic value of the service provided by the national park during a year. A total of 300 sample visitors were collected from the proposed site. To determine the sample size of visitors, visitors' statistics from previous years has been used.

g) Estimation of individual consumer's surplus

Once the functional form of the demand equation for the service under consideration is specified, individual consumer surplus can be calculated by integrating the area of the demand function between the travel cost and the choke price. Choke price is the price at which individuals demand for recreation would become zero. In case of a linear demand curve the consumer surplus for an individual making *r* visits (per period) to the site is estimated using the formula as follows:

$$CS_i = -r_i^2/2\,b \qquad (4.15)$$

for $i = 1,2,3,. . . . . .,n$

Where 'i;' stands for individuals and 'n' the number of observations in the sample.

Similarly for log linear demand the consumers' surplus is estimated as

$$CS_i = -r_i/2\,b \qquad (4.16)$$

for $i = 1,2,3,. . . . . .,n$

In the ITCM method consumer's surplus is calculated for each sample observation and a summary measure of the sample consumer surplus can be obtained taking the sample mean of the consumer surplus. However several mean consumer surplus can be estimated for individuals falling under different socio-economic and demographic groups.

h) Estimation of the average consumer surplus per visit and average total willingness to pay (WTP) per visit.

The average consumer surplus per visit is calculated by dividing the total consumer surplus per individual by the annual sample average number of visits. The total average WTP is calculated by summing up the average consumer surplus per visit and the average travel cost per visit. Once the consumers average willingness to pay is calculated, it can be used for

estimating the total value of recreational services provided by the site. The total value that individuals put on a site for availing recreation during one time period (usually over a period of time) is estimated by multiplying the individual WTP with the total number of visitors to the site.

4.5.4. Results of Econometric Method Used for Estimation:

4.5.4.1 Individual demand for recreation: In this study, the multiple regression analysis has been used to test the hypotheses specified in Table 4.23. In Table 4.25, we present the results of the linear model, wherein, the number of visits are specified as the function of all explanatory variables. In Table 4.24 and Table 4.26, the empirical estimates of the log-linear model are presented.

Table 4.23: No. of Visits (VIS) as a Function of TC, INC, AGE and EDN (Linear Model)

Model Summary				
Linear	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.387	0.150	0.138	8.974
Arguments: (Constant), EDN, AGE, TC, INC				

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients	t-statistics	Level of Significance
Linear		B	Std. Error	Beta		
	(Constant)	15.700	3.604		4.356	0.000
	TC	-0.006	0.001	-0.357	-6.351	0.000
	INC	0.0001	0.000	0.053	0.877	0.381
	AGE	-0.117	0.059	-0.111	-1.977	0.049
	EDN	-0.066	0.243	-0.016	-0.271	0.787
Dependent Variable: VIS						

Table 4.24: Log of No. of Visits (LV) as a Function of TC, INC, AGE and EDN (Linear Model)

Model Summary				
Log linear	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.522	0.273	0.262	0.925
Arguments: (Constant), EDN, AGE, TC, INC				

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients	t-statistics	Level of Significance
		B	Std. Error	Beta		
Log linear	(Constant)	2.488	0.371		6.699	0.000
	TC	-0.001	0.000	-0.481	-9.260	0.000
	INC	0.00002	0.000	0.127	2.285	0.023
	AGE	-0.018	0.006	-0.152	-2.943	0.004
	EDN	-0.004	0.025	-0.010	-0.172	0.863
Dependent Variable: LV						

Table 4.25: Linear demand curve for No. of Visits (VIS)

Model Summary				
Linear	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.360	0.130	0.127	9.471
	Predictors: (Constant), TC			

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients	t-statistics	Level of Significance
Linear		B	Std. Error	Beta		
	(Constant)	11.539	0.707		16.312	0.000
	TC	-0.006	0.0009	-0.360	-6.678	0.000
	Dependent Variable: VIS					

Table 4.26: Log-Linear Linear demand curve for No. of Visits (LV)

Model Summary				
Log-linear	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.481	0.231	0.229	0.956
	Arguments: (Constant), TC			

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients	t-statistics	Level of Significance
Log-linear L		B	Std. Error	Beta		
	(Constant)	2.001	0.071		28.023	0.000
	TC	-0.001	0.0001	-0.481	-9.488	0.000
	Dependent Variable: LV					

Using both linear and log-linear functional forms, the β coefficients for the explanatory variables have been estimated. In this study we have incorporated four explanatory variables that are frequently identified as robust explanations of individual visit rates for availing recreational opportunities. Those are travel costs to the site, monthly income, age and education (in number of years). As expected, it was found that travel costs incurred by individuals are inversely related to the visitation rates. The estimated beta coefficient for the travel cost also seemed to be highly significant. Thus, it may be inferred that higher travel cost and higher age of the potential visitor reduces the demand for recreation. The coefficient of income exhibits a positive sign indicating direct relationship between income and demand for recreation. These are also the relationships expected *a priori.* However the coefficient of education turns out to be insignificant, which is a welcome sign that people irrespective of their educational attainments enjoy the beauty of the nature.

4.5.4.2 Recreational Value and Consumers surplus

The sample average travel expenses incurred by individuals to reach the site was estimated to be Rs. 480.2 /-per visit. The sample average consumer's surplus per visit corresponding to log-linear and linear demand curve were estimated to be Rs.500/- and Rs.1711/- respectively. However based on the R^2 value the log-linear model was found to be more appropriate for the dataset as against the linear one. Using the per visit sample average consumer surplus and travel cost, the average willingness to pay was estimated as follows.

Table 4.27: Valuation of Recreational Services of Dandeli Park

Model	Average TC/Visit/person (Rs)	Average CS/Visit/person (Rs)	Average WTP/Visit/person (Rs)
Log linear	480.2	500	980.2
Linear	480.2	1711.06	2191.2

During the data collection period in Dandeli wildlife sanctuary, visitors' statistics were collected from different sources (govt and private guesthouses, lodges and hotels etc.) and an approximate estimate of 18,000 visitors from all over Karnataka and outside pay visit to the sanctuary for recreational purpose every year. Table 4.28 provides the estimated consumers

surplus and recreational value (from the log-linear demand curve) of the Dandeli wild life sanctuary for the study year.

Table 4.28: Consumers' Surplus and Recreational Value of Dandeli Park

Total (In Rupees)	Consumers surplus (Rs)	Recreational value (Rs)
	90,00,000	1,76,43,600

The money value that individuals put to avail recreation during the study period was estimated to the tune of Rs 1,76,43,600. This is the recreational value of the park in 2004-05, assuming that about 1800 visitors visited the park. The total consumer surplus was estimated to be Rs. 90,00,000. This shows the estimated value of benefits that visitors gain by paying visit to the Park. The surplus is also suggestive of the value that individuals are willing to pay to enjoy the environmental resources.

With the growth of eco-tourism and increasing concern among different national and international agencies, NGOs and governments for conservation and preservation of natural resources, non-market valuation techniques are needed to estimate the economic benefits of environmental resources like wild life sanctuaries, national parks, *etc.* Keeping in view a substantial amount of latent consumer's surplus and recreational value (that individuals put on them) we may justify the need for raising resources through entry fees to access and avail recreational utility from such environmental endowments, which would not only contribute to the national economy but also raise resources for the long debated issue of sustainable management of natural resources. The total use value (in an accounting year) estimated from our study is just a case study which may be replicated for other wild life sanctuaries in the state of Karnataka. The estimates so derived could then be incorporated in the national income accounting system.

4.5.5 Estimated share of recreational value of forests in GSDP

The estimated value of recreational value in GSDP is provided in the following Box.

Box 4.3: Recreational value as % to GSDP

Based on the travel cost method and by using the primary data we got the recreational value of forests in the study area as Rs 37142.86 per Sq km and for the state as whole it is estimated to be Rs 21.12 crores which constitutes 0.02 % of GSDP at current prices for 2002-03. This can be said to be the uppermost limit, as not all forests can be converted into wild-life sanctuaries or parks.

4.6 Case Study on Carbon Sequestration in Forests of Karnataka

Global carbon is held in a variety of different stocks. Natural stocks include the most important carbon stock, *i.e.*, the atmosphere and the terrestrial system besides fossil fuel deposits and oceans.

4.6.1 Sources of carbon

Atmosphere: In atmosphere carbon is present as carbon dioxide gas (CO_2). The dominant component of the Green House Gas (GHG) is carbon dioxide and it occupies 0.03% of the atmospheric volume. The concentration of atmospheric CO_2 alone has increased by 25% since the pre-industrial era. (IPCC, 1992).

Terrestrial system: In terrestrial system carbon is sequestered in rocks and sediments, in swamps, wetlands and forests, in the soils of forests, agricultural lands and grasslands. The amount of carbon stored in any stock may be large even if there are the changes in that stock, fluxes are small or even zero. An old forest whose growth is slowed down or experiencing little net growth would have this property. On the other hand, the young and fast growing forests the stocks may be small but the fluxes may be significant. The potential for agricultural crops and grasses to act as a source and sink and sequester carbon appears to be limited due to their short life and limited biomass accumulation.

4.6.2 Carbon flow in different systems

A sink is defined as a process or an activity that removes the greenhouse gases from the atmosphere. A stock that is taking –up carbon is called a ‘sink’ and one that is releasing

carbon is called a 'source'. Shifts or flows of carbon over time from one stock to another, for example, from the atmosphere to the forest, are viewed as carbon "fluxes". In different activities carbon is transferred from one stock to other over the time. For example: Fossil fuel burning, shifts carbon from fossil fuel deposits to the atmospheric stock. Physical processes also gradually convert some atmospheric carbon into the ocean stock. Plants fix atmospheric carbon in cell tissues as they grow, thereby, transforming carbon from the atmosphere to the biotic system.

4.6.3 Carbon sequestration

Carbon sequestration refers to the provision of long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere reduces or slow down. Terrestrially, carbon is stored in vegetation and in the soil. Plants store carbon for as long as they live, in terms of live biomass. Once they die, the biomass becomes a part of the food chain and eventually enters the soil as soil carbon. If the biomass is incinerated or burnt, the carbon is re-emitted into the atmosphere and is free to move in the carbon cycle.

Carbon sequestration can also mean removing carbon in the form of carbon dioxide from the atmosphere and storing in it terrestrial, oceanic or freshwater aquatic ecosystems, which are known as sinks. Sequestration technologies can capture carbon at its source (*e.g.*, power plants, industrial processes) and direct it to non-atmospheric sinks (*e.g.*, depleted oil and gas reservoirs, unmineable coal seams, deep saline formations, deep ocean, *etc.*), as well as processes that increase the removal of carbon from the atmosphere by natural processes (*e.g.*, forestation).

4.6.4 Role of forests in carbon sequestration

The role of forests in carbon sequestration is the most important. Forests have greatest potential as a sink to promote net carbon sequestration. Forest biomass accumulates carbon over decades and centuries. The carbon accumulation potential in forests is large enough that forests offer the possibility of sequestering significant amount of additional carbon in relatively short periods. Growing trees act as sinks and absorb large amounts of carbon dioxide, storing or "sequestering" vast amounts of carbon in the trees. Among the many

benefits that forests provide, there is growing appreciation of their role as major repositories of carbon. The biomass of trees and vegetation in forests harbours vast reserves of carbon that help to keep in balance the carbon cycle on which life on Earth depends. If forests managed for carbon sequestration are allowed to mature and remain unharvested, one of the long-term effects may be enhanced biodiversity.

As plants and trees grow they absorb carbon dioxide and the process of photosynthesis splits the gas into carbon and oxygen. The carbon is then used to build cell walls and allow the plant to grow. Many of these carbon dioxide-derived products, particularly lignin and cellulose, are present in large quantities within the woody tissues of trees and shrubs. Hence, as long as these plants are alive and growing, they actively remove carbon from the air around them. The net effect is to remove carbon from the atmosphere. Trees absorb large amounts of carbon dioxide as they are growing and hold the carbon, even if they are cut down. Only if the trees decay or the wood burns, the carbon is returned to the atmosphere. So growing trees is an excellent way of sequestering carbon, as well as contribution towards improvement of the environment. Old growth forests have limited potential for absorbing additional atmosphere carbon. When ecosystem climax level is reached, old growth forests in effect become neutral, acting primarily as a fixed carbon sink rather than net sequesters. The impacts of climate change are likely to affect the fluxes of carbon and water to and from the atmosphere.

4.6.5 Soil as a Carbon Sink

In the carbon cycle soil also constitutes one part, where the carbon transports from the atmosphere through photosynthesis into the biosphere and then it reaches the soil. In soil carbon can have a longer or shorter pause before it continues in the cycle. Soil microbes carry out the decomposition of the plant residue, changing them into organic matter. The organic matter offers many benefits to the soil including the retention of the carbon from the atmosphere. The decomposition process not only leaves carbon in the soil, it also gives back nutrients to the soil captured by the plants by their roots. The amount of organic carbon held in the soil is the difference between how much is added to the soil as crop residue, manure, sewage and sludge and how much is lost through respiration, mineralisation or erosion. Soil is a passive carbon sink depending on the outside factors, not as the biosphere, which has an

unlimited access to the carbon in the atmosphere. The carbon sequestration in the soil can be improved by the crop rotation in the land, using natural fertilizer like green manure and controlling erosion. Carbon sequestration is not only a channelization of CO_2 from the atmosphere; it also benefits agriculture.

4.6.6 Carbon Budgets and Carbon Sequestration Potential of Indian Forests

There have been global level assessments of dimate change on major biomes, but these are of limited use for policy makers for translating into adaptation strategies at the national or regional levels. Realizing the need for assessing the impact of projected climate change at regional and national levels, a few studies along these lines have been initiated (Watson, et al, 1998). Even in India, preliminary studies carried out in Western Ghats in the south and Himachal Pradesh in the north, showed the potential significant impacts of projected climate change on forest ecosystems.

In India, estimates of biomass using direct measurements are not available for all forest types in the country. According to Haripriya (2000), the biomass density/ha in Indian forests is around 92t/ha and the biomass data are converted to carbon values by assigning a carbon content of 0.5 Mg C per Mg oven dry biomass. While computing the total volumes of carbon "lost" (or harvested) one should include: (a) carbon transferred to forest products (in the form of biomass); (b) releases of carbon from forest biomass into the atmosphere while clear cutting or partial cutting; and, (c) releases to soil pool. A study by Haripriya (2003) has assumed that when logging is done by clear cutting only 80% of the stem biomass is transferred to wood products, 10% remains on the stump and 5% is transferred to the soils. The amount of carbon remaining on the stem or transferred to the soils gives the amounts of logging damage. By comparing effects for characteristic forest types in India, it is feasible to assess the large-scale consequences of climate change on forest resources, for carbon sequestration, on long term carbon balance of the forest and for the feedback resulting from vegetation-atmosphere interactions. Table 4.29 and Table 4.30 depict the carbon sequestration and financial potential in different regions of India.

Table 4.29: Carbon sequestration potential

Carbon Sequestration Potential				
Sl.No	**Location And Region**	**A & R Activity**	**Annual C Sequestration Potential / Year**	**Total t c / Yr.**
1	Kaluasar, WB	Sal regenerating	2.7	240
2	Kharikamathani, WB	Sal regenerating	1.1	62
3	Uthanayagram, WB	Sal regenerating	2.0	1605
4	Kapasgaria, WB	Sal regenerating	1.8	44
5	Bhagawatichowk, WB	Sal regenerating	1.7	90
6	Kunbar, Gujarat	Regenerating teak	0.9	170
7	Rampur, Gujarat	Regenerating teak	1.0	119
8	Ganda, Gujarat	Regenerating teak	0.8	83
9	BadaBhilwada, Rajsthan	Deciduous	2.0	1200
10	Allali, Karnataka	Evergreen	2.0	147
11	Hunasur, Karnataka	Evergreen	3.8	453
12	Kutling, Orissa	Regenerating Sal	1.4	357
13	Kugwe, Karnataka	Evergreen	3.0	580
14	Halakar, Karnataka	Evergreen	1.7	34
15	Nabra, Orissa	Regenerating Sal	1.1	54
16	Gadabanikilo, Orissa	Regenerating Sal	2.6	158
17	Asundariya, Gujarat	Regenerating teak	2.1	374
18	Baluji Na Muvada, Gujarat	Deciduous	4.9	595
19	Dabbar, J & K.	Pine	1.3	65
20	Johnu, J & K.	Pie	1.0	10
21	Ritti, J & K.	Pine	0.8	16

Source: P. Sudha, CES, Bangalore

Table 4.30: Financial Potential of carbo n Sequestration

Sl.No	Location & Region	Total t c / Year	Financial value (rupees)	Financial value (Rs/ HH/Yr)
1	Kaluagar, WB	240	119925	1845
2	KhariKamathani, WB	62	31065	485
3	Uthannayagram, WB	1605	802620	16052
4	Kapasgaria, WB	44	22062	368
5	Bhagawatichock, WB	90	44785	1066
6	Kunbar, Gujarat	170	85070	516
7	Rampur, Gujarat	119	59700	1085
8	Garda, Gujarat	83	14500	96
9	BadaBhilwada, Rajsthan	1200	599760	4224
10	Allali, Karnataka	147	73548	645
11	Hunasur, Karnataka	453	226500	1606
12	Kugwe, Karnataka	580	290030	1585
13	Halakar, Karnataka	34	16900	147
14	Kutling, Orissa	357	178560	484
15	Nabra, Orissa	54	27420	57
16	Gadabanikilo, Orissa	158	78750	551
17	Asundariya, Gujarat	374	187005	1281
18	Baluji Na Muvada, Gujarat	595	297375	2124
19	Dabbar, J & K	65	32250	2150
20	Johnu, J & K	10	5176	83
21	Ritti, J & K	16	8200	55

Source: P. Sudha, CES, Bangalore

The forest degradation and loss in India is largely due to extraction to meet demands and not due to conversion of forests to agriculture, as area under crops has stabilised over the past two decades (Ravindranath and Hall, 1995). According to the recent land use-land cover statistics for India generated by remote sensing techniques, the area under non-forest degraded lands is 93.68 m ha and 35.89 m ha is under forest degraded lands. The standing biomass (as above and below ground biomass) in India is estimated to be 8,375 million tones for the year 1986, of which the carbon storage would be 4,178 million tones (Rabindranath et al.1997). The total carbon stored in forests, including soil is estimated to be 9578 m t. Carbon emission

from fossil based energy production and consumption activities in India have been estimated at 152-205 m t[2] per year, which shows a wide variation estimated by different scientists and ecologists. The total carbon emanating from the agricultural activities including the fuel burning ranges from 43 m t to as high as 115 m t per year. Carbon flow is expressed in the form of carbon uptake and carbon emissions. Carbon flow in the Indian forest as estimated by ADB (1998) is presented in the table below. It is evident from the table that carbon emissions from the forest and land use change are nearly offset by carbon uptake in forests and plantation.

Indian forests are under immense pressure and there may be a net loss of forest wood in future. From a long-term sustainable development perspective, India needs to enhance afforestation and reduce pressure on forests. To increase the area of forests, India has targeted wastelands and marginal lands for reforestation. Apart from sustainable harvesting, plantation forestry seems to be an alternative to meet the future needs of biomass. As our existing forests are inadequate to meet the future demands of biomass and land availability for plantation forestry is not a constraint in the immediate future, the establishment of forests outside the current forest area is inevitable. India has nearly 5 million of degraded lands. According to a study by Chopra and Kumar (2002), at least 39 m ha the degraded lands mentioned above are clearly feasible for carbon sequestration. Of these, about 6 m ha of pastureland can be brought under community forestry and about 9 m ha of cultivable wasteland under short timber plantation, 6 m ha of miscellaneous tree crops and other than current fallow lands can be for long timber plantations, 12 m ha for partially degraded areas for natural regeneration and 6 m ha of fully degraded forests for enhanced regeneration. Such a mix of forestry options with land capability can enhance the sequestration potential by 78 million tones of additional carbon per year by the year 2020. The additional supply of woody biomass will help to sequester an additional 78 to 147 m t of carbon as against 150- 200 m t of carbon emission from the fossil fuel energy sector (Warran and Patwardhan, www.ranwa.org). Table 4.31 depicts the carbon flow in Indian forests.

[2] m t indicates million tones and m ha indicates million hectares.

Table 4.31: Carbon flow in the Indian forests

Carbon flux	Sub-component	Carbon (thousand tonnes)
Changes in biomass per year	Carbon uptake increment	43033
	Carbon release (consumption from biomass)	41350
	Net carbon emission	183
Annual carbon emissions	off-site emission	4155
	On-site emission	0
	Decay of above ground biomass	0
	Soil	10132
	Total release	14287
Carbon uptake in abandoned land	Carbon uptake in abandoned land (10 years)	2750
	Carbon uptake by soil	9449
	Carbon uptake by above ground biomass on	0
	Carbon uptake I soils (>20 years)	0
	Total carbon uptake in abandoned land	12199
Total carbon emissions		**405**

Source: *Asian Development Bank (ADB), 1998*

4.6.7 Carbon Stock Scenario in the Green belt of Karnataka

Carbon stock dynamics has been calculated in the different districts of Karnataka by different researchers. Bhat et al (2003) on the carbon stock dynamics of Uttara Kannada district shows that there is an enhancement in the carbon stock during the study period of ten years with an average growth of 1.008t/ha/year. There are also observations that the minor forests, which are subjected to intense human pressure, had a negative growth rate, *i.e.*, 0.237 t/ha/year, while the reserve forests have a carbon assimilation rate of 1.31 t/ha/year. This indicates that human pressure has certainly decreased the carbon accumulation in the minor forests of Uttara Kannada.

In Uttara Kannada among different forest categories and management regimes, the highest carbon stocks are found in Reserve Forests (RFs) in hilly region or upghats of the district followed by the RFs in the coastal area. When the district as a whole is considered, it is observed that the forests are fixing carbon at the rate of 1.008 t/ha/year. Thus, an average of 633346.6 tonnes of carbon is assimilated every year from the forests of Uttara Kannada (Table given below, taken from Bhat *et al*, 2003).

Table 4.32
Estimated carbon stock (t/ha) and carbon dynamics (t/ha/yr) in different forestland use types and in the Uttar kannada district of the Western Ghats

Estimated carbon stock (t/ha) and carbon dynamics (t/ha/yr) in different forestland use types and in the Uttar kannada district of the Western Ghats are given below. Averages for each forest type are the weighted average using the mean of that area from the sample plots and the area of the forest type in that region. (Note that according the Karnataka Forest Department records, 505920 ha of land is RF and 122 400 ha is MF in the Uttar Kannada district. In the coastal zone, 266176 ha is designated as RF and 71 187 ha is MF. Similarly, 239744 ha is RF and 51213 ha is MF in the upghat or hilly zone of the district)

Forest site and land use category	Estimated carbon stock		Change in carbon stock	carbon stock during 1994 including recruits	Net change in carbon stock (%)	Annual loss/gain of carbon (%)
	1984	1994				
Average of MFs of hilly (upghat) area	97.22	97.95	0.69	101.18	3.96 (4.07)	0.396
Average of RFs of hilly (upghat) area	121.56	119.98	-1.58	121.75	-0.19 (-0.15)	-0.019
Average of hilly (upghat) area	101.51	101.79	0.286	104.8	3.297 (3.24)	0.3297
Average of MFs of coastal area	73.35	65.88	-7.43	66.38	-6.93 (-9.45)	-0.692
Average of RFs of coastal area	111.84	132.67	20.83	133.75	21.91 (19.59)	2.191
Average for coastal area	81.44	79.97	-1.47	80.6	-0.84 (-1.032)	-0.084
Average of MFs of the Uttara Kannada district	83.32	79.28	-4.04	80.95	-2.37 (-2.84)	-0.237
Average of RFs of the Uttara Kannada district	106.94	118.04	11.09	120.04	13.09 (12.23)	1.31
Uttara kannada district average	102.34	110.49	8.14	112.42	10.08 (9.84)	1.008

RF: Reserve Forest MF: Minor Forest
Source: Bhat et. al. 2003

For conversion of volume of the growing stocks of forests into the units of carbon, biomass estimation is required. In India estimates of biomass using direct measurement are not available for all forest types in the country. Haripriya (2000) used the volume inventory data to estimate the carbon content of the biomass. According to the study the biomass data are converted to carbon values by assigning a carbon content of 0.5mg C Mg oven dry biomass. Using these estimates we have calculated the carbon content of forests of four study areas of different districts of Karnataka taking the total standing biomass of forests of each study area into consideration.

Table 4.33: Different study areas of Karnataka with biomass and carbon stock estimation

Sl. No	Study areas	Study areas belonging to different districts of Karnataka	Total Standing Biomass of study area in tonnes/hectare (t/ha)	Total Carbon stock 'C' in tonnes/hectare (t/ha)
1	Agumbe	Shimoga	423.318	211.659
2	Bannadpare	Kodagu	434.003	217.0015
3	Kagneri	Hassan	450.188	225.019
4	South Bhadra	Chikmagalur	607.769	303.8845
		AVERAGE	**478.819**	**239.659**

Source: Rai (2000)

The Table 4.33 shows four study areas of Karnataka with the total standing biomass were calculated by Rai (2000). The total carbon stock in tonnes per hectare was calculated after multiplying the biomass of the areas with 0.5 mg of carbon per mg oven dry biomass taken from Haripriya (2000).

Tropical forests, as large stocks of carbon in the form of biomass, release more CO_2 into the atmosphere when disturbed (Palm, et al., 2002). The higher productivity of tropical forests has made them carbon sinks, which assimilate higher amounts of carbon dioxide (CO_2) than being emitted globally. Due to terrestrial forest destruction, the carbon sink is diminishing, as is the biomass extracted from these forests, adding to the carbon pool in the atmosphere. According to Lugo and Brown (1992), higher values of biomass/carbon stock are associated with less human or natural disturbance, or better sites. Human disturbed forests will have lower biomass. Wang, et al. (2001) reported a negative correlation between carbon densities and population density in the forests of China. So the best option for reducing the increase of CO_2 in the atmosphere is to opt for plantations and forest improvements, which have the potential to replace the burning of fossil fuels and sequester bulk carbon in the form of biomass.

4.6.8 Estimated Share of Carbon Sequestration Value in GSDP

We calculated the carbon content of forests of Karnataka using following method. We have assumed that the forests in Karnataka have biomass density of 92t/HA (Haripriya 2000). Per Ha biomass density (i.e. 92t) has been multiplied by total forest area (i.e., 382830 Ha) to

get total biomass in forests of Karnataka. The estimated biomass of forests of Karnataka is 352215560 tonnes. The biomass data are converted to carbon values by assigning a carbon content of 0.5mg C Mg over dry biomass (i.e. 352215560 tonnes X 0.5mg = 176107780 t). We have valued carbon at the rate of US$20/metric tonne of carbon (Haripriya 2000). The value of dollar was around Rs. 47.33 during the year 2002-03. The estimated value of carbon content in the forests of Karnataka is Rs. 16659.79 crores. This constitutes 14.6 % of GSDP at current prices in 2002-03 (Box 4.4).

Box 4.4: Estimated Share of Carbon Sequestration Value in GSDP

We calculated the carbon content of forests of Karnataka using secondary data. . The estimated value of carbon content in the forests of Karnataka is Rs. 16659.79 crores. This constitutes 14.6 % of GSDP at current prices in 2002-03. **It needs to be kept in mind that this is a stock concept and not a flow concept. Only the flows can be used in the national income accounting, and the stocks can find their place in natural resource**

4.7 Case Studies on Fuel Wood Used by Local Industries

The case study of fuel wood was undertaken since fuel wood can be directly valued based on the market price and consumption for various small-scale units. However, the prices arrived at for the fuel wood may not necessarily represent the true value of the soft wood used as fuel wood for household and small industry purposes as the market for fuel wood is regulated by the State Forest Department and the Karnataka Forest Development Corporation. This case study was conducted in the second phase of the study.

4.7.1 The Study Area: A brief Profile

The region was purposively selected to be the Uttar Kannada district of the state as about 76 percent of the total geographical area of the district is under forests. As mentioned earlier, Uttar Kannada is the most natural resource rich district of Karnataka. The district has five types of forests. These are: 1) evergreen (EG); 2) semi-evergreen (SE); 3) moist-deciduous (MD); 4) scrub and thorny forests; and, 5) unwooded forests. The evergreen forests are found in places where the rainfall is more than 225 cm and form a narrow strip along the Western Ghats. The semi-evergreen forest are found in places where the rainfall is from 150 cm to 250 cm, the evergreen and semi-evergreens are the home of the soft woods utilized for plywood, matchwood and packing timber and raw material for electric transmission lines. The moist deciduous forests are situated in the rainfall areas of 100 cms and more. These types of forests are rich in timber trees, e.g., Rosewood, teakwood and *hone, matti, nandi, etc.*, which grow naturally. These forests are important for timber and firewood production. In the areas where the rainfall is below 90 cms the dry deciduous forests are found. The scrub and thorny forests are found in places where the rainfall is below 60 cm and the soil types that are found in these are trap soil, mixed red and black soil. In these forests, sandal and other minor forest produce species, firewood and timber species are grown. Unfortunately, these forests are subject to heavy pressure from firewood extraction, grazing and fauna.

It was observed that the household consumption of the fuel wood is in relatively smaller quantities. Hence the case study was limited to the small scale units using fuel wood for various purposes. On the basis of information provided by the Divisional office of the Conservator of Forests, Department of Forest, Sirsi, due to the prevalence of the small scale units utilizing fuel wood for commercial purposes in Sirsi, Honnavar, and Bhatkal; these taluks were selected for detailed survey.

These taluks have also rich sources of timber, match wood and plywood, and bamboo, besides that in supply of fuel wood. The hard and soft species of wood of commercial importance are collected and sold in public auctions through the government timber depots, besides supplies of tree to the railways, defence, ship-building industries, housing and private users. In addition, timber and poles are being supplied for the construction of houses.

4.7.2 The Sample

The sample of 32 local firms using fuel wood for various purposes was included in this case study and these producers were interviewed during July 2005. These local producers were spread across 14 villages. Amongst the local producers in the village using the fuel wood for a particular purpose, the producers were selected randomly for detailed interviews. Interviews were conducted through pre-tested questionnaires. The village level information for Haldipur, Sirali and Industrial Estates was collected based on the village level questionnaire for valuation of fuel wood. The questionnaires designed for fuel wood valuation at both village level and local producer level are presented in Appendix II.

4.7.3 Observations

Based on the data collected from the local producers only one producer was reported to be collecting fuel wood from the forest, whereas, 19 producers were buying fuel wood either from the State Forest Department Depots and 7 producers purchased fuel wood from the market. Out of the 32 local producers, 5 producers had stopped using fuel wood for commercial purposes and had shifted to other sources of energy. Three were bakery units using electricity for commercial purposes and two were using LPG for processing fruits products and other cooking needs for commercial purposes. The selected local producers use fuel wood for making products like bakery products, betelnut boiling, making tyres and resale of tyres, baking earthen tiles (used for roofing), preparation of coconut flakes and powder, dry-cleaning of clothes, iron rod making, pickle making, soap and detergent making, groundnut roasting, and heating water (in lodge) and cooking in hotels. Table 4.34 gives the general profile of the fuel wood using local producers surveyed.

Table 4.34 : General profile of fuel wood using local producers

SL. No.	Particulars	Description	Frequency
1.	No. of local producers surveyed		32
2.	No. of villages		14
3.	No. of produce types		14
4	Types of ownership		
		Individual	25
		Partnership	6
		Co-operative	1
5.	No. of employees in production units		
		Males (maximum)	176
		Males (minimum)	2
		Females (maximum)	75
		Females (minimum)	1

Source: Field Survey, 2005

These units consume fuel wood in varying quantities depending upon their scale. The units require about 500 gms of fuel wood to about 50 quintals of fuel wood per day. The price of obtaining fuel wood also varied from Rs. 50 to Rs. 300 per kg; however, this also depends upon the type of fuel wood. Therefore, the value of fuel wood consumed by the sample units ranged from as low as Rs. 480 per annum to as high as Rs. 25,00,000 per annum. The number of persons employed in these units ranged from 1 to 176 and there is a wide difference between male and female employment.

Fuel wood consumption pattern and prices as reported by sample local producers are presented in Table 4.35.

Besides buying the fuel wood, 3 producers also reported their subsidiary source of fuel as agricultural by-product, mainly paddy husk. Another form of energy for running these commercial units was electricity. Power is used for purpose of lighting and also running the machinery.

Table 4.35 : Fuel wood consumption and prices

S. No.	Particulars	Description	Frequency
1.	Source of fuel wood		
		Forest	1
		Government depot	19
		Market	7
2.	Fuel wood quantity per day		
		Maximum (quintals)	50
		Minimum (quintals)	6
3.	Fuel wood Price		
		Maximum (Rs./ quintal)	50
		Minimum (Rs./quintal)	300
4.	Fuel wood value		
		Maximum (Rs.)	480
		Minimum (Rs.)	2500000
		Total value (Rs)	4902428

Source: Field Survey, 2005

Removal of firewood from the forest is one of the most important factors responsible for degradation of the forests. The dependence of the people on biomass to meet their energy demand is closely associated with their poverty. Population increase, inefficient chullas (stoves) and lack of alternative clean energy sources have also accentuated the problem further. Trees are lopped by the community for firewood and for green manure. The problem of firewood removal from the forest is more severe in the forested districts like Shimoga, Uttar Kannada, Dakshina Kannada, etc. due to low availability of agricultural wastes.

A study regarding household consumption of fuel wood for domestic purpose conducted by the Directorate of Economics and Statistics (2002) indicates that nearly 80 percent of the households still depend on fuel wood based energy indicating the severity of the problem. The per capita consumption of fuel wood in the State was estimated in 1987 to be 1.5 kg/day. Based on this data the annual demand for fuel wood in the State may be estimated to be around 28 million tons in 2001. Another study by (Ranganath, 1993 in SOER, 2004) revealed that the total demand for firewood in the state was 19.4 million tons, out of which 18 million tons was the domestic demand. On reviewing the consumption pattern it was observed

that the major portion of the demand in rural areas (94 percent) is met by gathering twigs, lops and tops of the tree and only 6 percent of the consumption is in the form of logs and billets. The total supply from government and private land has been estimated as 0.284 million tons. Thus the bulk of the demand is met through informal collections from the forest area as well as from crop residues and some shrubs like *Prosopis juliflora.* It is estimated that out of 20 million tons of fuel wood consumed in the State, the fuel wood from forest is around 5 million tones per year. This figure is also corroborated by a study conducted by Ravindranath and Hall (1995). Thus, informal removal from forests puts a tremendous pressure on the forests resources leading to gradual degradation.

Fuel wood sold through government depots is marketed at administered price decided by the state forest corporation and does not necessarily depict the true market value of the produce let alone its environmental value. Moreover, the fuel wood used for commercial purposes is of different types and hence, difficulties of aggregation become quite insurmountable.

We have not attempted valuation of fuelwood consumption by local producer in this study, for the sheer fact of avoiding double counting. The sale of fuel wood by government depots is already accounted for in the national income accounts and we have also included the case study on consumption of fuelwood for household purposes.

4.8 Case Study on Medicinal Plants

4.8.1 Study Area

District of Uttar Kannada is selected for this case study, as it is endowed with rich biodiversity of both flora and fauna. The district has many tourist places in dense forests with wide ranging herbs and shrubs used for medicinal purposes. With the increased demand for various species of medicinal plants, several nurseries of the State Forest Department have been brought under the cultivation of *Vinca rosea*, *Rauwolfia cauescens* and *Discoria floribunda*. Nearly 16 species of medicinal value have been introduced in Dandeli Nursery to study the growth data and behaviour pattern, for further trials. Besides state government efforts in

conservation of biodiversity and cultivation of commercially useful medicinal plants, non-government organizations have also sponsored projects in conservation of germplasm of rare, economically and medicinally important plant species in the state (accessed on November 11, 2005; http://www.baif.com/Bird_K.htm).

The evergreen and semi-evergreen dense forests of Uttar Kannada are rich in herbs and other plant species which are of much significance in alternative forms of medicine like ayurveda. However, the harvesting of medicinal plant species from the forests is not allowed under the government rules. Hence, the medicinal plant nurseries are cultivated at large scale in southern parts of the district. These cultivated plants and their parts are processed for medicinal and cosmetic use in processing units in Bangalore and Kodagu districts. The forest department also cultivates some medicinal plants and sells the produce. On the other hand, villagers who are skilled in identifying the medicinal plants harvest them from time to time and process and sell it either locally or in other towns.

To estimate the value of medicinal plants due to existence of natural biodiversity of the forest, a case study of medicinal plants was conducted. Sirsi taluka has been selected for the study as the taluka is an important holder of medicinal plants in the state. Based on the information from the ayurveda doctors in the Sirsi town villages were surveyed in Sirsi taluk of Uttar Kannada District. Before selecting the villages for detailed sample household survey a few nurseries under the State Forest Department and private nurseries cultivating medicinal plants in the district were visited and key information was collected.

4.8.2 Sample Profile

In Sirsi taluk four villages were selected for detailed survey. A sample of 30 households was interviewed in four villages, viz., Hunasehalli, Niranalli, Saunda and Vasegadde in Sirsi taluk of Uttar Kannada. The sample households were of three types: (i) those who had qualified ayurvedic doctors; (ii) who were not formally trained but collected, cultivated and sold medicinal plants as a commercial avenue; and, (iii) those who (only a few) were cultivating and collecting medicinal plants only for household consumption. The village level information for two villages, viz., Hunasehalli and Saunda was collected based on the

village level questionnaire. A questionnaire addressing the specific issues relevant to medicinal plants was designed to undertake household survey. The household and village level schedules are presented in Appendix II. The approach towards use and existence of medicinal plants, awareness regarding conservation of medicinal plants and willingness to pay for conservation of medicinal plants are the specific issues enquired at the household level. The general profile of the households surveyed for valuation of medicinal plants is presented in Table 4.36.

Table 4.36: General profile of households surveyed for Medicinal plants

Sl. No.	Particulars	Description	Frequency
1.	Number of sample households		30
2.	No. of villages		4
3.	No. of taluks		1
4.	Annual income of the household		
		Minimum (Rs.)	2000
		Maximum (Rs.)	80000
		Average (Rs.)	19000

Source: Field Survey, 2005

4.8.3 Observations

The medicinal plants used for different ailments are of different types like herbs, shrubs, and trees. In the case of different medicinal plants, different parts are used like, seeds, fruits, stem, leaves, tree bark, root, etc. These plant parts are accordingly processed locally, e.g., dried and powdered, and sold to specific private companies or doctors or directly in the market. Based on the different kinds of ailment treated by the medicinal plants, their prices ranged from Rs. 10 per kg to Rs. 100 per kg. However, many of these plants, when processed through high technology usage fetch much higher prices. The commonly found medicinal plants in Uttar Kannada are *halberu, tulsi, hatti,* pepper, *yalakki, chee tulasi, halaberu,* ginger. The usage of medicinal plants for different kinds of ailments, information regarding existence of markets for medicinal plants is summarized in Table 4.37. Most of the households reported that the medicinal plants are used for ailments, such as, common colds and mild fevers. This is based on the knowledge of the local people. However; a few ayurvedic doctors interviewed were of the opinion that the medicinal plants are now used at large scale by people who reside outside the village. There is an Ayurvedic College in the district. The medicinal plants

cultivated in the district are used for various ailments including the severe ailments like cancer, diabetes, etc.

Table 4.37 Approach to Medicinal plants

S. No.	Particulars	Description	Frequency
1.	Treatment mode		
		Local herbs	16
		Primary health centre	6
		Community health centre	
		Government hospital	6
		Private hospital	1
2.	Form of treatment		
		Allopathic	1
		Ayurvedic (medicinal plant)	26
		Local herbs	1
3.	Ailments treated with medicinal plants		
		Stomach ailments	1
		Common cold	17
		Mild fevers	6
		Bone injuries	1
		Other ailments	5
4.	Availability of medicinal plants decreasing		
		Yes	28
		No	2
5.	Reason stated		
		Increased usage	13
		Commercialization	11
		Non-conservation	5
6.	Markets for medicinal plants		
		Yes	10
		No	20
7.	Market price of medicinal plants		
		Maximum (Rs./kg)	110
		Minimum (Rs./kg)	10
8.	Accessibility to medicinal plants		
		<2 kms	19
		2-4 kms	6
		>4 kms	3
9.	Frequency of collecting plants in a year		
		1	5
		2	2
		3	6
		4	1
		5	3
10.	To whom plants are sold		
		Villagers	22
		Outsiders	1

Source: Field Survey, 2005

When asked about the conservation of medicinal plants, all the households were aware of the need for conservation. Their willingness to pay for conservation was as high as 28 out of 30 households interviewed. Households were also willing to contribute labour for conservation of medicinal plants. However, the amounts of financial and labour contribution which the households were willing to pay were of extremely low amounts. The descriptive statistics of the willingness to pay for the conservation of medicinal plants is summarized in Table 4.38. The villagers who expressed their willingness to pay for the conservation of medicinal plants ranged from Rs. 5 to Rs. 100. Also different villagers were willing to pay to different kinds of institutions, e.g., village panchayat or any other village organization.

Table 4.38: Willingness to pay for conservation of medicinal plants

S. No.	Particulars	Description	Frequency (No. of HHs)
1.	Awareness about conservation	Yes	30
2.	Willingness to pay	Yes	28
		No	2
3.	Willingness to contribute labour	Yes	23
		No	7

Source: Field Survey, 2005

4.8.4. Share of medicinal plants in GSDP

On the basis of the average willingness to pay of Rs 23.48 per Ha collected from the households for the preservation of medicinal plants we estimated the total willingness to pay for the state for the preservation of medicinal plants. The share of medicinal plants in GSDP for the year was estimated to be 0.01 percent for the year 2002-03.

Box 4.5: Unrecorded share of medicinal plant in GSDP

The share of medicinal plants in GSDP for the year was estimated to be 0.01 percent for the year 2002-03.

4.8.5 Limitations

Most of the respondents reported that proper markets for medicinal plants did not exist and medicinal plants were locally processed at household levels and sold. In other words, market for such plants was rather thin. The estimation done in this study provides merely a direction for more elaborate estimates for future studies.

4.9 Case Study on Valuation of Sacred Groves

Traditionally many tree species have been treated sacred all over India. The most commonly conserved tree specie by the village communities due to religious/cultural purposes has been *Ficus benghalensis* (Vat Vriksha). Uttar Kannada district has many tree species treated as sacred groves or *devarakadu*. Tree like *Dipterocarpus indicus* are mainly confined to just a couple of sacred groves of Katlekan in Siddapur taluk and Karikan in Honavar taluk. The natural occurrence of *Vateria indica*, another Dipterocarp, is exclusive to just a single grove in Mattigar in Siddapur. (Chandran and Gadgil, 2005).

4.9.1 The Study Area

In Siddapur taluk of Uttar Kannada sacred groves are found in clusters of villages. The sacred groves found in this taluk are also called *kans* or *devarakadu*. These groves are generally a group of plant species which include a few woody trees surrounded by many shrubs, herbs, climbers and creepers. Siddapur taluk has hilly terrain and has scanty forest growth except in the eastern and south-eastern parts of taluk where there are sandalwood forests. The western part of the taluk has semi-evergreen forests. There are many large patches of the evergreen forests called *Kans* (the sacred groves) in this taluk mostly confined to the west. These contain valuable matchwood; however extraction is not possible due to communication to these areas and also due to religious reasons.

4.9.2 The Sample Profile

The sacred groves are not recorded in the State Forest Department since they are sparsely located in the villages. These villages too exist in clusters in the taluks of Uttar Kannada. Based on the literature and through visits to individual villages for the purpose of this study two villages were selected from Siddapur taluk of Uttar Kannada district. These

two villages are Hittalgoppa and Kavanchur. Detailed households survey of 30 households was undertaken in July 2005 in these two villages. The village and household questionnaire designed for the study are presented in Appendix II. A general profile of the households surveyed is summarized in Table 4.39.

Table 4.39: Sample Coverage surveyed for Sacred Groves

Sl. No	Particulars	Frequency
1.	No. of sample households	30
2.	No. of villages	2
3.	No. of taluks	1
4.	Sacred Groves in the village	7

Source: Field Survey, 2005

4.9.3 Observations

As most the sacred groves do not come under dense or open forests, the information about groves is not available in the district forest official records. The groves are found on the open village lands or even private agricultural fields. Due to their sparse distribution even in each village the area under groves is less. The groves do not fetch any produce which can be used for direct consumption or for any commercial purpose. The area of a *devarakadu* in the villages ranges from 0.025 acres to as high as 8 acres. The sacred groves include tree species with root systems that can hold soil during the rainy season.

In most of the villages the sacred groves have small temples. The grove deity is worshipped once or twice a year. The villagers are generally aware of any ecological benefits of the existence of these groves; nevertheless, there are no community restrictions for ecological reasons but only religious restrictions on felling of sacred groves. In seven out of thirty cases, the villages the community has punished the person or a group for felling of sacred groves. Most of the villagers were believer of sacred groves. Moreover, the sacred groves consist of plant species which, if sold in market, would fetch prices equivalent to any fuel wood species and some woody species. Only one sample household reported the likely price of felling a sacred grove. The maximum price that could be fetched in hypothecated market for wood from the sacred grove would be Rs. 600 per quintal and for a non-woody

species it could be as low as Rs. 40 per quintal. The household level summary statistics pertaining to sacred groves is presented in Table 4.40.

Table 4.40: Attitudes Regarding Sacred Groves

Sl. No	Particulars	Description	Frequency
1.	Believer in sacred groves		
		Strong believer	27
		Believe but not strongly	3
		Non believer	0
2.	Temple near the sacred grove		
		Yes	24
		No	6
3.	People assemble for religious function relating to sacred grove		
		Yes	30
		No	0
4.	Distance of sacred grove		
		<2 kms	25
		2-4 kms	5
		>4 kms	0
5.	Distribution of sacred groves		
		Many places in village	24
		Specific location	6
6.	Ownership of sacred groves		
		Community	30
		Individual	0
		Government	0
7.	Area under sacred groves		
		Maximum (acres)	8
		Minimum (acres)	0.25
8.	Terrain where sacred groves are located		
		Slopes	1
		Plains	29
9.	Groundwater condition near sacred grove		
		Good	15
		Medium	12
		Poor	3
10.	Canopy of the sacred groves		
		Dense	5
		Medium	25
11.	Species		
		Woody	25
		Mixed	5

Source: Field Survey, July 2005

The forest department district office has formed a 'village forest committee' and these committees are responsible for conservation of these groves. Some funds that have been raised through local fares and contributions from the state government as grant, have been

given to the village forest committees for the fencing of the area under sacred groves. The villagers expressed their awareness regarding conservation of sacred groves for biodiversity; however, they were of the opinion that the groves are generally conserved only for religious purposes. Out of the 30 households surveyed only 18 expressed their willingness to pay for conservation of sacred groves. Table 4.41 summarizes the willingness for conservation of sacred groves as expressed by the sample respondents.

Table 4.41: Willingness for conservation of sacred groves

Sl. No.		Description	Frequency
1.	Does market exist for sacred groves		
		Yes	0
		No	30
2.	Price of felling a similar species		
		Maximum (Rs./ quintal)	600
		Minimum (Rs./quintal)	40
3.	Sacred groves need to be conserved for biodiversity		
		Yes	29
		No	1
4.	Restraints imposed by village on cutting the sacred groves		
		Yes	21
		No	9
5.	Punitive action taken		
		Yes	7
		No	23
6.	Willing to pay for conservation		
		Yes	18
		No	12
7.	Willing to contribute labour		
		Yes	18
		No	12

Source: Field Survey, 2005

4.9.4 Estimated share of Sacred groves in GSDP

We estimated the average willingness to pay to preserve the sacred groves on the basis of the information collected from the households, which was of the order of Rs 5547.5 and the total area under sacred groves was 0.762 Ha. To get the total willingness to pay for Karnataka to preserve the sacred groves, we multiplied the willingness to pay per ha by the total sacred

groves area and arrived at the value of Rs 1.85 crore for the year 2004-05. After adjusting the value for the year 2002-03 we estimated the share of sacred groves in GSDP may be 0.001 per cent. Since sacred groves are not available for commercial purposes, use of market price method would have been inappropriate and hence, the contingent valuation method had to be applied for estimation of value of sacred groves.

4.9.5. Limitation

The small size of the sample for estimating the value of sacred groves is the important shortcomings of the present study. But it may not affect the result significantly as the sacred groves also very rarely exist at present.

Box 4.6: Estimated share of Sacred groves in GSDP

We estimated the share of sacred groves in GSDP as 0.001 per cent for the year 2002-03 on the basis of the willingness to pay by the households.

4.10 Case Study on Watershed Benefits

The terrain of Uttar Kannada district is such that it makes steep slopes and with rocky base. The watersheds naturally drain through gullies into the seasonal and perennial rivers. However, some areas in Sirsi taluk of the district have topography which benefits from construction of check dams and other watershed components. A check dam is generally constructed on small streams and long gullies formed by the erosive activity of water. Ideally, a check dam is located in a narrow stream with high banks. A check dam serves many purposes: (i) It cuts off the runoff velocity and reduces erosive activity; (ii) the water stored improves soil moisture of the adjoining areas; and, (iii) allows percolation to recharge the aquifers. In some watershed bunds also help in conservation of water. Bunds are small earthen barriers provided in agricultural lands with slopes ranging from 1 to 6 percent. They control the effective length of slope and thereby, reduce the gain in velocity of runoff flow to avoid gully formations. Bunds are constructed with the following objectives: (i) to increase the time of concentration of rainwater where it falls and thereby allowing rainwater to percolate into the soil; (ii) converting a long slope into several ones as to minimize velocity and thereby reducing the erosion by runoff water; and, (iii) to divert runoff either for water harvesting

purposes (Accessed on October 08, 2005 http://www.rainwaterharvesting.org/Rural /Contemporary _more.htm#chec) . The forests serve the purpose of watershed by preventing surface water run-off and increasing groundwater aquifer recharge. Hence, the watershed benefits were studied.

4.10.1 The Study Area

For the valuation the watershed benefits of the forest the case study of watershed villages in Uttar Kannada district was undertaken. The main geographical feature of the district is that of Western Ghats or Sahyadhri range, which runs from north to south through the district. Between the Sahyadhris and the sea is a narrow coastal strip. Behind the coastal plain are flat-topped hills from 60 to 100 meters in height, and behind the hills are the ridges and peaks of the Sahyadhris. A moisture-bearing wind come from the west and yearly rainfall averages 3000 mm on the coast, and as high as 5000 mm on the west-facing slopes of the Sahyadhris. East of the crest is the rain shadow of the Sahyadhris, which receive as little as 1000 mm annually. Much of the rain falls in the June-September monsoon.

The groundwater in the district accumulates under the water table in the weathered mantle and gets jointed and fissured in bed rocks (Karnataka State Gazetteer: Uttar Kannada, 1989). The average annual rainfall in the district is 2741.7 of this rain water and little extent through seepage from the streams, tanks, reservoirs and water applied for irrigation. It is discharged artificially by abstraction of water from dug wells. The fluctuation of water table varies in the district from 3 to 12 m for hard rock area and alluvium, the specific yield varies from 2 to 3 per cent.

4.10.2 The Sample Profile

On the basis of information from the Water Resources Division office and Watershed Development office in Sirsi taluk three villages were identified for conducting detailed study of watershed benefits in Uttar Kannada. A sample household survey of 32 households was undertaken based on random selection of households who are stakeholders in the respective watershed. The households were selected and interviewed from 3 villages, namely, Kadabal, Nirnahalli and Salakani. Village level information for Nirnahalli and Salakani villages was

sought from the key informants. The village and household level schedules for survey are presented in Appendix II.

4.10.3 Observations

Most of the respondent households were landowners and they cultivated land. Since the direct benefits of watershed are assessed through the increase in cropping intensity of cultivable land and through expansion of area under cultivation of agricultural crops and pastures, hence, farming households were selected. The general profile of sample households is summarized in Table 4.42. In some parts of Uttar Kannada due to hilly terrain, and also due to high rainfall during shorter spells of time the rainwater runoff causes soil erosion leaving the soil with shallow depth and low water holding capacity. In the watershed villages the stakeholders are aware of the benefits of watershed development and also benefits of existence of forests in their role of soil erosion prevention.

Table 4.42: General Profile of the households surveyed in Watershed villages

S. No.	Particulars	Description	Frequency
1.	Number of sample households		32
2.	No. of villages		3
3.	No. of taluks		1
4.	Land holding		
		Yes	28
		No	4
5.	Size of holding		
		1 Acre	11
		2 acres	7
		3 acres	7
		4 acres	1
		6 acres	1
		7 acres	1
6.	Irrigated land (partially or completely)		
		Yes	27
		No	1
7.	Source of irrigation		
		Canal	1
		Watershed stream	9
		Open well	3
		Tube well	1
		Others	1

Source: Field Survey, 2005

The households surveyed expressed their willingness to pay for conservation and development of watershed. Out of 32 respondents 27 were of the opinion that area under

watershed was declining since the forests were being cut for timber felling. The responses about willingness to pay by sample households have been presented in Table 4.43.

4.10.4. Share of Watershed in GSDP of Karnataka

We estimated the willingness to pay by the households for the watersheds and the total value of willingness to pay for the preservation of watershed was Rs 48.03 crore for the year 2004-05. The adjusted value for the year 2002-03 was Rs 43.23 crore. The share of watersheds in the GSDP was 0.04 per cent in the year 2002-03.

Box 4.7: Share of Watershed in GSDP of Karnataka

We estimated the share of watersheds in the GSDP as 0.04 per cent in the year 2002-03 on the basis of willingness to pay by the households for preservation of watershed.

Table 4.43: Willingness to pay for development of watershed

Sl. No.	Particulars	Description	Frequency
1.	Distance from watershed		
		<2 kms	2
		2-4 kms	3
		>4 kms	
2.	Awareness of watershed benefits		
		Yes	32
3.	Is the area under watershed declining		
		Yes	32
		No	
4.	Reasons		
		Extension of agricultural land	2
		Felling of forests for timber	27
		Others	3
5.	Willing to pay for conservation/development of watershed		
		Yes	30
		No	2
6.	Willing to contribute labour		
		Yes	25
		No	7
7.	Willing to contribute material		
		Yes	21
		No	10

Source: *Field Survey, 2005*

4.11 Summary

In this chapter, 8 case studies have been conducted. These are demonstrative in nature rather than conclusive. Accounting for forests in India still requires tremendous data support both of primary and secondary in nature. Though value of timber marketed is incorporated in the national accounts/state accounts, it is necessary to maintain the physical accounts, as well. An inventory of timber resources at the annual frequency is desired which will also detail the varieties and volumes. Only then, more meaningful valuation methodologies can be applied for timber resources than what is being currently resorted to. As regards NTFPs, the official agencies need to prepare inventory of such resources and market valuation of recurring NTFPs, such as fuelwood, fruits, lac, gums, resins, etc., can be undertaken using market prices. The valuation seems fraction of what it ought to be, as is indicated in this study. As regards grazing services, we have merely estimated the benefits provided by forests for grazing animals. A subtraction is warranted for degradation of soil erosion caused due to grazing of animals. Only then such accounts will be complete. Here, we see an interesting spillover from forest to land accounts. As regards medicinal plants also, markets are discovering the value of such resources and this is visible in various cases of patenting of products based on traditional knowledge pertaining medicinal plants. In the years to come, the markets for medicinal plants are expected to widen and thicken and hence, the use of market prices may suffice for such valuation. As regards sacred groves valuation, it is rather difficult and application of market based methodologies (even though it might be in the nature of stated preference) may not be appropriate. Traditionally, in India, natural resources have been deemed sacred and worshipped. However, for financial benefits, there are cases of violation of traditions, as also found in our case study. More or less the entire sample community agreed for preservation of groves. The question of willingness to pay either in financial or in terms of labour seemed irrelevant to the respondents. In brief, the methodologies for valuation cannot be applied irrespective of the cultural contexts. Again the watershed benefits are difficult to value, though not as much as the sacred groves. The reason being that watershed benefits also translate in terms of financial gains to the community. However, keeping in view these limitations we have made an attempt to valuate the benefits of forest resources based on the willingness to pay elicited from the primary survey and also used market price method for valuation of NTFPs.

Chapter - 5

LAND SECTOR (EXCLUDING MINING)

5.1 Introduction

As indicated earlier, land has been historically considered as a non-produced asset and the stock of land is considered to be given in physical terms (barring land reclaimed from sea). Though this may be true, *the value of land* can change with change in its usage pattern. Though the physical quantity of land is datum, the change in quality of land is important both from environmental and socio-economic angles. Land degradation and sub-optimal use of land resources impinges on the potential generation of income in future and hence, is of concern from the point of view of sustainable development. Land degradation is becoming a major constraint on future growth and development, especially in developing countries. The real costs of land degradation are increasingly felt. The impact is not only widespread it is also reaching irreversible levels in economies like India. Moreover, the replacement costs (due to soil reclamation and land degradation) are mounting and proper accounting of the losses due to land degradation would make a dent in the national income, which is being ignored currently (Reddy, 2003).

Land degradation takes a variety of forms. Water-related soil erosion is one such form of land degradation. Soil erosion takes place mainly due to floods, surface run off and due to excess or inappropriate use of water resulting in salinity and alkalinity of soil. Industrial pollution also causes land degradation, if industrial effluents are littered on surface or allowed to be discharged in subsurface water bodies. The use of polluted water results in severe damage to crop lands with significant decline in yield rates of crops. The economic impacts are substantial even though the area affected by this problem may be low. Wind erosion is another major problem which creates land degradation. Most of these problems, except perhaps wind erosion, are man-made and in the long run reduce the potential income generation from the use of land resources.

Land degradation is akin to depreciation in the stock of land. Perpetuation of this depreciation along with the fact that such depreciation completely escapes national income accounting is tantamount to overestimation of national income and ignoring the decline in the generation of income stream from land resources. This in turn leads to erroneous land management policy decisions. One of the very obvious impacts of these policy decisions is in terms of the threat to the livelihoods of the poor, especially rural poor.

The present chapter is organised as follows; we first highlight the extent of land degradation in India in an inter-country perspective in section 5.2. This is done with a view to highlight the need for such data at sub-national level for India. Ultimately, the purpose of including land resources for national income accounting is to formulate policies for sustainable use of land in future. The data format provided in this section is likely to be useful from the point of view of emulation at the state level in India. In section 5.3 we discuss the accounting framework for land resource (land-use and land cover) as discussed in SEEA 2003. Section 5.4 details the land-use and land cover classification adhered to in India. Section 5.5 analyses the land use pattern in Karnataka. The change in land use through the physical flow accounts of land of the state is presented in section 5.6. In section 5.7 the activities/ sectors that are relevant for land use changes in Karnataka are presented. Section 5.8 details the impact of environmental and socio-economic impact of land degradation and also provides an overview of land resources in PASIR framework for Karnataka. In section 5.9, we present the soil degradation status of Karnataka and using the restoration cost approach, we provide the estimates of expenditure that is needed to restore the soil quality in the State. The valuation of land adjusting to SDP using the replacement cost method is presented in this section. Section 5.10 provides a summary of the chapter. Lastly, tables containing the data on relevant variables for sustainable land use are appended to the chapter.

5.2 Land Degradation in India

The main causes of land degradation specified by the Food and Agricultural Organization (FAO) and used for data classification are: agriculture (A); overgrazing (O); deforestation (D); industrialization (I); and, over exploitation of vegetation (V). The types of land degradation are categories as follows: water erosion (W) wind erosion (N); chemical

deterioration (C); and, physical deterioration (D). In Table A5.1 to Table A5.3, we have highlighted the land degradation problem in India in a perspective of Asian and Pacific countries.

5.2.1 Land degradation caused by human activity:

It can be seen from Table A5.1 that for Asia and Pacific region, about 28 % of the land is not degraded whilst in India the corresponding figure is 37 %. However, this should not be construed as a laudable factor, since we need to complement this information with the severity of land degradation. In India, only 5 % of land is either light or moderately degraded. The corresponding figure for the Asia and Pacific region is as high as 44 %. India has about 59 % of its land which is severely or very severely degraded. For the Asia and Pacific region economy the corresponding figure is just about 29 %. In other words, the intensity of land degradation problem caused by human activity is rather high in India.

5.2.2 Land degradation caused by agricultural activity

The main causes of land degradation in India are said to be deforestation and agricultural activities and the main types of degradation are that of water erosion and chemical degradation. In Table A5.2, we see that in Asia-Pacific countries, about 12 % of degraded land is due to agricultural activity, whereas, in India the corresponding figure is about 8 %. Moreover, in India, agricultural activities account only for 14 % of degraded land, whereas, in other economies the respective figures are much higher.

5.2.3 Land degradation severity and population density:

In Table A5.3, we provide data on land degradation severity and population distribution. It can be seen from this Table that in India, population density is higher in areas where land is either not degraded or lightly degraded. In severely and very severely degraded land area, population density is much lower. In other words, this is a pointer to the fact that if land degradation becomes severe, it becomes difficult for population to sustain itself in this kind of land, especially if the population is dependent on land based activities, such as agriculture, forestry, mining, *etc.*

5.2.4. Impact of land degradation

A summary of the studies related to the impact of land degradation (mainly for India) is presented in Table 5.1.

Table 5.1: Impact of Land Degradation

Sl. No	Study	Region /country	Type of Degradation	Impact	Main Findings
1	D Narayan and Rambabu (1983)*	All-India	Water erosion	16.35 t/ha/year Gross erosion: 5.3 billion tonnes/year Net erosion: 1.572 million tonnes/year	
2	Singh et al (1990)*	All-India	Water erosion	Loss of soil: 4,978 million tonnes/year loss of nutrients: 0.76 per cent	Loss of nutrients range from 0.23 per cent in slight erosion to 3.64 per cent in very heavy erosion
3	Bansil (1996)*	All-India average	Soil erosion (mainly water)	13.5 million tonnes	Ranging from 0.06 million tonnes of bartey to 8.4 million tonnes of sugarcane
4	FAO (1993)*	All-India average	Soil erosion (mainly water)	7.3 million tonnes per year	Ranging from 0.03 million tonnes of barley to 4.31 million tonnes of sugarcane
5	Pagiola (1995)	Bangladesh	Soil erosion (mainly water)	Between 1979-82 and 1991-94 productivity of paddy has fallen by 39 per cent	The decline is more in the case of local varieties
6	Pagiola (1994 and 1996)	Kenya	Soil erosion (mainly water)	Due to the topsoil losses yield rates are going down by 22 kg/ha in case of maize and 15-18 kg/ha in case of beans. An estimated decline of 20 per cent in 10 years	
7	Joshi et al (1996)	Maharashtra	Soil degradation	Degraded soils give 50 per cent low yields in the case of cotton and 35 per cent low yields in the case of sorghum	Market value of degraded soils is 50 per cent lower than good soils
8	Reddy et al (1996)	Rajasthan	Soil degradation		Market value of degraded soils is one third of that of good soils
9	Sehgal and Abrol (1994)	All-India average		Crop losses range from 135 to 73 per cent depending on the crop, degree of erosion, slope and soil depth	Black and red soils are the worst effected, when compared to alluvium-derived soils
10	Singh (1994)*	All-India	Salt affected (salinity-alkalinty)	7.8 million hectares	It ranges from 0.26 million hectares in Orissa to 1.2 million hectares in Mp. About 50 per cent of the canal commands are salt-affected
11	FAO (1993)*	All-India average	Salinity	6.2 million tonnes	Ranges from 0.3 million tonnes of barley to 3.7 million tonnes of sugarcane
12	Indian (1986)*	All-India average	Salinity	9.65 million tonnes	Ranges from 0.03 of barley to 6.49 of sugarcane
13	Sehgal and Abrol (1994)*	All-India	Salt affected (salinity-alkalinty)	10.1 million hectares	-
14	Joshi (1987)	Gujarat (Khuda district)	Salinity	Productivity losses range from 70 per cent in the case of local paddy and wheat to 25 percent in the case of potato	Productivity losses range from 10 per cent in the case of low salinity to 85 per cent in the case of high salinity for paddy
15	Singh (1994)*	All-India	water logging	Losses range from 80 per cent in the case of potato to 40 per cent for paddy	-
16	Behera and Reddy (2000)	Andhra Pradesh	water logging	4.5 million hectares of which 2.2 million hectares in canal commands	-
			Industrila degradation	Paddy yields have dropped by 80 per cent in seven years due to high EC levels. The per acre loss is about Rs. 9000 per crop/year	The loss to agriculture due to industrial pollution is estimated at Rs. 23,000 per household per annum.
17	Datta and Dayal (2000)	Uttara Pradesh	Ground water pollution	in the cast of high salinity net income from wheat dropped by 52 per cent and mustard by in the 34 per cent. In the case of Alkalinity the decline is by 45 per cent and 28 per cent respectively.	-

Source: Reddy 2003, as cited in TERI (1998)

Table 5.2 Extent of Land Degradation as per NRSA (Mn Ha)				
Sl.No.	Category	1980-82	1988-89	1986-99
1	Salt Affected	3.90	1.99	2.05
2	Waterlogged	0.88+	1.22	1.66+
3	Marshy/swampy		0.82	
4	Gullied/tavenous	4.33	2.02	2.06
5	Land with or without scrub	10.80	26.50	19.40
6	Milling/industrial waste	-	0.12	0.13
7	Shifting cultivation	2.40	2.82	3.51
8	Degraded pastures and grazing	-	-	2.60
9	Degraded land under plantation crops	-	-	0.58
10	Total degraded land	22.31	35.49	31.99
11	As a percentage of geographical area	6.79	10.80	9.73
12	As a percentage of cultivable area	11.31	18.00	16.31
Note: + Waterlogged, marshy and swampy areas are clubbed.				
Source: Reddy (2003)				

It can be seen from Tables 5.1 and 5.2 that soil erosion due to water related and overgrazing are threatening the productivity potential and adversely affecting the livelihood sustenance. ***The FAO indicates that currently almost 58 % of India's land is degraded due to human activity. NRSA states that about 9.73 % of India's land was degraded during 1986-99.*** Some reconciliation of the data from different sources is badly needed.

5.3 Accounting for Land Resources

As mentioned earlier, land accounting can be done in both physical and monetary terms and such accounting can be done in both stock and flow frameworks. It may not be out of place to reiterate that in the case of land, the flows in physical account should be incorporated in terms of deterioration in land quality as well. The use of observed market prices for valuation of land is though straightforward from application point of view, it is not an ideal solution due to a variety of reasons (SEEA 2003). First, more often, market for land is quite thin, if we consider all varieties of land in different locations. Second, land prices may be subject to many distortions due to legal regulation. Due to tax considerations and registration and stamp duties, a common practice in India is to understate the price of land in land deals. Some land may not be permitted to be exchanged, such as; land designated as public areas,

common property land and remote and inhospitable land. Third, land is rarely exchanged as a separate asset. Often land under buildings is sold with the buildings in a single transaction, without separating the value of land from value of buildings. Moreover, amenity value of land and the ecosystem aspects are also merged with the direct use benefit. Separation of each of these elements of land may not be possible. Globally, an asset account for land in physical terms is rather simple as there could, at best, be marginal changes in land area during a year due to erosion or land reclamation but in general terms, the volume of land in physical terms does not change. The more relevant information from the *three pillar approach* to sustainability is the use to which land is put and the type of land cover which supports (or not) other forms of life and which regenerates the atmosphere.

***5.3.1 Accounting of Degradation of land and soil*:** The major way in which land is actively rather than passively (in situ) used is to support biological resources. It can support biological resources even if it is non-cultivated. The properties which support biological growth are contained in the soil and hence the valuation and changes in valuation of land may equally be attributed to soil. Even if land is used unsustainably, the soil has an infinite life and therefore no adjustment for depletion is necessary and the entire value of the resource rent arising from biological growth should be treated as income. However, where land gets degraded due to human activity, a depletion adjustment to income is applicable. "The degradation of land/soil can be defined as the decline in the biological productivity or usefulness of land and soil resources for their current predominant intended use caused through the use of the land by humans" (Gretton and Salma, 1996, as cited in SEEA 2003). Land degradation implies that agricultural activity removes nutrients from the soil, reduces soil depth due to its erosion, leads to salinity and alkalinity of soil. In the absence of natural regeneration or land management, the productivity of the land is therefore adversely affected. Land degradation also takes place in the form of changing mineralisation of soil due to irrigation, altered soil acidity and heavy metal contamination. To quote from SEEA (2003), "It can also involve changes in soil structures and erosion that occurs with soil structure decline, surface scalding, water and wind erosion and mass movement of slopes. Degradation of land resources can also involve changes in biological conditions due to factors such as woody shrub infestation, disappearance of perennial bush, clearing of native vegetation, invasion by feral animals and other pest species and pollution from farm residues and farm wastes. Offset against these are improvements in

land quality from soil conservation, afforestation and other changes in agricultural practices. In the context of economic assets used here, land degradation represents the decline in the capital value of land over time caused by economic activity (after deducting price rises due to inflation). This decline in value represents the fall in future productive capacity of the land. As such, it stops well short of a full measure of the cost of land degradation to environmental systems more generally as it does not include impacts such as the deterioration of river systems. Degradation of land or soil leads to a decline in production and hence a decline in the resource rent earned by the land compared to the resource rent which would have accrued if there had been no decline. To calculate the decline of the value of the land it is necessary to compute the net present value of future land rent that is foregone due to degradation attributed to the year in question. The impact of degradation, the decline in the value of the land should be shown as depletion of natural resources even though it is due to qualitative changes in the soil and not quantitative changes in the land itself".

In brief, land and ecosystem are closely related to environmental assets. As mentioned earlier, in the SNA, land is treated as a non-produced asset, which provides economic benefits and constitutes a significant part in the total wealth of the nation. The use of land for different economic activities and the potential of land should be considered together from an ecological point of view, for a better understanding of the relationship between the economic activities and the environment. A comprehensive set of land and ecosystem accounts link the economic and environmental dimensions and permits aggregated indicators to be derived. These indicators can provide the background for land related policies such as nature protection, agriculture and transport policy. The integration of a comprehensive land and ecosystem accounting module in the SEEA is useful for the following reasons:

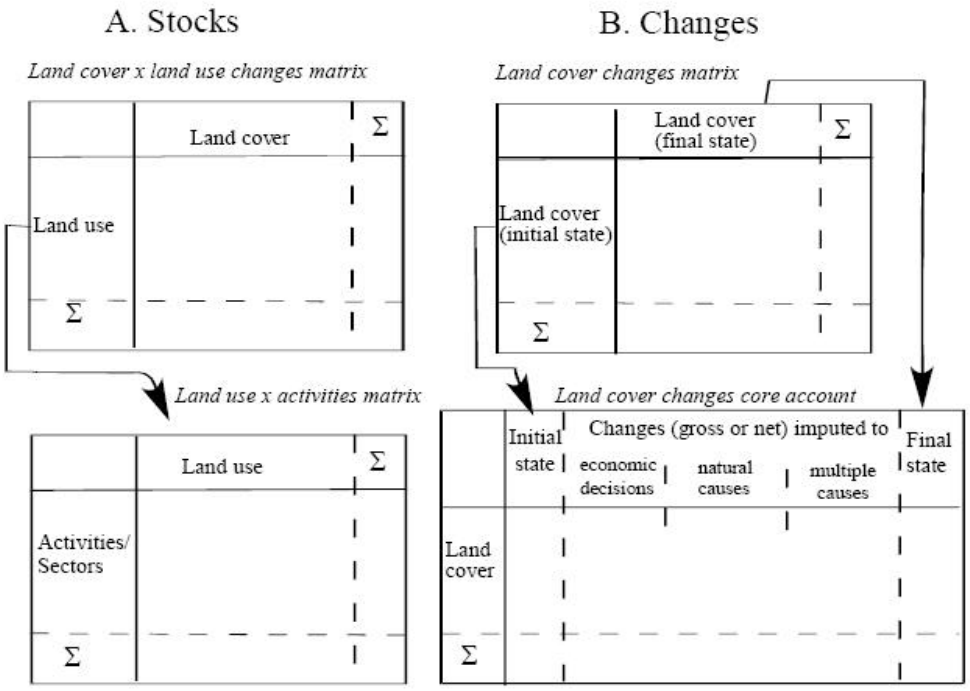
- It provides complete picture of land cover and land use for a nation.
- It allows the derivation of trends and indicators of change.
- It helps in the integration of diverse data sources on land cover and land use as well as with other data. (For example: population, economic activities, water balance, species or fertilizer use)
- It promotes standardization in classification of land cover, land use and causes of changes in land cover and land use.

- It allows changes in land use, land cover, habitats and biodiversity to be linked to the driving forces.

5.3.2 Valuation of Land–use and Land Cover:

Land cover indicates the (bio) physical dimension of the earth's surface. As against it, the land use is based on the functional dimension of land for different economic activities. A single land cover can be put to parallel or multiple uses. On the other hand, economic uses of the land along with natural processes (irrespective of whether modified by human activities or not) determine land cover. The links between land use and land cover and their change over time is at the core of land accounting in the SEEA. In Chart 5.1, we present the structure of the land cover/land use accounts (SEEA 2003). Preparation of land accounts would entail all the information which is highlighted in Chart 5.1

Chart 5.1: Structure of the land cover/land use accounts (SEEA 2003)



Source: Conference of European Statisticians, 1995; p.6.

5.4 Land–use and Land cover classification in India

Land use statistics form part of the agricultural statistics. The land use data generation is a byproduct of maintaining village level land records. The statistical information set-up and the quality of information collected were strengthened and improved after the government accepted the recommendations made by the Royal Commission on Agriculture in1928. With the beginning of the planning era in 1951-52, a number of schemes were introduced to improve the statistical base of Indian agriculture. Extension of reporting area, estimation of production of protective foods and minor crops of commercial importance and preparation of index numbers, etc, were incorporated as part of the improvement and up gradation in agricultural statistics. After 1950-51, a nine-fold classification was introduced for Land-Use classification that is being still followed in the country. Statistics on land use are collected at present in the form of the nine-fold classification on yearly basis. The National Remote Sensing Agency (NRSA) conducted a land use survey using Remote Sensing Technique in the year 1988-89 at the behest of the Planning Commission in which they had classified the land by visual interpretation technique and digital techniques into twenty-two categories. In Box 5.1, we provide the land use classification adhered to for official publication of data. In Table 5.3, we provide the land cover classification as used in India.

Box 5.1: Land–use classification in India

1. **Forest**: Includes all lands classed as forests under any legal enactment dealing with forests or administered as forests.
2. **Area under Non-agricultural Uses**: Includes all lands occupied by buildings, roads and railways or under water, *e.g.* river, and canals and other lands used for non-agriculture purpose.
3. **Barren and un-culturable land**: Includes all barren and un-culturable land like mountains, desert etc.
4. **Permanent pastures and other grazing lands:** Includes all grazing lands where they are permanent pastures and meadows or not. Village common grazing land is included under this head.
5. **Land under miscellaneous tree crops, etc**: This includes all cultivable land, which is not included in 'Net Area Sown' but is put to some agricultural uses. Lands under Casuarina trees, thatching grasses, bamboo bushes, and other groves for fuel, etc which are not included under 'Orchards' should be classed under this category.
6. **Culturable Wasteland**: This includes lands available for cultivation. Such lands may be either fallow or covered with shrubs or jungles, which are not put to any use. Land once cultivated but not cultivated for five years in succession should be include in this category at the end of the five years.
7. **Fallow lands other than current fallows**: This includes all lands, which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five years.
8. **Current Fallows**: This represents cropped area, which are kept fallow during the current year. For example, if any seeding area is not cropped against the same year it may be treated as current fallows.
9. **Net Area Sown**: This represents the total area sown with crops and orchards. Area sown more than once in the same year is counted only once.

Table 5.3: Land Cover Classification in India

Level 1	Level 2	Level 3
1. Built-up land	1.Towns & Cities	
	2. Villages	
2. Agricultural land	1. Crop land	1. Kharif
		2. Rabi
		3. Kharif + Rabi
	2. Fallow	
	3. Plantations	
3. Forest	1. Evergreen/semi evergreen	1. Dense
		2. Open
	2. Deciduous (Moist & dry)	1. Dense
		2. Open
	3. Scrub forest	
	4. Forest blanks	
	5. Forest plantations	
	6. Mangroves	
4. Wastelands	1. Salt affected land	
	2. Waterlogged land	
	3. Marshy/swampy land	
	4. Gullied/ravinous land	
	5. Land with scrub	
	6. Land without scrub	
	7. Sandy area (coastal & desertic)	
	8. Mining/industrial wasteland	
	9. Barren rocky/stony waste/sheet rock area	
5. Water bodies	1. River/stream	
	2. Canals	
	3. Lake/reservoirs/tanks	
6. Others	1. Shifting cultivation	
	2. Grass land/grazing land	1. Dense
		2. Degraded
	3. Salt pans	
	4. Snow covered/glacial area	

5.5 Land-use/Land cover pattern in Karnataka

Land-use pattern in Karnataka is provided in Table 5.4. As mentioned earlier, the physical stock of land is constant, but the land-use pattern has undergone a change. The major changes have been witnessed in the use categories of permanent pasture and grazing land, current fallows and land put to non-agricultural use. Whereas, the land under permanent pastures and grazing land has decreased, the land under current fallows and that put to non-

agricultural use has increased. This seems to be indicative of urban pressure on land and degradation in soil quality in the state.

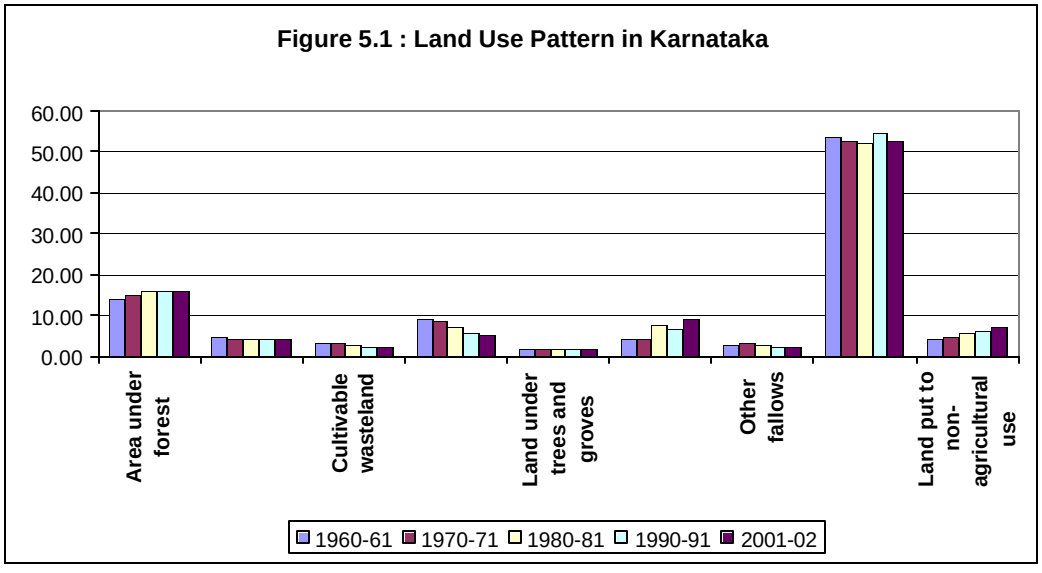
Table 5.4: Physical Stock of Land in Karnataka- Land Use Pattern

Land Use Category	Area as a % of Total Geographical Area of Karnataka										
	1960-61	1970-71	1980-81	1990-91	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02
Area under forest	14.2	15.2	15.9	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1
Barren and uncultivable land	4.7	4.4	4.4	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1
Cultivable wasteland	3.5	3.2	2.6	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2
Permanent pasture and grazing land	9.1	8.5	7.1	5.8	5.4	5.3	5.3	5.2	5.1	5	5
Land under trees and groves	1.9	1.6	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6
Current fallows	4.4	4.3	7.7	6.8	6.7	6	8.8	6.6	7.8	7.2	9.1
Other fallows	2.7	3.5	2.9	2.4	2.3	2.1	2.1	2.1	2.2	2.1	2.2
Net Area Sown	53.6	52.8	52	54.5	54.7	55.7	52.9	55.1	53.9	54.6	52.7
Land put to non-agricultural use	4.3	4.9	5.6	6.2	6.6	6.7	6.7	6.8	6.8	6.9	7
Total Geographical Area of Karnataka ('000 hectare)	19050	19050	19050	19050	19050	19050	19050	19050	19050	19050	19050

Source: *Karnataka at a Glance (Various issues)*

It can also be seen from Figure 5.1 that almost more than half of the geographical area in the state is put to agricultural use.

Figure 5.1 : Land Use Pattern in Karnataka



5.5.1 Land-use/Land cover pattern in districts of Karnataka

In Table A5.4, we present the distribution of area for a particular land use across the districts of the state. In Table A5.5, different uses to which land is put in each of the districts of Karnataka in relation to its geographic area has been provided. We also have highlighted the cells which account for more than one fourth area put to a particular use in the district to highlight the pressures/resources in that districts. Except for Uttara Kannada, all the districts have a sizeable proportion of land which is put to agricultural use. In Bangalore Urban, it is the land put to non-agricultural use which is predominant. The districts of Uttar Kannada, Dakshina Kannada, Chamarajanagar, Chickmaglur, Kodagu, etc., are rich in forest resources. Bijapur and Raichur have substantial fallow lands.

From the point of view of economic planning, diversifying the industrial activity in the areas in which land is not cultivable could be considered. This would enhance the value of land in monetary terms, though not in physical quantity. Some indications to this effect are already seen in Raichur in the very recent period for which official data is not available. This could also distress the industrialization process in Bangalore.

5.6. Changes in Land Use and Land Productivity in Karnataka

5.6.1 Change in land use (Physical flow account):

After taking a view of the stock of land resources in Karnataka, we try to examine the changes (**Physical flow account**) in land use in Karnataka. This information has been provided in Table 5.5.

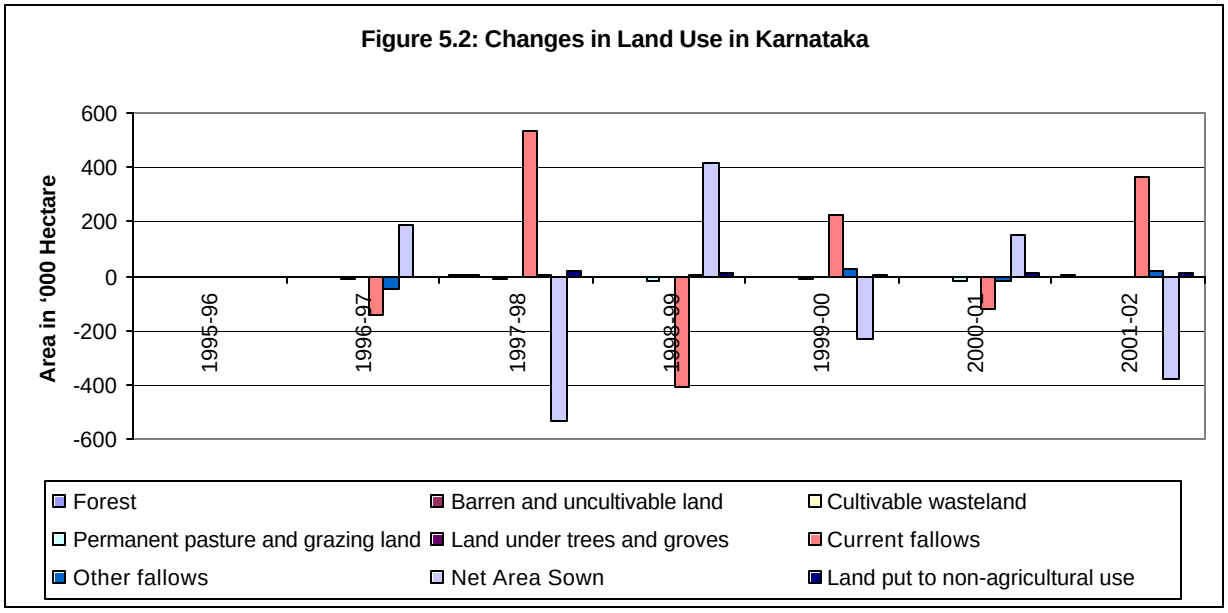
Table 5.5: Changes in Land Use in Karnataka (Physical flow account for land)

Land Use Category/Year	Area in '000 Hectare						
	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02
Forest							
Opening stock	*3062*	*3062*	*3062*	*3063*	*3063*	*3063*	*3063*
Change in the area	*0*	*0*	*1*	*0*	*0*	*0*	*6*
Closing stock	*3062*	*3062*	*3063*	*3063*	*3063*	*3063*	*3069*
Barren and uncultivable land							
Opening stock	*800*	*800*	*799*	*802*	*799*	*796*	*794*
Change in the area	*0*	*-1*	*3*	*-3*	*-3*	*-2*	*-6*
Closing stock	*800*	*799*	*802*	*799*	*796*	*794*	*788*
Cultivable wasteland							
Opening stock	*442*	*442*	*441*	*439*	*435*	*433*	*427*
Change in the area	*0*	*-1*	*-2*	*-4*	*-2*	*-6*	*-4*
Closing stock	*442*	*441*	*439*	*435*	*433*	*427*	*423*
Permanent pasture and grazing land							
Opening stock	*1028*	*1028*	*1017*	*1005*	*987*	*979*	*959*
Change in the area	*0*	*-11*	*-12*	*-18*	*-8*	*-20*	*-3*
Closing stock	*1028*	*1017*	*1005*	*987*	*979*	*959*	*956*
Land under trees and groves							
Opening stock	*320*	*320*	*317*	*313*	*312*	*305*	*303*
Change in the area	*0*	*-3*	*-4*	*-1*	*-7*	*-2*	*-1*
Closing stock	*320*	*317*	*313*	*312*	*305*	*303*	*302*
Current fallows							
Opening stock	*1278*	*1278*	*1138*	*1671*	*1266*	*1489*	*1367*
Change in the area	*0*	*-140*	*533*	*-405*	*223*	*-122*	*362*
Closing stock	*1278*	*1138*	*1671*	*1266*	*1489*	*1367*	*1729*
Other fallows							
Opening stock	*444*	*444*	*396*	*399*	*401*	*426*	*409*
Change in the area	*0*	*-48*	*3*	*2*	*25*	*-17*	*17*
Closing stock	*444*	*396*	*399*	*401*	*426*	*409*	*426*
Net Area Sown							
Opening stock	*10419*	*10419*	*10609*	*10075*	*10489*	*10259*	*10410*
Change in the area	*0*	*190*	*-534*	*414*	*-230*	*151*	*-379*
Closing stock	*10419*	*10609*	*10075*	*10489*	*10259*	*10410*	*10031*
Land put to non-agricultural use							
Opening stock	*1257*	*1269*	*1269*	*1284*	*1295*	*1301*	*1312*
Change in the area	*0*	*0*	*15*	*11*	*6*	*11*	*13*
Closing stock	*1257*	*1269*	*1284*	*1295*	*1301*	*1312*	*1325*
Total Geographical area of Karnataka	**19050**	**19050**	**19050**	**19050**	**19050**	**19050**	**19050**

In Figure 5.2, we see that the main changes in land use have been substitution between current fallow land and net sown area. These changes could be due to the rainfall variations

which would lead to change in the net sown area and concomitant variations in the current fallow lands.

Figure 5.2: Changes in Land Use in Karnataka



5.6.2 Change in land Productivity

In this section we provide the area and productivity of land in terms of different crop outputs in Karnataka. From 1970-71 to 2001-02, the total area under various crops (mentioned in Table 5.8) has hardly risen. Productivity of land has not even doubled during this period for (Table A5.6 and A5.7)**,** any of the crops. In fact, in some cases, one observes the decline in productivity rather than an increase. This is despite the fact that the consumption of fertilizers in Karnataka (Table:A5.4) over this period has increased by 14 times! In brief, the incremental impact of fertilizer consumption on productivity is vanishing and this is due to, *inter alia*, degradation in soil quality, which in turn has resulted due to overdose of chemical fertilizers in Karnataka.

5.7 Activities/ Sectors/Policies Influencing the Land Use Changes in Karnataka

The present study used the **PASIR** (Pressure, Activity, State, Impact and Response) framework to identify the key economic sectors/activities (excluding mining) in the state from which environment-related pressures are originating to have an impact on the resource base of the land and forestry sector. The following are the activities/sectors influencing the land use changes in Karnataka.

5.7.1 Land Reforms

Karnataka's land reforms had twin objectives of 1) conferring ownership on erstwhile tenants and 2) redistribution of surplus lands available in excess of ceiling to the deserving. This policy has relatively achieved it (KLUB, PP-582).

The Karnataka Land Reforms Act 1970 limits the land holding in Karnataka to 4.05-8.10 ha for irrigated lands with two crops, 10.12-12.14 ha in case for irrigation lands with single crop and 20.85 ha for dry land by the individual farmers with exception to plantation crops. The act intended to distribute the surplus land, to be made available through land ceiling, to the landless. Having failed in this, the governments opted for the easier option, *i.e.* to curtail CPR area and distribute it to the landless, though, as indicated earlier, most of it went to those who already possessed land. Thus, the land distribution policies proved quite regressive in effect.

In the year 1995, the state of Karnataka has brought out an amendment to the Land Reforms act. The 1995 Land Reforms Amendment Bill has brought a major change in the agrarian relationship by following measures: provision to lease in agriculture land for aquaculture for a period of 20 years in the districts of Dakshina, Kannada and Uttar Kannada up to 40 units (around 220 acre); agricultural land cannot be inherited by anyone whose income from the non-agricultural source will not exceed Rs.2.00 lakhs; up to 180 acres of D class land can be leased to a housing project; up to 21.6 acres can be leased for educational institution; up to 108 acres of D class land can be leased to a housing project; up to 108 acres of D class land can be leased for horticulture, floriculture and agro based industries (Kushalappa, 2003).

5.7.2 Agricultural Policy

The agricultural policy outlines the need to take the opportunities opened up by trade at national and global levels in an environment of economic liberalization. The policy suggests to improve the farming efficiencies in the use of resources and to protect the environment. The agricultural policy attempts to provide industrial status to agriculture. The measures include increasing the area under irrigation from present level of 24 lakh ha to 49 lakh ha. Further the policy suggests reforms in the agricultural institutions marketing, storage, and export and credit sectors. The green revolution and development of high tech agriculture has influenced the land use pattern and the land quality to a great extent. Use of chemical fertilizers, hybrids, water intensive crop production, and pesticides also has greatly impacted the land use and the soil characteristics.

5.7.3. Irrigation and Fertilizer Use

Karnataka being predominantly a dry farming state, concerted efforts have been made to increase the area under irrigation in the state. Many major and medium irrigation projects apart from minor irrigation works were taken up as five-year plan programmes. As a result, the area under irrigation has increased gradually. Table 5.6 shows irrigation potential created in Karnataka under various projects.

Table 5.6: Irrigation Potential Created (as in March 2000)

Projects under which irrigation potential is created	Area (Ha)
a) Under 8 major and 32 medium completed projects	453054
b) Under 19 major and 21 medium ongoing projects, bringing the total potential under major and medium projects to 1741771 Ha	1288717
c) Under completed minor projects using surface waters	939566
d) Under 13743 small tanks having less than 4 Ha Ayacut (now with the Zilla Panchayats)	33021
e) Under irrigation from ground water sources	908563
Total	**3622921**

Source: KSLUB, 2001

Table 5.7 shows area submergence in relation to irrigation potential in different basins in Karnataka. The area submerged is 1.95 lakh Ha. On an average for every hectare of submerged area irrigation potential is 15.04 Ha.

Table 5.7: Area Submergence in Relation to Irrigation Potential in Different Basins in Karnataka (Area; Ha)

Sl.No.	Basin	No. of Projects covered	Area submerged ha	Irrigation potential ha	Ratio of area submerged to irrigation potential
1	Krishna Basin	22	124630	1668437	13.39
2	Cauvery Basin	16	62673	1204686	19.29
3	Godavari Basin	2	6411	35614	5.55
4	Other	3	948	19221	20.27
	Total	**43**	**194662**	**2927958**	**15.04**

Source: *KSLUB*, 2001

The productivity has not increased despite considerable increase in the area under irrigation and fertilizer use (Table A5.8). The reason for the stagnation in productivity (Table A5.6 and A5.7) could be the decline in fertility due to land degradation.

Due to excessive irrigation in the command areas and growing of water intensive crops the environmental impacts are water logging, salinity and alkalinity affecting the crop productivity. The water logging is causing salt accumulation in the irrigated tracts making the soil productivity low. The continuous water logging has lead to salinity affecting the soil structure and texture. The alkalinity is making the soil totally uncultivable. The socio-economic impacts of salinity and alkalinity are low yields, low income and loss of land permanently for cultivation.

In Table 5.8, we present the environmental problems, which have reached alarming proportions in various districts of Karnataka.

Table 5.8: Environmental Hotspots in Karnataka

Issues	Districts
Excessive chemical use	Shimoga, Mandya, Bellary, Raichur
Excessive Pesticide use	Gulbarga, Bijapur, Raichur
Soil erosion	All Northeastern plain districts
Water erosion	Coastal and Western Ghat districts

Source : *State of Environment Report - SOER*, 2003

5.7.4 Mining

Karnataka being one of the mineral rich states of the country, mining provides substantial non-tax revenue to the state's exchequer. Of the state's total area of 192000 square kilometers, more than 40000 square kilometers of green stone belts are known to contain vast mineral deposits of gold, silver, platinum, copper, diamond, iron, manganese, chromite, lime stone, dolomite, etc. At present about 20 varieties of major minerals and five varieties of minor minerals are being exploited in the state. 568 mining leases of major minerals covering an area of 21247 hectares, 5650 quarry leases of minor minerals covering an area of 4526 hectares have been sanctioned in the state till December 31, 2004. The share of mining and quarrying in the NSDP of the state was about 0.6 % of NSDP in the state. Since the present study excludes mining from its accounting framework we have not discussed this issue in detail.

5.7.5. Hydroelectric projects

Power is an important component for agricultural as well as industrial development. Hydroelectricity generation entails submergence of valuable land. Thermal power generation units will also require land. This is now an essential component of our economic activities.

The information that could be collected indicates that the existing area utilized for power generation is 0.81 lakh Ha and the requirements are 0.913 lakh Ha by 2005 and 0.927 lakh Ha by 2010 (KSLUB 2001).

5.7.6 Poor Institutional and Regulation Mechanism

The state has around 8 lakh ha of C and D class land, which is under Revenue and Forest department control. The state Government has passed an order directing the Revenue department to handover the C&D class lands to the Forest Department. However the Government in its subsequent order has ordered to transfer only 18.32 lakh ha of C&D class lands to be handed over to the Forest department. Due to poor institutional and regulation mechanism much of the C&D class land is under various kinds of encroachments. The district forests have different nomenclature in different districts such as Assessed wastelands, Minor forests, Bane, soppinabetta, paisari, and other such names. The KFD has identified roughly about 12 lakh of deemed forests, which has rich bio-diversity and other forestry features. The state has roughly 19 lakh ha wastelands which are under the ownership of both private and state government and its agencies. The government of India has setup wasteland Development Board to develop wasteland and to convert these wastelands as productive sites as the waste land is unfit for cultivation.

5.7.7. Roads

Road communication is of prime importance for economic development/extension activities. The types of roads also are equally important and this infrastructure determines the mode of transport for consumable articles, output of agriculture and industries, movement of raw materials etc. Karnataka state at present has reasonably good network of roads, however, further development is imminent during the next 25 years to support agriculture and allied activities. Table 5.9 shows area under different types of roads in Karnataka (1998).

Table 5.9: Area Under Different Types of Roads in Karnataka

Type of Road	Length in Km	Width Mt	Calculated area in Ha
National highway	2355	9.00	21195
State highways			
A) Single lane	6276	3.75	2353.5
B) Medium lane	3663	5.50	2014.65
C) Double lane	1098	.--	5191.65
Sub: Total	11037	.--	5191.65
District roads			
A) Single lane	26453	3.75	9919.87
B) Medium lane	1766	5.50	971.3
C) Double lane	142	7.50	106.5
Sub: Total	28361		10997.67
Other domestic roads	1644	3.75	616.5
Village roads	42791	3.75	10646.62
Irrigation roads	9417	3.75	3531.37
Taluk development roads	31583	3.75	11843.62
Forest road	2582	3.75	968.25
Grand total	129770	.--	88346.25
Source: Karnataka state land use board, 2001			

The total area under roads is 0.88 lakh ha amounting to 0.46 % of the total geographical area of the state.

5.7.8. Railways

Development of infrastructure under railways is very important for the development of agriculture as well as industries. The network of railways in the state is given below in Table 5.10.

Table 5.10: Network of Railways in Karnataka

Sl No	Length in Km. Revenue Division	No of Rly. Station	Broad gauge	Meter gauge	Narrow gauge	Total length
1	Bangalore	128	769	100	102	971
2	Belgaum	96	531	259	.--	790
3	Gulbarga	72	598	145	.--	723
4	Mysore	94	295	413	.--	708
	Total	**390**	**2173**	**317**	**102**	**3192**

Source: Karnataka state land use board, 2001

5.7.9. Urbaninsation

The rapid growth in urban population in the state has been driven by both push and pull factors. The absence of basic amenities/facilities and the lack of employment opportunities in rural areas act as push factors driving away the population from rural areas as well as small urban settlements. On the other hand, the perceived presence of such facilities in larger urban settlements acts as the pull factor leading to the migration of rural population into the urban areas. The following table shows details of urban population in Karnataka.

Table 5.11: Urban Population by Classification of Towns in Karnataka, 2001 and the Projections for 2011

Population range	Class of Town	2001 Census Data		Projections for 2011	
		Urban Population	% Share of Urban Population	Urban Population	% Share of Urban Population
1 lakh or more	Class I.	12043036	67	15792075	70
50000-99999	Class II	1726134	10	3002218	13
20000-49999	Class-III Cities/towns	3096525	17	3042434	13
10000-19999	Class-IV towns	839021	5	624630	3
5000-9999	Class-V Towns	192477	1	195437	1
Less than 5000	Class-VI Towns	22665	0	17598	0
Karnataka Urban	**All towns**	**17919858**	**100**	**22674392**	**100**

Source : *State of Environment Report - SOER*, 2003

The environmental impacts of the problems associated with urban planning and growth are listed below (SOER, 2003);

1. Ground water contamination due to soak pits and improper drainage system near open wells,
2. Decrease in groundwater recharge due to increasing surface runoff due to paved areas,
3. Polluting surface water bodies like tanks by the letting sewage into the lakes,
4. Health problems due to uncollected garbage strewn around,
5. Health problems due to crowding of families in one-room or two-room houses,
6. Increase in temperatures due to radiation from buildings and paved roads (heat islands), and inadequate tree cover to counter this rise in temperature. Air circulation is also reduced due to the dense residential development and loss of vegetation/tree cover.

After 74th constitutional amendment act came into force, the municipalities are being declared as planning authorities having jurisdiction over municipal limit. Forty-one town municipalities are declared as planning authorities under Karnataka town and country planning act. The Department of Town planning is made responsible for preparation of development plans. The department also assists these municipalities in enforcement and implementation of these plans. So far development plans have been prepared for 24 such towns and preparation of plans for the remaining 17 towns is at different stages.

5.7.10 Industries

The land resources of the state are largely depended upon the rate and level of industrialization in the state. The existing area covered by industries is 0.18 lakh Ha and the demand for additional land required for industrial development was estimated to be 20654.19 Ha for the year 1999-2000 for the state as whole. The details are presented in Table 5.12.

Table 5.12 : Demand of Land for Industrial Use in Karnataka by KIADB and KSSIDC

Sl No	Sector/particular KIDB,	Existing area (Ha)	Estimated additional requirement (Ha)	Total
1	Industrial area	10248.79		
2	Single unit complexes	7589.55		
3	Karnataka hand loom development corp. ltd	45.45		
4	Karnataka state handcrafts development. Corp. ltd	6.07	20234.30	38138.17
5	Karnataka leather industries dev. Corp. ltd	11.45		
6	Karnataka housing board	2.56		
	Total KIDB	17903.87		
7	Karnataka small scale industries development corporation ltd.	594.79	419.89	1014.68
	Grand Total	**18498.66**	**20654.19**	**39152.85**

Source: KSLUB, 2001

5.7.11. Monoculture

Most of the agriculture is monoculture like paddy, sugar cane, cotton which draw same nutrients at the same level making the soil poorer of such nutrients and requiring heavy manuring. Inorganic fertilizers alter the soil texture and structure. Only few mixed crops are raised such as maize, pulses, cowpea, sesame etc. *Prosopis* sp. has invaded most of the vacant lands in the Northeastern plains like Bellary, Gulbarga, Raichur making them unfit for cultivating any other species or crop. The only positive factor is that it has met the fuelwood demands of those areas fully.

5.7.12 Lack of integrated watershed management leading to forest and land degradation

The state having 80 percent of the land under rainfed cultivation and only around 20 percent covered under irrigation. As the state's major landscape falls in the arid and semi-arid zone the moisture is the major limiting factor in the crop production. Subsistence farming practices, accelerated soil and water erosion, erratic rainfall, over population, and high density livestock population have contributed for the unsustainable land use patterns leading to land degradation. As per survey (NBSS & LUP) out of 120.85 lakh ha of cultivated area, 68 lakh ha (57 % of TGA) needs soil and moisture conservation treatment.

The land degradation due to poor soil and water conservation measures and lack of watershed approaches has impacted the land in many ways. It is estimated that nearly 250 tons of soil per ha is washed away annually. So far 32 lakh ha has been brought under watershed projects, still more than 50% is uncovered. The rate of infiltration and siltation is very high in the arid zones indicating the severity of the problem.

5.8. Land resources of Karnataka: PASIR framework

The activities discussed in the preceding section are put in the PASIR frame work in Table 5.13 which provides a glimpse of pressure of these activities on the land resources in respect of environmental and socio economic impacts.

Environmental impacts: Accelerated soil and water runoff (erosion), low water infiltration have resulted in reduction in the groundwater table. Water level in open wells and bore wells has come down. The rate of soil and water erosion has caused siltation in the tanks and reservoirs. The dead water storage capacity of many of the reservoirs has reached zero level due to accumulated silts in the reservoirs.

Socio-economic impacts: The loss of soil fertility has resulted in low crop production affecting the overall economy status of the people. The nutrient status of soil has also come down.

Table 5.13: Land Resources in Karnataka: PASIR Framework

Pressure	Activities (Socioeconomic)	State (Ecological & socioeconomic)	Impact (Ecological & socioeconomic)	Response
Irrigation	Provision of irrigation facility induces the farmers in the command area to get irrigation facility.	Area submerged under irrigation projects is 1.95 lakh Ha. On an average for every hectare of submerged area irrigation potential is 15.04 Ha. Farmers started growing water intensive crops such as paddy and sugarcane. Increase in the farm income. Increase in the socioeconomic status of the farm households	Area under horticulture & plantation crops has increased. The additional area has come either from wastelands brought under cultivation or from the common lands that show the declining trend. Productivity has not increased despite considerable increase in the area under irrigation & fertilizer use. Water logging, salinity & alkalinity are affecting the crop productivity. The socio-economic impacts of salinity and alkalinity are low yields, low income and loss of land permanently for cultivation.	Regulation of cropping pattern in the command areas.
Fuelwood & fodder & grazing	Fuelwood and fodder are the main biomass requirements of the people. HHs in the non-forest villages collect these items mainly from the CPLRs at free of cost.	This reduces the availability of trees and bushes on these lands Free availability of fuelwood and fodder induces HHs to collect more from CPLRs.	Decrease in trees and bushes on these lands leads to soil erosion. Increases time and distance to be covered to collect fuelwood and fodder.	Government started social and farm forestry to meet the needs of the local people.

Table 5.13: Land Resources in Karnataka: PASIR Framework (Continued)

Pressure	Activities (Socioeconomic)	State (Ecological & socioeconomic)	Impact (Ecological & socioeconomic)	Response
Policy governing the commons	Policies governing the commons are weak. HHs have incentive to occupy lands along the river and tank foreshore areas for cultivation.	The common lands including Gomals (village pasture lands), wastelands, foreshore areas, river banks, beaches, streams and canal banks are in a highly degraded state due to unregulated use of resources by the community. Encroachment, excessive use of resources and lack of regulatory policy mechanism and agencies to protect these natural resources are the main causes of degradation.	Disturbances in the hydrological cycle have affected the ground water table storage capacity of the tanks and water bodies. The lack of water during summer is very acute in the state affecting the crop production and access to the clean water. The drying up of water bodies has affected the life in the water thus contributing the depletion of bio-resources. The disturbances in the hydrological cycle have affected the crop productivity and income level of the people. The non-availability of water in the reservoirs has created innumerable problems like loss of crops, migration of people in search of employment, scarcity of drinking water and access to clean water etc.	Government has taken some measures to control encroachments. Watershed development programme
Road & Rail	Provision of transport facility	Increased employment and income earning opportunities	Land under the roads increased (other types of land decreased) Increase in employment and income levels.	Government is trying to construct more roads.
Hydroelectric projects	Power is an important component for agricultural as well as industrial development.	The hydroelectric projects have submerged large areas of good forests (and agricultural land) especially in the Western Ghats and other lands adjoining to it, not only for reservoir but also for transmission lines, substations etc. Displacement of the people and lack of rehabilitation measures.	The existing area utilized for power generation is 0.81 lakh Ha and the requirements are 0.913 lakh Ha by 2005 and 0.927 lakh Ha by 2010. Conflicts with the state government.	Hydroelectric projects are essential components of our economic activities.

Table 5.13: Land Resources in Karnataka: PASIR Framework (Continued)

Pressure	Socioeconomic activities	State (Ecological & socioeconomic)	Impact (Ecological & socioeconomic)	Response
Mining	Karnataka being one of the mineral rich states of the country, mining provides substantial non-tax revenue to the state's exchequer. Of the state's total area of 192000 square kilometers, more than 40000 square kilometers of green stone belts are known to contain vast mineral deposits.	Mining is going on both in government and private lands, disfiguring the land, its terrain, slope and vegetation. The annual growth rate of area covered by this activity is about 2 to 5 percent. In view of liberalized policy the growth of area under mining could be from 4 to 5 percent per annum. Contribution of mining & quarrying in net state domestic product is Rs. 606 lakh in the year 2002-03 (i.e. 0.60 % of SDP)	The reclamation processes take time by which time the accelerated soil erosion would lead to siltation of rivers, tanks and the consequent floods, water pollution etc, causing sufficient damage to environment. Kudremukh iron ore project is one of the glaring example of land and forest degradation, in spite of their efforts for afforestation, soil conservation, etc.	The Karnataka mines and mineral Act outlines the mining policy of the state. The state policy of the mining department is to regulate the mineral exploitation without damaging the environment. The current policy of the state is to maximize the mine extraction in the non-forests area without damaging the environment.
Industries	Industrial sector adds significantly to the income and employment in the state.	The total land utilization for industries is 18498.66 Ha (0.096 % of TGA) and additional requirement in future as per estimates will be 20654 Ha and total area by 2025 will be 39152 Ha (0.20 % of TAG). There were 9171 factories providing employment to 891649 employees, averaging to 97 employees per factory	Industries are concentrated in Bangalore, Dharwad, D.Kannada, Mysore and Bidar districts. Pollution of land, water & air. Direct effect on health of the people.	State pollution control board stipulates specific conditions relating to the temperature, volume, composition, rate and point of discharge of emission and effluents.

Table 5.13: Land Resources in Karnataka: PASIR Framework (Concluded)

Pressure	Socioeconomic activities	State (Ecological & socioeconomic)	Impact (Ecological & socioeconomic)	Response
Urbanisation	The rapid growth in urban population in the state has been driven by both push and pull factors. The absence of basic amenities/facilities and the lack of employment opportunities in rural areas act as push factors driving away the population from rural areas as well as small urban settlements. On the other hand, the perceived presence of such facilities in larger urban settlements acts as the pull factor leading to the migration of rural population into the urban areas.	The pressure of growing urban population results in demand for additional land, which may result in using up agricultural land on the periphery of urban areas. The deficiency in affordable housing makes the economically poorer sections of the population move to the periphery of the cities. Certain sections of the migratory urban population do not like to live in the periphery of the city and seek accommodation nearer to city centers/workplace. This results in higher density (but low rise) settlements and/or conversion of land uses like water bodies, borders of roads and railway lines and open spaces into housing activities. The change in the land use from green belt associated activities to urban activities on the periphery of the city then affects the hydrological characteristics and hence the environment of the urban areas.	Absence of provision of water and sewage system by the state (due to illegal nature of these sites and construction) forces people to draw usage of ground water and use soak pits for toilet activities, thus affecting the environment. The slum population in Karnataka has been growing at a high rate and the living conditions in slums are poor especially in terms of access to basic services	The Karnataka Town & country Planning Act, 1961 provides for a three-tier system of urban planning. In February 2004 the Karnataka State Legislature has passed an amendment to the above-mentioned Act.

5.9 Soil Resources in Karnataka

Earth needs to be nurtured with mother's care because earth gives everything for sustaining life. This statement is substantiated for soils, which form one of the most precious natural resources of the earth. For sustainable agricultural production, it is necessary to focus attention on the soil and climate resource base, current status of soil degradation, etc. For this it is essential to study various soil quality parameters and prepare a soil quality index for the state. So we have to take physical account of these parameters (both static and dynamic), process the data, analyse the things to draw inferences, thereby it is possible to know the relative contribution of each parameter and the inter relationship of such parameters in determining overall soil quality index. Different soil and land parameters are as follows:

1. Soil depth
2. Soil texture
3. Soil colour
4. Soil drainage & permeability
5. Soil available water capacity
6. Soil erosion
7. Soil gravelliness
8. Slope
9. Soil degradation
10. Land capability
11. Land irrigability

5.9.1 Methodology of the Soil quality Study

Natural Resource Accounting is a revaluation of the conventional National Income Accounts of a country, region or state adjusting for the values of natural resources used up or deployed in various economic activities during the accounting period. Natural resources, as they appear in nature, get degraded in quality and depleted in stock due to economic and human activities. They also go through natural decay and regeneration processes. If such natural assets as 'stocks' and their changes as 'flows' are left out from the framework of national income accounting, there can be either an under estimation or over estimation of the income of a country / state.

In this context, various soil potentials and problems were considered to take physical and monetary accounting of soil resources. One of the pioneer study of Parikh and Ghosh (1995) considered only 6 parameters, like, soil type, colour, depth, salinity, drainage and percolation.

After consulting soil scientists and soil survey experts, and by following many research studies in this area, 11 soil and land quality parameters were taken into account in the present study

The data on both static and dynamic parameters were collected from Dept. of Agriculture, National Bureau of Soil Survey & Land Use Planning, All India Soil & Land Use Survey, University of Agriculture Sciences, Dharwad.

In the case of dynamic parameter like soil erosion, soil degradation etc, 2 point data or data over a period of time was collected to know the change in soil status.

Example: During 1990's eroded area is 184.53 lakh ha 2000-01 estimated statistics was 190.68 lakh ha. Here additional area of 6.15 lakh ha is brought under eroded land over a period of 10 years.

For most of the parameters the extent of area under different category was straight away borrowed from NBSS Publication No. 47.

Reclamation cost of degraded & problematic soils was collected by S R (schedule of rates) of Watershed Department, where estimated cost of soil & water conservation structures is given in Table 5.28.

Saline Soils are accumulated with salts which are injurious to normal plant growth and these soils are having pH<8.2, exchangeable sodium percentage ESP < 15. These salts are to be removed from root zone by impounding good quality water in the field. In order to improve saline soils in 1 ha area 10 skilled labourers @ Rs. 100 /- and 50 unskilled labourers @ Rs. 50 /- are required for doing earth work, to let out irrigation water, to provide drainage

channels. In addition to this, power operated implements & irrigation water are used whose cost is Rs.2000 /-. The cost for improving the saline soils is presented in Table 5.28.

Sodic Soils

In the Table 5.28 approximate reclamation cost of sodic soils was estimated**.**

pH>8.2, ESP>15, these soil, turn very hard at surface & involve amendment like gypsum leading to increased reclamation cost.

Acid Soils pH<5.5, plants cannot uptake nutrients though they are available in sufficient quantities in the given soil. So pH needs to be brought to neutral range (6.5-7.5) by adding Agril. Lime (40% CaO).

Water logged soils

Reclamation does not involve any amendment, but only labour works & power operated implements.

Soil Depth

Depth of the soil determines the effective rooting depth for plants and in accordance with texture, mineralogy and gravel content, the capacity of the soil column to hold water. To classify the soils into depth classes, some generalization in respect of depth classes has been made as large number of combinations occur. The different classes along with their depth range are given in Table 5.14 in terms of area and as % of the total geographical area (TGA) of Karnataka.

Table 5.14: Soil Depth Classes in Karnataka

Class No	Depth range (in Cms)	Area	
		000' Ha	%TGA
1	<25	2624.2	13.8
2	25-50	497.8	2.6
3	50-100	4423.5	23.3
4	100-150	10907.7	57.3
Total		**18453.2**	**97**

Source: *NBSS* (1998)

Soil Texture

Soil texture means the relative proportion of primary particles of sand, silt and clay. The surface layer of a soil to a depth of about 25 cms is the layer most used by crop plants. The textural class guides us to understand soil water retention and availability, workability of soil, infilteration and drainage conditions and crop suitability. Surface soil texture data are grouped into three main classes viz, sandy, loamy and clayey. The details are shown in table 5.15.

Table 5.15: Surface Soil by Texture in Karnataka

General Terms	Basic Soil Textural Class Names	Area (000' Ha)	% TGA
1. Sandy Soils		84.4	0.4
a) Coarse Textured	Sand, Loamy sand		
2. Loamy Soils		7204.7	37.9
a) Moderately Coarse Textured	Sandy loam, Fine sandy loam		
b) Medium Textured	Loam, Silty loam, Silt		
c) Moderately fine Textured	Clay loam, Sandy clay loam		
3. Clayey Soils		11163.8	58.7
a) Fine Textured Soils	Sandy clay, Silty clay, Clay		

Source: *NBSS* (1998)

It is one of the important and permanent characteristics that has direct bearing on structure, porosity, adhesion, and consistency. And its importance is also manifested in its influence on microbiological activities and physicochemical behavior of soils.

Soil Colour

Colour is one of the important characteristics of soils, which provides ready clue to soil conditions and several important soil properties. And these things can be observed directly in the field. Soil colour is due to either mineral matter or organic matter and most of the times admixture of both. Red, yellow or brown colours are because of different degrees of oxidation, hydration and diffusion of iron oxide in soils. Dark colours are associated with one or a combination of several factors, including impeded drainage conditions, content and state of decomposition of organic matter, sodium saturation of colloidal complex.

Soil colours are determined by Munsell colour chart by comparison with standard coloured chips. For instance, if 5 YR 3/2 is the quantified data of colour (which is basically a qualitative parameter) it can be interpreted as follows.

Here, 5 YR- is 'hue' i.e. dominant spectral colour

3 - is 'value' i.e. relative lightness of colour

2 - is 'chroma' i.e. relative purity or strength of colour.

In Karnataka we find only 4 kinds of 'hues', *viz*, 2.5 YR, 5YR, 7.5YR and 10YR

Example;

2.5YR – Pale red, Reddish brown, Dark red, Reddish black

5YR- Reddish yellow, Reddish brown, Light gray, Black

7.5YR-Pink, Strong brown, Gray, Black

10YR- Yellow, Yellowish brown, Dark gray, Very dark grayish brown.

Reference: 1. U.S.Dept. of Agriculture (1969)

2. Munsell colour chart

Soil Drainage and Permeability

Soil drainage in a dynamic sense refers to the rapidity and extent of the removal of water from the soil, in relation to additions, especially by surface runoff and by flow through the soil to underground spaces. Drainage affects the water air relationship in soils and suggests availability of oxygen to plants. Drainage data can be interpreted for determining the suitability of soils for different crops and crop planning. Precise knowledge of drainage conditions help in identifying the areas suitable for irrigation.

The concept of soil drainage has 3 aspects

a) Runoff-external soil drainage
b) Internal soil drainage
c) Soil permeability

Soil permeability is the quality of the soil that enables it to transmit water or air, which can be measured quantitatively in terms of rate of flow of water through a unit cross section of saturated soil in unit time, under specified temperature and hydraulic conditions. In the absence of precise measurements soils may be placed into relative permeability classes through studies of structure, texture, porosity, cracking and other characteristics of soil profile in relation to local use experience.

Table 5.16 : Soil Drainage Classes in Karnataka by Area

Sl. No	Class	000 ha	%TGA
1	Excessively drained	476.2	2.5
2	Somewhat excessively drained	2886.2	15.1
3	Well drained	10859.2	57.0
4	Moderately well drained	4097.6	21.0
5	Imperfectly drained	45.7	0.2
6	Poorly drained	95.3	0.5

Source: *NBSS* (1998)

Available water capacity of the soil is nothing but the ability of the soil column to retain water between the tensions 0.33 bar (i.e. wilting point) and 15 bar (i.e. field capacity) in a depth of 100 cm or the entire column whichever is earlier. This is largely influenced by soil properties such as soil texture, soil depth, kind of clay minerals and gravel content. This information is of a great value for crop planning particularly in drought prone areas. There are 4 classes in respect of water capacity of soil in Karnataka.

Table 5.17 : Water Capacity of Soils in Karnataka by Area

Class	AWC (mm/m)	Area	
		000' Ha	%TGA
Very low	<50	4306.1	22.6
Low	50-100	4114.1	21.6
Medium	100-150	5676.1	29.9
High	>150	4356.4	22.9

Source: *NBSS* (1998)

Soil Erosion

The term soil erosion is used for accelerated soil erosion resulting from disturbance of the natural landscape by burning, excessive grazing, forest cutting and over tillage usually by man. All these activities result in degradation of soil and landscape. The following symbols are used to indicate the different degrees of erosion during 1985-90.

e_1 – No or slight erosion: 25 % of 'A' horizon (topsoil) is lost

e_2 – Moderate erosion: 50 to 75 % of 'A' is lost

e_3 – Severe erosion: entire 'A' horizon is lost, 'B' (sub soil) is exposed, incipient gullies.

e_4 – Very severe erosion: 25 to 75 % of 'B' is lost, plough layer in 'B' horizon, few shallow gullies or an occasional deep gully.

Table 5.18 : Soil Erosion Status Over the Period in Karnataka

Erosion Class	Total Affected Area (000 Ha)		% to TGA	
	1985-90	2001	1985-90	2001
Slight	5660	2993.3	30.7	15.7
Moderate	10146.4	6716.4	55.0	35.2
Strong	NA	5101.7	NA	26.8
Severe	2604.1	2128.6	14.1	11.2
Very Severe	42.2	1761.2	0.2	9.2
Extremely Severe	NA	367	NA	1.9
Total	**18452.7**	**19068**	**100**	**100**

In 2001 the following classification was used for determining the soil loss:

Slight	= 5
Moderate	5-10
Strong	10-15
Severe	15-20
Very severe	20-40
Extremely severe	= 40

Soil Gravelliness

The term gravel refers to mass of pebbles, i.e. coarse fragments with size 2 mm to 75 mm (< 2 mm fractions will become soil particles) that include rock and mineral fragments and pieces of ironstone. The presence of gravel in the soil influences moisture storage, infiltration and runoff and hinders plant growth by impeding root growth and seedling emergence.

Table 5.19 : Extent of Soil Gravelliness in Karnataka

Class	Gravel (%)	Area '000 ha	% TGA
Slight	< 15	11442.9	60
Moderate	15 – 35	1066.3	5.6
Strong	> 35	5943.5	31.2

Source: *NBSS* (1998)

Slope

Slope refers to the inclination of the surface of the soil area. It is an integral part of any soil as a natural body, not something apart from it. A simple or single slope is defined by its gradient, shape and length. The length and gradient of slope influences soil formation and soil depth and as such affects land use and land development. Slope classes and their respective area are given below.

Table 5.20: Slope Classes and Their Respective Area in Karnataka

Sl No.	Classes	% Slope	Area 000' Ha	% TGA
1	Level to nearly level	0 – 1 %	3244.0	17.58
2	Very gently sloping	1 – 3 %	7122.8	38.60
3	Gently sloping	3 – 8 %	5921.6	32.09
4	Moderately sloping	8 – 15 %	882.1	4.78
5	Moderate steeply sloping	15 – 30 %	396.7	2.15
6	Steely sloping	> 30 %	350.6	1.90

Source: *NBSS* (1998)

Soil Degradation

In spite of the organized agricultural research Indian productivity level in food grains is still way behind the developed countries. Increasing demand for food and other allied products due to the fast growing population has led to over exploitation of our natural resources and has ultimately degraded and polluted them to an unacceptable level. The availability of cultivated lands has compelled us to practice arable farming on lands, which are not suitable for cultivation, and thus has put more stress on this ecologically vulnerable resource.

Soil degradation is presently viewed as a serious and widespread problem. In order to tackle this problem and suggest ameliorative measures, it is necessary to assess the extent, type and severity of soil degradation. Here, the type of soil degradation refers to the process that causes the degradation. For example, displacement of soil material by water etc.

Soil degradation status of Karnataka was assessed from the soil map having 121 soil units at association of soil families with phases. Each mapping unit was assessed for the kind, degree and extent of degradation. The severity class was worked out based on the degree and extent of degradation.

Table 5.21: Soil Degradation Status in Karnataka (1985-1990)

1.Kind of degradation	Degree of degradation				Total area ('000 ha)	% TGA
	Slight	Moderate	Strong	Extreme		
Water erosion	661	3675	139	1393	5868	30.6
Nutrient loss	-	-	600	30	630	3.3
Salinity	-	100	-	-	100	0.5
Sodicity	-	-	10	-	10	0.1
Water erosion + compaction & crusting	420	472	-	49	941	4.9
Water erosion + nutrient loss	55	47	30	-	132	0.6
				Total	7681	40.0

Source: *NBSS* (1998)

Table 5.22 : Soil Degradation Status in Karnataka: 1999/2003

Type of Area	Area (000 Ha)	% TGA
Total Degraded Area (1999)	11400	51.0
Salt Affected (Salinity & Alkalinity) Area (1999)	179	0.9
Total Waste Land of the State (2003) for 14 dist	17096	12.27

Source: *1. Saxena and Pofali (1999)*

Table 5.23 : Area Affected by Salinity of Soil in Karnataka: 2000

Projects	Area (in Ha)
1) Tungabhadra	26018
2) Malaprabha	1807
3) Ghataprabha	3504
4) U.K.P	5639

Source: *KSLUB* (2001)

Land Capability of Soil

Land capability classification is an interpretative grouping of soils mainly based on (1) the inherent soil characteristics, (2) external land features (3) Environmental factors that limit the use of land. Information on the first two terms is provided by standard detailed soil survey. Scientific survey and classification of soils are the primary requirements for uses of varying intensity. So totally there are 8 capability classes I to IV being arable and V to VIII are non-arable type land.

These classes are subdivided into land capability subclasses based on predominant hazards or limitations operating on the land. Thus the following 4 hazards are recognized and the symbol indicated against each are used as suffix to the concerned land use class.

(i) **E**rosion and runoff ……. e

(ii) Excess of water (wetness, high
Water table, drainage problem) …… w

(iii) Root zone limitations (shallow depth,
low water-holding capacity,
Salinity or alkalinity)……s

(iv) **C**limatic limitations …….c

Table 5.24: Land Capability of Soils in Karnataka

Land Capt. Class	Description	Area		Remarks
		000 ha	% TGA	Subclass with % TGA
II	Good cultivable lands having minor problems (texture, drainage, erosion etc)	3548.9	18.6	II w 4.95
				II s 9.43
				II es 4.26
III	Moderately good cultivable lands with moderate erosion, slope, drainage and soil problems	7746.9	40.7	III e 21.29
				III w 0.55
				III c 2.03
				III es 16.79
IV	Fairly good cultivable lands having severe erosion, drainage, climate and soil problems	4411.3	23.2	IV w 0.52
				IV c 4.55
				IV es 18.09
VI	Land well suited for grazing & forestry having severe erosion, topography and soil problems.	2745.9	14.4	VI e 11.13
				VI es 3.28
VIII	Lands suitable only for wildlife recreation and quarrying	486.4	2.5	VIII 2.55

Source: *NBSS* (1998)

Land Irrigability of Soil

Land irrigability classification is an interpretation grouping of soil based on physical and socio-economic factors in addition to the soil irrigability and is primarily concerned with predicting the behaviour of soils when they are brought under irrigation. Lands suitable for irrigation are grouped under classes 1 to 4 according to their limitations. Lands not suited for irrigation are placed under classes 5 and 6.

Like land capability classes, land irrigability classes are subdivided based on certain limitations. They are indicated by suffixing the letters by ‘s’ ‘t’or ‘d’ to the class number. Here ‘s’ represents the limitations in soil, ‘t’ refers to topography and ‘d’ for drainage.

Table 5.25 : Land Irrigability of Soils of Karnataka

Irrigability class	Description	Area	
		'000 ha	%TGA
2	Lands that have moderate limitations of soil & drainage for sustained use under irrigation	3701.1	19.4 (2s-13.42) (2d-6.01)
3	Lands that have severe limitations of soil, drainage & slope for sustained use under irrigation.	8696.6	45.7 (3s-36.5) (3st-9.15)
4	Lands that have very severe limitations of topography & soil for sustained use under irrigation.	3224.9	16.9 (4st – 12.47) (4s-4.46)
5	Lands not suitable for irrigation due to topographic, soil & rock exposure limitations	3316.7	17.41

Note: Figures in parenthesis indicate the land irrigability subclasses with their respective %TGA
Source: *NBSS* (1998)

Amelioration cost of problematic Soil in Karnataka

Table 5.26 provides a synoptic view of the Area under Different Soil Quality Parameters in Karnataka. Table 5.27 and 5.28 provide the estimates of Reclamation of degraded lands for Karnataka and amelioration cost of problematic soils in Karnataka state for the year 2003-04. These estimates have been obtained by using the market prices of inputs and labour. The approach used here to value the environmental damage is through the restoration cost method. The restoration cost of the soil degradation is estimated to be about Rs 468.2 crore. On the basis of this estimates we have estimated the contribution of land resources to SDP and it is provided in Box 5.2.

We have used the data on cost of soil loss for one year to estimate its share in SDP, as we did not have the data over a period of time to capture the changes in terms of degradation of soil/land for the state.

Table: 5.26: Area Under Different Soil Quality Parameters in Karnataka

Soil Quality Parameters for Karnataka		
Soil Depth (Depth range in Cms)	**Area ('000 Ha)**	**% T G A**
<25	2624	14
25-50	498	3
50-100	4424	23
100-150	10908	57
Total	**18453**	**97**
Soil Texture	Area ('000 Ha)	% T G A
Sandy soils	84	0
Loamy soils	7205	38
Clayey soils	11164	59
Total	**18453**	**97**
Soil Drainage	Area ('000 Ha)	% T G A
Excessively drained	476	3
Somewhat excessively drained	2886	15
Well drained	10859	57
Moderately well drained	4098	21
Imperfectly drained	46	0
Poorly drained	95	1
Total	**18460**	**96**
Soil Available Water Capacity (AWC Class in m m/m)	Area ('000 Ha)	% T G A
Very low (<50)	4306	23
Low (50-100)	4114	22
Medium (100-150)	5676	30
High (>150)	4356	23
Total	**18453**	**97**

Soil Quality Parameters for Karnataka		
Soil Depth (Depth range in Cms)	**Area ('000 Ha)**	**% T G A**
Slight (<15)	11443	60
Moderate (15-35)	1066	6
Strong (>35)	5944	31
Total	**18453**	**97**
Soil Slope (Class in % slope)	Area ('000 Ha)	% T G A
Level to nearly level (0-1)	3244	18
Very gently sloping(1-3)	7123	39
Gently sloping (3-8)	5922	32
Moderately sloping (8-15)	882	5
Moderate steeply sloping(15-30)	397	2
Steely sloping (>30)	351	2
Total	**17918**	**97**
Soil Colour	Area ('000 Ha)	% T G A
Gravelly red loam	316	2
Non gravelly red loam	191	1
Gravelly red clay	3611	19
Non gravelly red clay	2990	14
Shallow black	**1596**	**8**
Medium deep black	598	3
Deep black	3109	16
Total	**12411**	**63**

Source: NBSS & LUP, Bangalore; Dept of Agriculture, GoK (1998)

Table 5.27: Reclamation of Degraded Lands for Karnataka (2003-04)

Category	Area ('000 Ha)	Conservation Structures	Unit	Unit Cost
Eroded Land	19068	1. Farm Ponds (12m*12m)	No	25000
		2. Contour Bunds	Ha	4800
		3. Graded Bunds	Ha	5000
		4. Check Dams	No	80000
		5. Vegetative Barriers	No	500
Guilled/Ravinous Land	30.2	1. Vented Dam	No	150000
		2. Vegetative Filter Strips	No	200
		3. Brushwood Check Dams	Ha	1000
		4. Drop Spillway	No	150000
Sands (Deserted Lands)	4.5	1. Incorporation of Fine Materials (Silt, Fine Earth, Organic Masures)	Ha	10000
Steep Sloping Lands	5	1. Contour Bunds	Ha	4800
		2. Bench Terraces	Ha	20000
		3. Graded Trenches	Ha	18000
		4. Vegetative Filter Strips	No	200
Gravelly/Stony Lands (>35%)	5943	1. Removal of Coarse Fragments	Ha	5000
		2. Rubble Boudler Checks(RBC)	Ha	4000
Rocky Land (Rock out Crops)	263	1. Contour Trenches (4*0.6*0.4m3)	No	200
		2. Catch Pits (Depending on Size)	No	1000

Unit costs are as per current SR (Schedule of Rates) of GoK; Local needs and resource availability will influence the unit cost estimates

Table 5.28: Amelioration Cost of Problematic Soils in Karnataka State (2003-04)

Category (Nature of Problems)	Area (000 Ha)	Amelioration				Mandays Per Ha					Other Costs (Rs)	Reclamation Cost Per Ha (Rs)	Total Cost (Lakh Rs)
		Input	Quantity (Ton/Ha)	Price (Rs)	Cost/ Ha (Rs)	Skilled		Unskilled		Total Amount (Rs)			
						No	Wages	No	Wages				
1. Saline Soils	95	,---	,---	,---	,---	10	1000	50	2500	3500	2000 (Irrigation & Machinery)	5500	5225
2. Sodic (Alkali Soils)	84	Gypsum (CaSO4H2O)	1.5	1500/ Ton	2250	15	1500	50	2500	4000	3000 (Irrigation & Machinery)	9250	7770
3. Acid Soils	1227	Agri. Lime (CaO 40%)	1	900/Ton	900	5	500	10	500	1000	600 (Machinery)	2500	30675
4. Water Logged Soils	63	,---	,---	,---	,---	10	1000	20	1000	2000	3000 (Drainages, Diversions, Waste Weirs)	5000	3150
Total													46820
Source: Estimates derived in consultation with Agriculture Dept and State Soil Survey Dept, GoK													

Box-5.2 Accounting of land resources in SDP

It was found that there is very marginal change in agricultural land over the years. The present study used the replacement cost technique to work out the cost of degradation. Soil nutrient loss has been treated as the annual decline in contribution of the land resources to SDP. In the present study the treatment of cost of soil is Rs 468.20 crores in the year 2003-04. Assuming the average annual inflation rate of 5 % in Karnataka, we deflated the soil nutrient treatment cost by 5 % and it was Rs 444.79 crores in the year 2002-03. This amount was subtracted from the contribution to SDP by agriculture sector to arrive at the adjusted SDP for this sector. The contribution to SDP without adjustment was 20.3 % and after **adjusting it was 19.9 %.** The contribution has declined marginally on account of degradation of land/soil.

5.10 Summary:

This chapter provides a perspective on degradation of land resources. As mentioned in the introductory section, there is a need to classify land in the state on a regular basis with respect to the intensity of degradation and the types of degradation. The format provided by the FAO is worth emulating in this regard as such data can provide a good guide to the policy making. We then discussed the SEEA (2003) framework for accounting for land resources and the associated difficulties with it. As land is usually not sold as a stand alone asset in the market, market value of land may consist of the value for location of the land (for commercial and industrial purposes), fertility of land (for agricultural purposes), etc. Moreover, land markets are rather thin as compared to the other assets. The data on land use and land cover is required in a matrix form to prepare the physical accounts for land. With the data at our disposal, we have been able to prepare the physical account for land use. The data requirements are enormous for preparing physical accounts itself, leaving alone monetary accounts for land resources. We have identified the impacts of land degradation; both environmental and socio-economic, in a PASIR framework for the state. As soil is one of the most important determinants of land quality for agricultural purposes, we have provided an in-depth overview of the soil resources of the state and also provided estimates of restoration of soil based on restoration cost approach. These estimates are used to estimate the adjusted SDP in the agriculture sector of the state which was 19.5 per cent as against 20.3 per cent without adjustment of land degradation.

Table A5.1: Land degradation: severity of human-induced degradation: Asia and Pacific

Land degradation													
Country	**Total area '000 km²**	**None**		**Light**		**Moderate**		**Severe**		**Very Severe**		**Cause**	**Type**
		'000 km²	**%**	**'000 km²**	**%**	**'000 km²**	**%**	**'000 km²**	**%**	**'000 km²**	**%**		
Australia	7667	3027	39	1183	15	3211	42	246	3	0	0	O	W,N
Bangladesh	144	7	5	0	0	98	68	39	27	0	0	A,D	C,W
Bhutan	47	1	2	31	67	11	24	0	0	3	7	D,O	W
Brunei	6	0	0	0	0	0	0	6	100	0	0	A,D	P,C,W
Cambodia	181	23	13	4	2	65	36	48	27	40	22	D	W
China	9550	2644	28	776	8	2835	30	2347	25	948	10	D,A	W,N
Fiji	18	18	100	0	0	0	0	0	0	0	0	NA	NA
Hong Kong	1	0	0	1	100	0	0	0	0	0	0	A	W
India	**3157**	**1184**	**37**	**16**	**1**	**111**	**4**	**1352**	**43**	**494**	**16**	**D,A**	**W,C**
Indonesia	1916	10	1	695	36	497	26	607	32	108	6	D,A	W,C
Japan	369	305	82	65	18	0	0	0	0	0	0	A	W
Korea, Dem People's Rep.	122	0	0	0	0	101	83	21	17	0	0	D,O,A	W,C
Korean Rep.	98	0	0	0	0	57	58	41	42	0	0	A,D	W,C
Laos	237	0	0	37	16	197	83	0	0	3	1	D	W
Malaysia	333	0	0	0	0	55	17	277	83	0	0	D,A	W,C
Mongolia	1560	235	15	321	21	606	39	399	26	0	0	A,O	N,W
Myanmar	677	9	1	0	0	424	63	237	35	6	1	D,A	W,C
Nepal	141	32	23	41	29	29	20	39	27	0	0	D,O	W
New Zealand	265	23	9	67	25	157	59	18	7	0	0	D,O	W
Pakistan	802	200	25	16	2	391	49	178	22	18	2	D,O,A	W,N,C
Papua New Guinea	462	363	79	84	18	15	3	0	0	0	0	D	W
Philippines	299	9	3	0	0	53	18	227	3	10	3	D	W
Solomon Islands	30	0	0	0	0	30	100	0	0	0	0	D	W
Sri Lanka	65	0	0	11	17	19	29	14	22	21	32	D,A	W,C
Thailand	513	0	0	10	2	102	20	144	28	258	50	D,A	W,C
Viet Nam	329	0	0	0	0	71	21	97	29	162	49	D,A	W,C
Total	**28989**	**8089**	**28**	**3357**	**12**	**9136**	**32**	**6336**	**22**	**2071**	**7**	**-**	**-**

Cause: A = agriculture; O = overgrazing; D = deforestation; I = industrialisation; V = over exploitation of vegetation

Type: W = water erosion; N = wind erosion; C = chemical deterioration; P = physical deterioration

Source: www.fao.org

Table A5.2: Human-induced land degradation due to agric. Activities: Asia and Pacific

Country	Land degradation (total)					Land degradation due to agric. activities				
	Total area	Severe	Very severe	Total degradation	% of total area degraded	Severe	Very severe	Total degradation	% of degraded area	% of total area
	'000 km²	'000 km²	'000 km²	'000 km²	%	'000 km²	'000 km²	'000 km²	%	%
Australia	7 667	246	0	246	3	146	0	146	59	2
Bangladesh	144	39	0	39	27	20	0	20	53	14
Bhutan	47	0	3	3	7	0	0	0	0	0
Brunei	6	6	0	6	100	4	0	4	63	63
Cambodia	181	48	40	89	49	0	8	8	9	4
China	9 550	2 347	948	3 295	35	1 887	182	2 069	63	22
Fiji	18	0	0	0	0	0	0	0	NA	0
Hong Kong	1	0	0	0	0	0	0	0	NA	0
India	**3 157**	**1 352**	**494**	**1 846**	**58**	**266**	**0**	**266**	**14**	**8**
Indonesia	1 916	607	108	714	37	152	65	217	30	11
Japan	369	0	0	0	0	0	0	0	NA	0
Korea, Dem People's Rep.	122	21	0	21	17	21	0	21	100	17
Korean Rep.	98	41	0	41	42	41	0	41	100	42
Laos	237	0	3	3	1	0	0	0	0	0
Malaysia	333	277	0	277	83	38	0	38	14	11
Mongolia	1 560	399	0	399	26	335	0	335	84	21
Myanmar	677	237	6	243	36	126	0	126	52	19
Nepal	141	39	0	39	27	0	0	0	0	0
New Zealand	265	18	0	18	7	5	0	5	30	2
Pakistan	802	178	18	195	24	44	0	44	23	6
Papua New Guinea	462	0	0	0	0	0	0	0	NA	0
Philippines	299	227	10	237	79	0	0	0	0	0
Solomon Islands	30	0	0	0	0	0	0	0	NA	0
Sri Lanka	65	14	21	35	54	0	0	0	0	0
Thailand	513	144	258	401	78	64	12	76	19	15
Viet Nam	329	97	162	259	79	71	19	90	35	27
Total	**28 989**	**6 336**	**2 071**	**8 407**	**29**	**3 220**	**285**	**3 506**	**42**	**12**

Source: www.fao.org

Table A5.3: Land degradation severity and population distribution: Asia and Pacific

Country	Total area	None		Light		Moderate		Severe		Very Severe	
	'000 km²	area (%)	Population density	area (%)	Population density	area (%)	Population density	area (%)	Population density	area (%)	Population density
Australia	7 667	39	1	15	1	42	0	3	0	0	NA
Bangladesh	144	5	407	0	NA	68	901	27	610	0	NA
Bhutan	47	2	170	67	34	24	10	0	NA	7	38
Brunei	6	0	NA	0	NA	0	NA	100	43	0	NA
Cambodia	181	13	136	2	67	36	26	27	13	22	82
China	9 550	28	3	8	89	30	31	25	43	10	49
Fiji	18	100	23	0	NA	0	NA	0	NA	0	NA
Hong Kong	1	0	NA	100	1084	0	NA	0	NA	0	NA
India	**3 157**	**37**	**343**	**1**	**377**	**4**	**291**	**43**	**252**	**16**	**169**
Indonesia	1 916	1	20	36	30	26	47	32	147	6	309
Japan	369	82	254	18	523	0	NA	0	NA	0	NA
Korea, Dem People's Rep.	122	0	NA	0	NA	83	131	17	368	0	NA
Korean Rep.	98	0	NA	0	NA	58	143	42	705	0	NA
Laos	237	0	NA	16	28	83	17	0	NA	1	56
Malaysia	333	0	NA	0	NA	17	156	83	33	0	NA
Mongolia	1 560	15	1	21	1	39	1	26	3	0	NA
Myanmar	677	1	184	0	NA	63	71	35	119	1	6
Nepal	141	23	164	29	42	20	127	27	174	0	NA
New Zealand	265	9	8	25	28	59	5	7	9	0	NA
Pakistan	802	25	144	2	835	49	145	22	124	2	90
Papua New Guinea	462	79	9	18	8	3	7	0	NA	0	NA
Philippines	299	3	131	0	NA	18	128	3	208	3	356
Solomon Islands	30	0	NA	0	NA	100	8	0	NA	0	NA
Sri Lanka	65	0	NA	17	135	29	385	22	428	32	110
Thailand	513	0	NA	2	116	20	55	28	101	50	137
Viet Nam	329	0	NA	0	NA	21	227	29	324	49	125
Total	**28 989**	**28**	**19**	**12**	**5**	**32**	**13**	**22**	**26**	**7**	**8**

Source: www.fao.org

Table A5. 4: Land Use Pattern in the Various Districts of Karnataka as a % of the State Area under a Given Use (2001-02)

District	Total Geographical Area	Area under forest	Not available for cultivation		Cultivable wasteland	Uncultivated land		Fallow Land		Net Area Sown	Total Gross Cropped Area	Area sown more than once
			Land put to non-agricultural use	Barren and uncultivable land		Permanent pasture and grazing land	Land under trees and groves	Current fallows	Other fallows			
Bagalkote	3.5	2.6	2.2	3.1	0.5	0.4	0.1	4.2	2.3	4.3	4.1	2.4
Bangalore (Urban)	1.1	0.1	6.9	0.6	1.0	0.5	2.5	0.9	0.7	0.8	0.8	0.4
Bangalore (Rural)	3.1	2.6	4.4	4.5	1.4	3.2	7.2	2.1	4.8	2.9	2.8	2.3
Belgaum	7.1	6.2	5.2	5.6	3.0	2.6	0.4	15.4	1.7	7.3	7.5	8.6
Bellary	4.3	3.2	5.2	6.8	5.9	0.6	1.2	5.5	1.7	4.6	4.5	4.1
Bidar	2.8	0.9	1.7	2.4	4.6	1.5	3.6	1.7	6.3	3.7	3.9	4.8
Bijapur	5.5	0.1	2.4	3.7	1.3	1.0	0.4	16.9	1.3	6.7	6.5	4.9
Chamarajanagar	3.0	9.0	1.8	2.7	1.8	2.4	1.6	2.0	5.9	1.5	1.7	3.1
Chickmagalur	3.8	6.5	3.2	3.6	5.1	10.2	7.1	1.2	1.4	2.8	2.6	1.3
Chitradurga	4.0	2.4	3.9	3.2	5.1	9.3	3.7	2.9	6.1	4.2	4.2	4.1
Dakshina Kannada	2.5	4.2	4.5	7.5	7.7	2.0	10.7	0.4	1.2	1.3	1.4	1.7
Davanagere	3.1	2.9	2.9	2.6	2.2	2.0	1.7	2.3	2.2	3.6	3.7	4.3
Dharwad	2.2	1.1	1.6	0.5	0.6	0.4	0.1	1.2	2.1	3.3	4.1	9.1
Gadag	2.4	1.1	0.8	1.5	0.2	0.3	0.1	0.4	1.9	3.9	3.8	3.0
Gulbarga	8.5	2.3	5.1	8.0	2.8	3.9	0.6	9.9	4.7	11.6	11.5	10.5
Hassan	3.5	1.9	5.9	3.9	3.8	3.5	2.1	2.5	6.2	3.7	3.5	2.7
Haveri	2.5	1.5	2.4	0.7	0.7	1.3	0.6	1.8	1.2	3.5	3.7	5.5
Kodagu	2.2	4.4	1.8	3.9	2.8	1.9	10.7	0.5	0.9	1.5	1.3	0.1
Kolar	4.1	2.3	5.6	8.0	3.0	10.3	4.5	5.0	2.2	3.5	3.2	1.3
Koppal	2.9	1.0	2.9	2.1	0.6	1.5	0.1	4.0	5.0	3.6	3.7	4.7
Mandya	2.6	0.8	4.6	2.7	9.9	4.0	1.1	2.2	5.4	2.5	2.5	2.4
Mysore	3.6	2.0	5.1	5.8	5.1	5.8	2.3	0.9	2.4	3.9	4.2	6.3
Raichur	4.4	0.6	1.6	2.5	2.5	2.1	4.5	9.5	10.9	5.2	5.2	5.1
Shimoga	4.5	9.0	6.7	1.7	4.0	17.3	9.0	0.8	7.7	2.1	2.1	1.7
Tumkur	5.6	1.5	6.3	8.6	14.8	8.9	6.7	5.0	9.4	5.7	5.4	3.2
Udupi	1.9	3.2	2.9	1.5	7.8	1.1	16.1	0.2	2.0	1.0	1.1	1.7
Uttara Kannada	5.4	26.5	2.6	2.1	1.7	2.0	1.5	0.5	2.4	1.1	1.0	0.6
Karnataka (Hectare)	**19049836**	**3069980**	**1325211**	**788100**	**423270**	**956051**	**301842**	**1728355**	**425535**	**10031492**	**11669750**	**1638258**

Table A5.5: Land Use Pattern in the Various Districts of Karnataka as a % of the Geographic Area of the District (2001-02)

District	Total Geographic Area in '000 hactare	As a % of the District Area										
		Area under forest	Not available for cultivation		Cultivable wasteland	Uncultivated land		Fallow Land		Net Area Sown	Total Gross Cropped Area	Area sown more than once
			Land put to non-agricultural use	Barren and uncultivable land		Permanent pasture and grazing land	Land under trees and groves	Current fallows	Other fallows			
Bagalkote	658877	12.3	4.4	3.8	0.3	0.5	0.0	11.0	1.5	66.2	72.1	5.9
Bangalore (Urban)	217410	1.5	42.2	2.2	2.0	2.4	3.5	7.2	1.3	37.6	40.7	3.1
Bangalore (Rural)	585431	13.9	9.9	6.1	1.0	5.2	3.7	6.3	3.5	50.4	56.7	6.3
Belgaum	1344382	14.2	5.1	3.3	0.9	1.8	0.1	19.8	0.5	54.2	64.7	10.5
Bellary	813196	11.9	8.4	6.6	3.1	0.7	0.4	11.7	0.9	56.3	64.6	8.3
Bidar	541765	5.1	4.1	3.5	3.6	2.6	2.0	5.5	5.0	68.7	83.2	14.5
Bijapur	1053471	0.2	3.0	2.8	0.5	0.9	0.1	27.7	0.5	64.3	71.9	7.7
Chamarajanagar	569901	48.4	4.3	3.8	1.3	4.0	0.8	6.2	4.4	26.9	35.7	8.8
Chickmagalur	722075	27.8	5.9	3.9	3.0	13.5	3.0	3.0	0.8	39.1	42.1	3.0
Chitradurga	770702	9.6	6.6	3.3	2.8	11.5	1.5	6.5	3.4	54.8	63.6	8.7
Dakshina Kannada	477149	26.9	12.5	12.4	6.9	4.1	6.8	1.4	1.1	28.0	34.0	6.0
Davanagere	597597	15.0	6.5	3.4	1.5	3.3	0.8	6.6	1.6	61.2	73.0	11.8
Dharwad	427329	8.2	5.0	0.9	0.6	0.8	0.0	4.7	2.1	77.6	112.4	34.8
Gadag	465715	7.0	2.2	2.5	0.2	0.6	0.0	1.4	1.7	84.3	95.0	10.7
Gulbarga	1610208	4.3	4.2	3.9	0.7	2.3	0.1	10.6	1.3	72.6	83.2	10.7
Hassan	662602	8.8	11.8	4.6	2.4	5.0	1.0	6.6	4.0	55.9	62.5	6.6
Haveri	485156	9.8	6.5	1.2	0.6	2.6	0.4	6.5	1.1	71.4	89.8	18.4
Kodagu	410775	32.8	5.8	7.5	2.9	4.3	7.8	2.1	1.0	35.8	36.2	0.4
Kolar	779467	9.0	9.5	8.1	1.6	12.7	1.7	11.2	1.2	45.0	47.7	2.8
Koppal	552495	5.3	7.0	3.0	0.5	2.7	0.0	12.5	3.8	65.2	79.0	13.8
Mandya	498244	5.0	12.2	4.3	8.4	7.7	0.6	7.6	4.6	49.6	57.5	7.9
Mysore	676382	9.3	9.9	6.8	3.2	8.2	1.0	2.4	1.5	57.8	73.1	15.3
Raichur	835843	2.2	2.5	2.4	1.3	2.4	1.6	19.7	5.6	62.5	72.5	10.1
Shimoga	847784	32.7	10.4	1.6	2.0	19.6	3.2	1.6	3.9	25.1	28.5	3.3
Tumkur	1064755	4.2	7.9	6.3	5.9	8.0	1.9	8.1	3.7	54.0	58.9	4.9
Udupi	356446	27.9	10.8	3.3	9.3	3.0	13.6	1.2	2.4	28.5	36.3	7.8
Uttara Kannada	1024679	79.5	3.3	1.6	0.7	1.9	0.4	0.9	1.0	10.6	11.6	1.0
Karnataka	**19049836**	**16.1**	**7.0**	**4.1**	**2.2**	**5.0**	**1.6**	**9.1**	**2.2**	**52.7**	**61.3**	**8.6**

Table A5.6: Area under principal crops in Karnataka(Lakh hectares)

Crop	1970-71	1980-81	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-2001(P)	2001-2002(A)
Rice	11.71	11.14	11.73	12.83	13.17	13.74	12.96	12.65	13.59	13.53	14.27	14.50	14.82	14.02
Ragi	10.64	10.57	10.55	11.18	10.38	10.29	9.44	10.20	10.35	9.39	10.31	9.16	10.21	8.97
Jowar	22.25	19.91	21.55	21.05	23.06	20.85	21.65	19.76	19.99	18.97	18.50	20.24	17.81	17.75
Bajra	5.62	5.64	4.25	4.14	3.75	3.00	2.94	4.00	4.17	3.02	4.17	4.22	4.42	2.51
Maize	0.63	1.57	2.50	2.83	3.15	3.18	3.44	3.65	4.46	5.61	5.12	6.06	6.69	5.92
Wheat	3.43	3.22	1.98	1.99	2.24	2.37	2.44	2.19	2.48	2.51	2.69	2.61	2.66	2.70
Minor millets	5.43	3.68	1.59	1.29	1.17	1.18	1.04	0.91	0.92	0.75	0.90	0.66	0.68	0.80
Total cereals	59.71	55.73	54.15	55.31	56.92	54.61	53.91	53.36	55.96	53.78	55.96	57.45	57.29	52.67
Tur	3.04	3.36	4.63	5.10	4.50	3.61	3.02	4.24	4.45	4.22	4.75	5.08	5.83	4.35
Total pulses	14.45	15.31	16.21	17.87	16.60	15.23	16.48	15.20	17.76	16.82	18.20	19.20	20.61	18.13
Total foodgrains	74.16	71.04	70.36	73.18	73.52	69.84	70.39	68.56	73.72	70.60	74.16	76.65	77.90	70.80
Groundnut	10.27	7.90	12.12	13.59	12.76	12.43	12.00	11.92	12.85	10.40	12.30	11.20	10.63	9.04
Total oilseeds	13.98	12.15	25.51	30.22	27.72	31.27	25.65	26.17	26.06	23.72	23.37	19.82	18.89	18.12
Sugarcane	1.04	1.54	2.72	2.85	2.61	3.01	3.45	3.23	2.82	3.09	3.39	3.73	4.21	3.78
Cotton	11.42	10.12	5.96	5.86	6.30	5.71	6.36	6.78	6.60	5.02	6.36	5.46	5.60	5.81
Total of the Above	247.78	232.88	245.81	259.29	257.85	250.32	245.17	242.82	256.18	241.43	254.45	256.04	258.25	235.37

Table A5.7: Productivity of Land for Different Crops in Karnataka (tones per hectare)

Crop	1970-71	1980-81	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-2001	2001-2002	2002-03
Rice	1.71	2.03	2.07	2.22	2.33	2.32	2.44	2.39	2.36	2.37	2.56	2.56	2.59	2.23	2.07
Ragi	0.84	1.01	0.93	1.32	1.48	1.52	1.43	1.59	1.44	1.36	1.68	1.53	1.79	1.44	0.93
Jowar	0.70	0.76	0.59	0.78	0.84	0.91	0.76	0.87	0.95	0.66	0.89	0.88	0.87	0.82	0.69
Bajra	0.38	0.34	0.48	0.48	0.57	0.61	0.40	0.67	0.65	0.44	0.68	0.60	0.74	0.41	0.39
Maize	3.44	2.43	2.52	3.02	3.10	2.98	2.87	3.13	3.11	2.69	3.26	2.65	3.19	2.36	2.07
Wheat	0.38	0.54	0.62	0.70	0.71	0.81	0.72	0.53	0.77	0.47	0.81	0.84	0.94	0.86	0.60
Minor millets	0.41	0.38	0.40	0.49	0.47	0.52	0.49	0.44	0.43	0.51	0.47	0.42	0.66	0.43	0.56
Total cereals	0.88	1.03	1.05	1.31	1.39	1.47	1.39	1.49	1.52	1.40	1.65	1.57	1.74	1.45	1.20
Tur	0.50	0.37	0.38	0.36	0.19	0.43	0.39	0.48	0.51	0.23	0.47	0.57	0.45	0.33	0.47
Total pulses	0.35	0.32	0.33	0.38	0.34	0.41	0.38	0.45	0.41	0.29	0.41	0.44	0.47	0.32	0.34
Total foodgrains	0.77	0.87	0.89	1.08	1.16	1.24	1.15	1.26	1.25	1.14	1.35	1.29	1.41	1.16	
Groundnut	0.76	0.60	0.67	0.81	0.89	0.96	0.79	0.96	0.89	0.68	0.97	0.69	1.02	0.68	0.64
Total oilseeds	0.63	0.53	0.52	0.60	0.63	0.60	0.60	0.67	0.67	0.48	0.72	0.60	0.80	0.58	
Sugarcane	77.94	78.75	76.29	84.43	86.13	75.09	95.92	85.32	82.89	93.85	102.57	95.89	102.90	95.95	84.88
Cotton	0.50	0.59	1.07	1.63	1.37	1.24	1.28	1.42	1.53	1.26	1.54	1.22	1.55	1.37	0.84

Table A5.8: Consumption of Fertilizer from 1970-71 to 2002-03 in Karanataka (in Tonnes)					
Si. No	**Year**	**Nitrogen**	**Phosphorus**	**Potash**	**Total**
1	1970-71	92510	37200	26080	155790
2	1971-72	98000	41500	27000	166500
3	1972-73	109008	52873	34693	196574
4	1973-74	107020	48290	39450	194760
5	1974-75	130000	54000	47800	231800
6	1975-76	131389	38118	34313	203820
7	1976-77	133151	43659	32710	209520
8	1977-78	160871	56755	52585	270211
9	1978-79	204433	81598	75139	361170
10	1979-80	204003	86567	75844	366414
11	1980-81	193111	80923	69836	343870
12	1981-82	211816	92291	79543	383650
13	1982-83	221202	97346	82844	401392
14	1983-84	269555	121388	96244	487187
15	1984-85	301559	169286	110440	581285
16	1985-86	295645	164443	95465	555553
17	1986-87	301559	161162	103063	565784
18	1987-88	286373	161897	110126	558396
19	1988-89	438035	230200	131617	799852
20	1989-90	391935	248999	138170	779104
21	1990-91	412295	256094	164521	832910
22	1991-92	447347	292017	166339	905703
23	1992-93	432603	254962	123451	811016
24	1993-94	472816	251820	116403	841039
25	1994-95	494690	202232	125821	822743
26	1995-96	536389	245310	154946	936645
27	1996-97	517387	191848	116641	825876
28	1997-98	602371	313487	189411	1105269
29	1998-99	638632	335955	174211	1148798
30	1999-2000	681414	374404	216066	1271884
31	2000-2001	731989	383500	232864	1348353
32	2001-2002	670681	360447	218264	1249392
33	2002-2003	600517	303819	195172	1099508

Chapter – 6

USE OF REMOTE SENSING FOR NATURAL RESOURCE ACCOUNTING

6.1 Introduction

Land use/Land cover information is a pre-requisite for optimal land use planning from a longer term perspective. In order to use land use optimally, it is not only necessary to have the information on existing land use/land cover but also the capability to monitor the dynamics of land use resulting out of changing demands of increasing population. Conventional ground methods of land use mapping are labour intensive, time consuming and are done relatively infrequently. These maps become outdated very quickly, particularly in a rapidly changing environment.

In the recent years, both remote sensing and geographic information system (GIS) have been used to acquire information of land cover and land use. Through remote sensing, it is possible to acquiring information about the earth surface features (land and ocean) and atmosphere using sensors onboard the air-borne (aircrafts and balloon) or space-borne (satellites and space shuttles/rockets) platforms. The remote sensing usually refers to the phenomenon of recording/observing/perceiving objects or events at remote places. The process of acquiring information about earth surface features from orbiting satellites is known as satellite remote sensing.

Geographic information system (GIS) allows integrating spatial and non-spatial data. It has opened up possibilities of integration of resource analysis with the decision support system, which are crucial in development planning. The GIS technology has a greater relevance in the context of various applications of natural resource mapping and monitoring.

In the recent years, satellite remote sensing techniques have been developed and these have proved to be of immense value for preparing accurate land use/land cover maps and monitoring changes at regular intervals of time. Based on the Indian experience in the land

use/land cover maps generation and monitoring changes at regular intervals of time, one finds that WiFs/AWiFs data can be used for level-I classification for national and regional level applications, whereas LISS-I or LISS-II can be used for up to level-II classification covering district or taluk areas. The LlSS_IV or LISS-III + PAN merged data is very useful for cadastral level and watershed level applications. In case of inaccessible region, this is the only technique of obtaining the required land use/land cover information on cost and time effective basis.

With the currently available satellite data, urban land use mapping and updation of base maps, change detection of city guide map, identification and mapping of transport network, detection and delineation of infrastructure facilities have been attempted for quite a few major cities, *viz*. Delhi, Bombay, Madras, Bangalore, Calcutta, Hyderabad, Ahmedabad, *etc.*

The rapid and hazardous growth of urban sprawl and increasing population pressure is resulting in deterioration of infrastructure facilities, loss of productive agricultural lands and green open spaces, loss of surface water bodies and depletion of ground water aquifer zones, air pollution, contamination of water, health hazards and micro-climatic changes. The satellite remote sensing with its ability to provide reliable and accurate information at regular intervals of time on urban resources/environment helps in formulating suitable plans and, strategies for effective urban planning and development.

The remote sensing through satellites can be an effective tool in planning to overcome many of the developmental issues related to the land use and land cover, such as:

(a) Urban land use planning, including urban housing, urban utilities and infrastructure, urban transportation and traffic planning, urban water supply and sanitation, urban cadastral and real estates, urban tourism and recreation, urban ecology and hazards, urban census, urban fringe area dynamics, *etc.*

(b) Change detection and updation of urban sprawls, open space mapping, landuse zoning, urban encroachment, industrial area zoning, *etc.*

6.2 Satellite Remote Sensing for land use/land cover mapping

The remotely sensed data has the advantages of providing synoptic view and large area coverage which helps in obtaining the proverbial "birds eye view" of the features. Satellites, which orbit around the earth, provide a vantage point to observe, measure, map and monitor the earth's natural resources. Remotely sensed data potentially offer a rich source of information about conditions on the earth surface that change over time. Measuring and evaluating changes in a landscape over time is an important application of remote sensing. With the launch of indigenous Indian Remote Sensing Satellites (IRS), data is available with more number of coverage's over the same region from 1988 onwards in the country.

The repetitive coverage of the satellite provides us an excellent opportunity to monitor the land resources and evaluate the land cover changes through a comparison of images acquired for the same area at different times. Changes like increased area under cultivation, conversion of annual crop land to horticulture, change in surface water area and levels, afforestration, soil reclamation, etc., could be monitored through satellite remote sensing. Over the years, its utility to detect and determine the extent and nature of changes over a period of time has been successfully demonstrated.

Using remotely sensed data, maps are created from numerical values that represent reflected energy from different land features. These data are translated into information either by visual interpretation or computer-aided image analysis techniques. The data then can be integrated with the other data such as physical parameters, socio-economic profiles and other related inputs using a Geographic Information System (GIS).

Presently data from IRS-1A/1 B, IRS-P2, IRS-P3, IRS-1C/1D and IRS-P6 (Resources at) satellites as well as data from foreign satellites like Landsat, Spot, Ikonos, Quick Bird, *etc.*, are available for monitoring natural resources of a given area. These satellites have sensors in the visible and infrared region and are good for assessing the land use /land cover classes in

the given district/taluk/watershed, type of vegetation, crop vigor, growth monitoring, green biomass, soil and water characteristics of the study area. However, these sensors have a constraint of not being able to sense the earth's surface below the clouds. This constraint is mainly operative during the Kharif season. Fortunately, the technology of microwave remote sensing has advanced well and now the Synthetic Aperture Radar (SAR), an active microwave remote sensing sensor, is capable of sensing through the clouds. Research studies clearly showed that SAR is a more appropriate sensor to be used under the conditions of cloud cover and it improves the mapping accuracy. At times it even provides additional information over and above that provided by the visible and near infrared sensors. India is expected to move to an operational satellite borne SAR in the near future. Experience gained so far shows that the repeat cycle now provided by the IRS series of satellites, that are operational, allows us to obtain cloud-free images at a frequency adequate to monitor and evaluate the land use / land cover changes.

6.3 Location and extent

The Karnataka state is situated between 110 3' and 180 45' north latitude and 74’ 12' and 78’ 48' east longitudes and lies in the west central part of the peninsular India. Its maximum length from north to south is about 750 kms and width from east to west is about 400 kms. The total geographical area of Karnataka is 1,91,791 sq.kms which is 5.35% of the total geographical area of the country.

Physiographically the state is divided into four regions, *viz*. Coastal region, the Malnad, Southern maidan and Northern maidan. Karnataka has a luxuriant coastline of 320 kms and coastal region is divided into coastal plains and Western Ghats. The Malnad consists of low line plateau with a mean height of 600 meters and densely forested Western Ghats that are sources of several rivers. The slopes of Ghats are covered with coffee and tea plantations, Sandalwood, Teak and Bamboo forest. The monsoon forests are also rich in wild life, such as, tiger, elephant, bison and deer.

The southern upland is characterized by undulating landscape, relatively flat surface with broad valleys. The southern upland consists of series of rolling granitic hills and is characterized by high degree of slopes. The northern maid an is treeless expansive plateau landscape forming northern part of the state. The topography combined with soils and climate is different from southern maidan region.

Karnataka is blessed with water wealth in its numerous rivers and streams. The Nandidurga in the east and the Western Ghat stretching from north to south along the coast are the main sources for giving rise to west and east flowing rivers. The Nethravathi, the Sharavathi, the Aghanashini, the Gangavali and the Kali are the main west flowing rivers. The northern plains are drained by Krishna and its tributaries like the Bheema, the Tungabhadra, the Ghataprabha and the Malaprabha river systems. The southern maidan is drained by the Cauvery and its tributaries like the Harangi, the Hemavathi, the Yagachi, the north Pennar, the palar and the south pennar.

The state, which lies in the central part of the peninsular Indian shield, is largely composed of greenstone belts, high-grade schists and Charnockites in vast expansive migmatitic gneisses. Depending on the geology, Climate, Vegetation and physiography in Karnataka, the soils have been identified into nine broad categories, *viz*., shallow black soils, medium black soils, deep black soils, red sandy soils, mixed red and black soils, red loamy soils, lateritic soils, lateritic gravelly soils and coastal alluvial soils. These varieties of soils have influenced the cropping pattern in Karnataka and provided a unique status as one with large range of crops.

The climate of Karnataka is essentially a tropical monsoon type. It has climates ranging from rainy monsoon on the west coast & the Western Ghats and Malnad areas to the semi-arid climate in the interior, central and northern districts and arid warm climate of Bellary-Bijapur districts. The state has four climatic seasons viz.

1. Winter or cold weather season
2. Summer or hot weather season
3. South west monsoon season and
4. North east monsoon season

As a part of this project, RRSSC-Bangalore was requested to provid the necessary RS and GIS based inputs based on a quick analysis of Landuse/Landcover pattern change in **eight districts of Karnataka, viz., Davanagere, Dharwad, Chitradurga, Kodagu, Hassan, Shimoga, Uttar Kannada and Dakshina Kannada districts 1998-1999 (data given is for 1999-2000) and 2004-2005.**

The Plate 6.1 shows the IRS 1 C/1 D satellite data digital mosaic of Karnataka state with the study area demarcated on the image. Plate 6.2 shows the Land use / Land Cover of Karnataka generated using IRS WiFS data for the Period of 1999-2000.

Plate 6.1 Digital Mosaic of Karnataka State

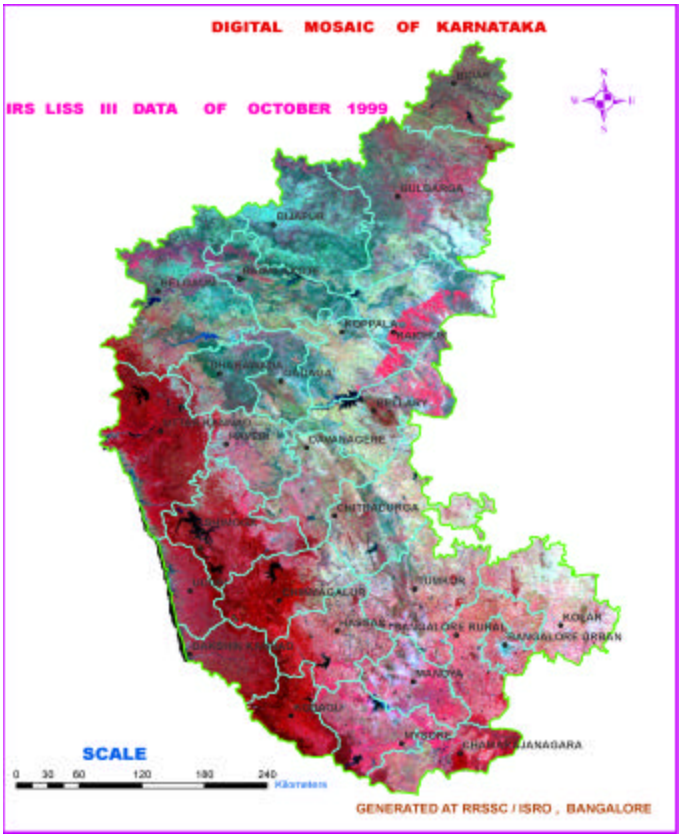
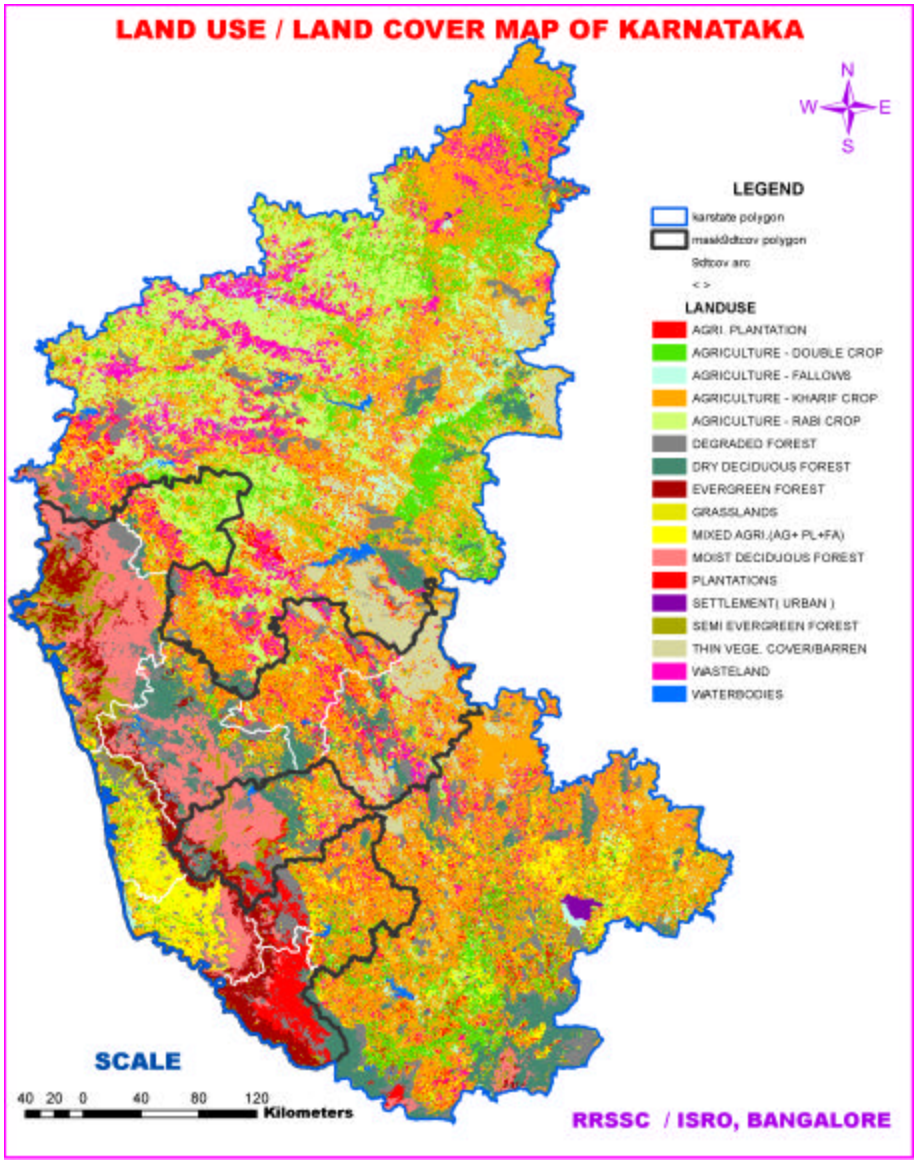


Plate 6.2: Land Use/Land Cover of Karnataka (1999-2000)



6.4 Objectives of the Study

The main objectives of the study include;

- Land use / land cover maps generation for identified 8 districts of Karnataka for the year 1999 -2000 (at 1 :250 000 scale)
- Land use / land cover maps generation for identified 8 districts of Karnataka for the year 2004 -2005 (at 1 :250000 scale)

- Change Analysis to identify the main land use / land cover changes in 8 districts of Karnataka for the period 1999 -2000 to 2004-2005.
- Providing of 1:50000 scale Hassan distict maps generated using 24 m resolution LISS III data on similar mode.
- Depiction of spatial extent of 3 Urban centers (city/town) of Karnataka with a gap of 5 -10 years indicating urban growth (on A3 size Photo Quality paper) using coarse resolution data.

6.5 Data Used

The Indian Remote Sensing Satellite (IRS) 1 C/1 D data of WiFS sensor with a spatial resolution of 188 m and IRS P6 (Resourcesat) AWiFS with a spatial resolution of 56 m are used for pre treatment and post treatment period respectively during the study. Data selection was critically dependent on the crop windows, crop calendars and vegetation dynamics of the different agro-climatic regions of the state. Keeping the time available and funds allocated, it was decided to use available satellite IRS 1 C/ 1 D WiFS data for 1998-1999 (October and January) time period and IRS P6 AWiFS for the period 2004-2005 (February). In addition, other reference maps and published literature obtained from other organizations were used as collateral data during finalization of maps and reports.

6.6 Methodology Adopted

Satellite Remote sensing data of the identified districts pertaining to 1999-2000 and 2004-2005 periods are analyzed. The analysis involves geometric corrections, digitization and extraction of the study area, classification of both date data and the change analysis. The classified images are compared to derive information on changes.

6.7 Ground Truth Data

The ground information on different land use/land cover categories and activities are collected by visiting the sample areas in the selected districts along with satellite imagery.

6.8 Satellite Data Analysis

6.8.1 Need for Digital Techniques

The inherent digital nature of remotely sensed data, supporting quantitative and statistical analysis of spectral measurements, led to rapid advancement in the field of digital techniques. At present a wide assortment of image processing techniques and Geographical Information System (GIS) techniques for application in various fields are available. New hardware and software concepts, characterized by fast data throughput enable users to handle large volumes of data interactively. Additionally, correct radiometry and maximum resolution of the remotely sensed data favored by digital techniques facilitate obtaining consistently reliable results.

6.8.2 Digital Analysis

The analysis was carried out at the Regional Remote Sensing Service Centre (RRSSC), Bangalore using Digital Image processing and Arc-Info as GIS software packages. The analysis involves geometric correction of satellite data with respect to map to start with, digitization of district boundary, extraction of the study area and discrimination of land use/land cover types. Comparison of two times classified outputs was done using change detection and analysis techniques with specific reference to land cover transformation.

6.8.3 Geometric Correction

Geometric correction of I RS data covering the study area was carried out in two steps:

- Acquisition of ground control points (GCPs) from 1 :50,000 Reference map and the satellite image and calculation of polynomial transformation model,
- Resampling of the input image using geometric rectification and grid transformation model to obtain rectified image.

Image to image registration of two period satellite data was carried out by identifying GCPs on common image locations with an accuracy of less than a pixel. This is essential to compare and derive the change information.

6.8.4 Supervised Classification

Maximum Likelihood Supervised classification was performed on both the satellite data to cluster the pixels with similar spectral characteristics into homogeneous classes with respect to ground truth information. The statistical co-variance matrix, correlation matrix and histograms were computed. The training set Separability was evaluated using divergence and bivariate frequency distribution of different categories. Refinement of spectral statistics by training set refinements were made based on the analysis and those training set / classes showing little or insignificant divergence indicating the similar spectral characteristics are combined together. Thus, the following broad land use/land cover classes, viz., irrigated crops, dry land crops, plantations, land with or without scrub, barren and water bodies were delineated.

The classification process comprises 3 steps

- Acquisition of ground truth
- Calculation of spectral statistics of training sets
- Classification using maximum likelihood algorithms.

The classification proceeds through selection of the training sets, calculation of the statistics of the training sets and the decision boundary of maximum probability based on mean vector, variance, covariance and correlation analysis of the pixels.

6.8.5 Acquisition of ground truth

The training area for classification should be homogenous and bordering pixels are not included. It should be well spread throughout the scene. Several training sets are required for the same land use class throughout the scene. There cannot be a standard prescription for the number of training sets for each class except for recommending as many training sets as are

needed to achieve satisfactory results. The spectral Separability of various categories is generally very narrow and hence precise ground truth collection is a pre requisite for better classification.

6.8.6 Statistics Generation

The second step in classification process is to obtain the statistics for different training sets. Reliability test of training sets is calculated by measuring the statistical separation between classes by computing divergence matrix. Another approach for evaluating the spectral Separability is the use of confusion matrix. In an ideal case, all non-diagonal elements of the confusion table would be zero, indicating no misclassification. The overall accuracy of the classification is finally assessed with reference to ground truth reserved for this purpose.

6.8.7 Classification

The statistics of the training sets thus obtained are used for classifying the image using maximum likelihood algorithms. Based on the statistics generated for the training sample areas, classification was performed using maximum likelihood algorithm for the entire study area. This algorithm assumes Gaussian distribution and each pixel is considered as a separate entity independent of neighbors. Using multivariate sample mean vector and inter band variance co-variance matrix, the probability of every pixel is calculated for each class and the pixel is assigned to the respective class, which has the highest probability. Those pixels not meeting the probability criteria are to be assigned to reject class, which are subsequently treated under post-classification refinement.

6.8.8 Referential refinement

The classified outputs of two seasons are refined with respect to each other. This refinement allows human logic in the decision rules. Often two features identical in their spectral response at a point of time can be separated based on changes in their response at a later date. This is particularly true with all features under going dynamic changes including vegetation. After refinement, an aggregate output of both the seasons is generated.

6.8.9 Change Detection Assessment Procedure

Remote sensing change detection is a process of determining and evaluating difference in a variety of surface phenomena over time. Changes can be determined by comparing spectral: response differences at the same spatial location among a set of two or more multi-spectral data acquired at different times. There are many change detection algorithms using digital techniques like image differencing, image ratioing, normalized vegetation index differencing, principal component analysis and comparison of classified images. The steps adopted are as follows:

- Supervised classification to delineate land use/land cover categories.
- Comparison of classified outputs to derive information on changes with respect toincrease/decrease in different land use/land cover categories.
- Interpretation and derivation of change statistics to evaluate the magnitude and direction of transformation.

6.8.10 Change detection

After refining the classified outputs of two season data, the changes can be detected and quantified with the help of customized Modeling tool. This program requires all of the image channels to be in a single database. It is therefore necessary to bring both the classified outputs of time T1 and T2 to a single image file. The decision rule information is created using the modeling language. The changes can be quantified with the help of report facility available in the modeling language itself. An example given in Table 6.1 may be noted.

Table 6.1: Reporting Format of Comparison Across Time T1 and T2.

Classified image (T1)			Classified Image (T2)			Change Between T1 and T2	
Sl. No	**Class**	**Code**	**Sl. No**	**Class**	**Code**	**New Code**	**Description**
1	Cropland	10	1	Cropland	10	100	(no change)
2	Cropland	10	2	Agro-hor1i.	50	110	(crop-Agro-hor1i.)
3	Wasteland	30	3	Wasteland	30	100	(No change)
4	Wasteland	30	4	Plantation	60	120	(+ve waste-pin.)
5	Wasteland	30	5	Cropland	70	130	(WL-crop)
6	Wasteland	30	6	Agro-forestry	80	140	(WL- Agro forestry)

6.8.11 Comparison of Classified Outputs

The classified images having different land use/land cover categories pertaining to pre and post treatment periods are compared to derive information on changes. The land cover transformation in terms of increase in vegetation cover, area under dry land crops, plantations, and irrigated crops. etc., are to be derived. The changes with respect to spatial extent of wastelands, fallow, number and spread of water bodies are also obtained in order to quantify the extent of changes in the district.

6.8.12 Interpretation and Derivation of Change Areas

The change images generated by comparing the two classified outputs are interpreted in order to evaluate the magnitude and direction of transformation, which has taken place over a period of time. The statistics with respect to increase/decrease in aerial extent of different land use/land cover categories in the district are to be derived. In addition, the change image depicts the spatial location and distribution of sites where the land cover has transformed.

6.9 Output Products Generated

The following are the resultant output products generated:

- Classified images showing the spatial distribution of land use/land cover Classes in both the periods for each district
- Change image depicting the spatial locations of transformation sites indicating the direction and magnitude of change for Chitradurga, Davanagere, Dharwad, Hassan and Shimoga districts

6.10 Land use/Land cover Categories

The classification system adopted is given in Plate 6.3. The various land use/land cover categories that are mapped using multi-season satellite data are briefly described below.

Plate 6.3: Land Use / Land Cover System Adopted for the present study

6.10.1 Agricultural land or Cropland: Cropping activities are spread throughout the year in Karnataka. There are three major seasons, *viz*, Kharif from June to October, Rabi from November to February and Summer from March to May. The prevailing cropping pattern is the result of physiography, climate and resources availability. The main crops grown include food crops such as Jowar, Paddy and Wheat among Cereals, Tur, Horse gram, Bengal gram are among pulses and Groundnut, Cotton, Sugarcane are the Chief commercial crops. Generally mono cropping and some places mixed cropping is followed. Under the irrigation facility, double cropping is followed.

The tonal contrast for this land use varies from bright red-to-red signifying different stages or crop growth besides the nature of soil, type of terrain, climate, etc. Its spatial extent varies in size and shape with fine texture (when crop is fully matured) to course and mottled texture (During early and late crop growth stages). It is contiguous under irrigated conditions and sporadic, non contiguous under dry land conditions. They often occur in association with valleys, flood plains, coastal low lands and gentle slopes.

6.10.2 Crop land of Kharif season : Kharif crops are those that are cultivated from June to September. The satellite imagery pertaining to September/October can be used to identify Kharif cropland when crops are at their maximum vegetative growth. The major Kharif crops grown include Jowar, paddy, Ragi & pulses. The prospects of Kharif crops in the State mainly depend upon the regularity of monsoon and to some extent on irrigation facilities. Nearly 46% of geographical area of the State is estimated to fall under this category .

6.10.3 Crop land of Rabi Season: Crops grown during November to March or early April come under this category. The imagery pertaining to December/January/February can be used for mapping croplands during Rabi season. Generally Rabi crops are raised wherever irrigation facilities are available and in the areas which receives North-eastern monsoon. The major crops grown include Jowar, Sunflower, Bengal gram, Chillies and other pulses. Rabi Jowar crop is mainly concentrated in the northern Districts of Karnataka.

6.10.4 Double Cropped Area (Kharif + Rabi): Area sown during both Kharif and Rabi seasons form double cropped area. This class is interpreted from satellite data acquired during both Kharif and Rabi seasons. Most of the double-cropped areas fall under command areas of major/minor irrigation projects or along flood plains of river courses. A few patches of double-cropped areas irrigated with ground water can also be delineated very well on the satellite data. The cropping intensity is very high in these areas because of physical factors like flat terrain, fertile soils and assured irrigation through canal system. Generally paddy, sugarcane, jowar/maize, groundnut are the major crops grown under this category.

6.10.5 Agricultural fallows: This class includes parcels of agricultural land that lies un cropped during both Kharif and Rabi seasons (current fallows). Analysis of two season data would clearly helps in delineating fallow lands. They are spectrally separable from croplands but tend to mix with certain categories of wastelands.

6.10.6 Agricultural plantations: These appear dark red in tone, small in size with regular shapes and sharp and smooth edges. The difference in tone may signify different types of plantations or same plantation in different stages of growth or foliage cover or due to seasons. These plantations occur on uplands, foothills and occasionally in river plains. Some plantations like Tea, Coffee, Rubber, and Areca nut occur amidst notified forest and outside notified forest areas. These can be easily identified using three multi-season data sets. The summer season data is more suited to identify these plantations. Cashew nut and mango are the major plantations observed in Belgaum, Dakshin Kannada and Kolar districts. Coconut gardens are the common features seen in coastal districts and valleys of Tumkur, Chitradurge, Chickmangalore and Hassan districts. Tea & Coffee plantations are mainly seen in Western ghat districts viz Chikmangalore, Hassan and Kodagu.

6.10.7 Forests: The Forest in the State occupies13th place in the Country. The vegetation in the state is divided into Ever/semi-Ever green, moist/dry deciduous and scrub and thorny bushes. These forest categories are identified using multi season satellite data, Forest Survey of India (FSI) maps and limited ground checks.

6.10.8 Evergreen/Semi evergreen forests:- These forests are found where the rainfall is more than 225 cm. The dense evergreen forests are found in Karwar near south of Supa reservoir, on the high ridges of Honnavar division, Theerthahalli-Agumbe area, Kudremukh-Bhagvathi Valley, Sakleshpur-Hassan high ridges, Kodague and Biligi Rangana hills. The semi evergreen forests are distributed predominantly south of Kali in Karwar, Yellapur and Sirsi forest sub divisions, Kumta of Kundhapur regions of Dakshina Kannada and Tarikere and Lakkavalli areas of Chickmangalore District.

6.10.9 Dry/Moist Deciduous Forests: The deciduous forests are situated in the rainfall areas of 100 cms and more. The moist deciduous forests are predominant in Haliyal, Yellapur and Sirsi sub division. They are also found in sagar-sorab region east of Linganamakki reservoir. The vast stretch of moist deciduous forest can be seen near Bhadra reservoir and south of Dakshina Kannada (Moodbidri). The dry deciduous forests are conspicuous in Belgaum, Nagarhole, Bandipur and Kollegal region of Mysore.

6.10.10 Reserved/Degraded forests: The lands under this category are found in places where rainfall is less than 60 cms. Mainly this category is found in the districts of Dharwad, Chitradurga, Belgaum and Bijapur. They are always found in association with barren rocky/stony wastes within notified forest boundaries with scrubs. This is mostly due to in-adequate and erratic rainfall and there is no distinct hill ranges owing to geological formation of the land in these places. The drought and extreme heat condition, excessive human interference makes forest areas as degraded scrub lands.

6.10.11 Forest Plantations: Extensive plantations of Teak, Eucalyptus, Casurina, Acasia, Glerecidia, etc., are raised in the cleared/felled area or degraded forest areas for improving potential of forests. Under many forestry/social forestry/watershed programmes, forest plantations have been raised in many parts of Karnataka. These degraded lands with plantations can be very easily identified in the multi-date images because of their tonal difference with neighborhood and also due to their regular shape and size with notified forest areas.

6.10.12 Wastelands: Wasteland refers to degraded land, which can be brought under vegetation cover with reasonable effort. These lands are not productive currently due to various problems such as soil erosion, salinity, water logging, extreme heat, etc. Due to spatial resolution limitations of Sensor used, all the wasteland categorizes have been identified and merged under this category. Based on white and bluish tone, the salt affected lands can be identified. Irregular black areas that appear white in tone in the Kharif cropped area are indicative of salinity, sodicity and other forms of land degradation. Water logged lands are those where the water is at/or near the surface and water stands for most of the year. Such

lands usually occupy topographically low lying areas. They appear dark bluish to blue in tone amidst cropland, irregular in shape with smooth and mottled texture and non-continuous. Eroded lands are identified by their characteristic white to light blue tone along drainage lines. Sandy beaches and river sandy areas are often easily identified because of their association and pattern. The barren rocky and stony areas varying dimension can be easily identified on hill summits (usually flat topped) or steep slopes or uplands. Land with or without scrub are very well identified using multi date data and in particular summer season data. They mainly occur as smooth pinkish to reddish tones on uplands, sloping sides of hills and even some times along the stream courses. They also occur in the fringe areas of many dense forest area of the state. These are currently under utilized due to some physical, physiological or financial management constraints.

6.10.13 Water bodies: It is an area of impounded water, areal in extent and often with a regulated flow of water. It includes man made reservoirs, lakes, tanks, canals, besides natural lakes, rivers, streams and creeks. These are easily identifiable by their characteristic, blue, deep blue and dark black colors. Dry tanks can be seen in shades of gray. The digital values of water bodies in all bands are low and are easily separable.

6.10.14 Grass lands/grazing lands: This category of lands is covered with natural grass along with other vegetation often grown for fodder and to feed cattle and other animals. This type of land is found mainly in Chitradurga and Mysore districts. We can also see large patches of natural grasslands in Western Ghat region on the hill summit. They can be easily identified on the multi-season data sets and particularly becomes conspicuous with neighborhood In summer data whenever they are burnt. They appear in black tones on the satellite imagery.

6.10.15 Thin Vegetation Cover/ Barren: This particular category is mainly observed in Chitradurga and Davanagere Districts. Due to extreme dry land condition, Multi cropping and early harvest of crops in these areas, it is very difficult to separate small patches of these mixed land use/ land cover classes using the IRS WiFS or AWiFS resolution data. Though the Kharif cropland dominates, the small patches of fallows, barren lands, rocky and scrublands with thin vegetation are included under this category.

6.10.16 Mixed Crop: This category of cropland occurs in the districts of Dakshina Kannada, Bangalore rural and Kolar districts. Due to spatial resolution limitation the pure classes like cropland (Kharif), agricultural fallows, plantations and scrublands are inseparable. These categories small in size are appearing together, they are classified as mixed crop areas in the present study.

6.10.17 Cloud: The clouds appear in white in color and also they can be easily identified, as they are also associated with cloud shadows. Most of the satellite data acquired during Kharif season depicts cloud and cloud shadows very well in white and dark black patches.

6.10.18 Built-up-land: The settlements such as cities, towns and major villages are included in this category. Built-up land comprises of all types of structures, houses, industries, play grounds, *etc*., large built-up areas could be delineated as dark bluish green to blush tone with definite shape, size and texture. Often built-up lands with high density of building appear in dark tone at the Centre and lighter at the periphery. They occur amidst agricultural land, forestland, and wastelands. They are associated with road, rail and canal networks.

6.10.19 Others: This category includes all those, which can be treated as miscellaneous. They can be areas under shifting cultivation, grazing lands, snow covered, mining areas, etc.

6.11 Results and Discussion

The land use /land cover maps and change maps generated for all 8 districts are given in Plate 6.4 to Plate 6.12. The following are the main observations made and are discussed district wise in the following paragraphs.

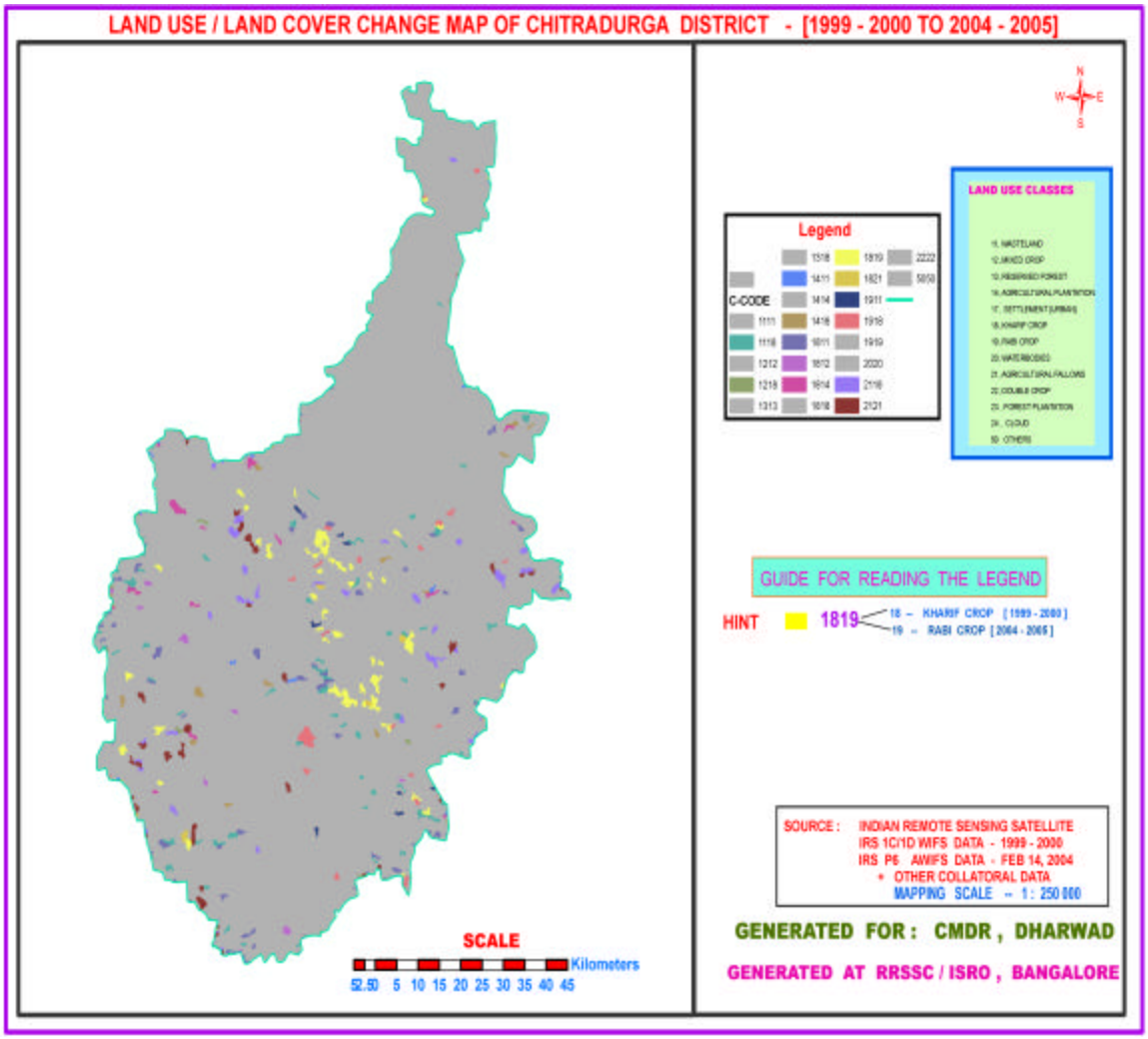
6.11.1 Chitradurga District:

The district is an historical place and it gets the name because of the presence of an umbrella shaped lofty hill (Chitrakaldurga). The whole district lies in the Valley of Vedavati River. The Thungabhadra river flows to the North-west of the district. The district is in Central zone. The average South-west monsoon rainfall is 290 mm. The soils of the district vary from

red sandy loam to shallow or medium black soils. The net area sown accounts to 53 per cent of the geographical area. The net irrigated area is 18 per cent of the net-cropped area. Major crops grown in the district include Ragi (14%), Jawar (13%) Groundnut (11%) and Paddy (9%). The land use and land cover change map of Chitradurga district is shown in Plate 6.5

The land use/land cover analysis indicates that the district mainly has Kharif lands, fallow lands, degraded forest and wastelands. The coconut plantations are found in river valleys. The two-date land use/land cover analysis indicates very little change in forest areas. Changes in forest and agricultural plantation areas were observed wherever watershed/ forest Developmental programmes are being implemented. The changes observed in cropland and fallow areas are mostly due to prevailing monsoon conditions. The limitations of spatial resolution have not allowed us to identify changes that have taken place in the fields of plantations raised under various Govt. schemes. During field work it was observed that farmers are taking up advance farming techniques and are progressively adopting Agro-horticulture and Agro-forestry in their agricultural fields. The land use and land cover change map of Chitradurga district is shown through Plate 6.4

Plate 6.4: LandUse/Land Cover Change Map of Chitradurga District



6.11.2 Davanagere District:

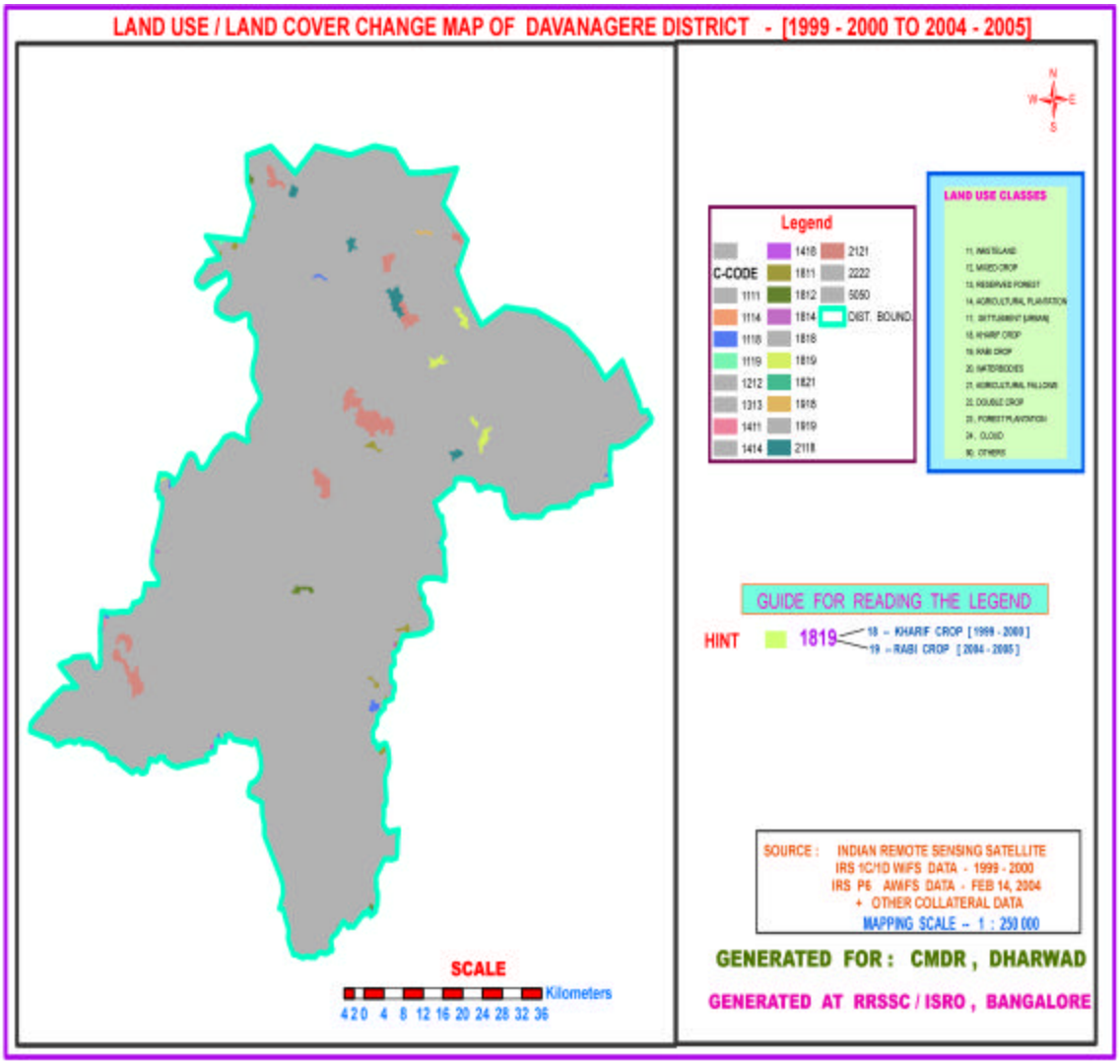
Davanagere is a new district formed out of few taluks re-grouping together from old Shimoga and Chitradurga districts. Davanagere is an important commercial, industrial and education Centre of the State. It is well known for its textiles and cotton mills. The district is in Central zone. The soils of the district vary from red sandy loam to shallow or medium black soils. Plate 6.5 reflects the detailed change in land use and land cover.

The land use/land cover analysis indicates that the district mainly has Kharif lands, fallow lands, degraded forest and wastelands. The coconut plantations are found in river valleys. The two-date land use/land cover analysis indicates very little change (Plate 6.6) in

forest areas. Changes in forest and agricultural plantation areas were observed wherever watershed/ forest Developmental programmes are being implemented. The changes observed in cropland and fallow areas are mostly due to prevailing monsoon conditions.

The limitations of spatial resolution have not allowed us to identify changes that have taken place in the fields of plantations raised under various Govt. schemes. During fieldwork it was observed that farmers are taking up advanced farming techniques and are progressively adopting Agro-horticulture and Agro-forestry in their agricultural fields.

Plate 6.5: LandUse/Land Cover Change Map of Davangere District

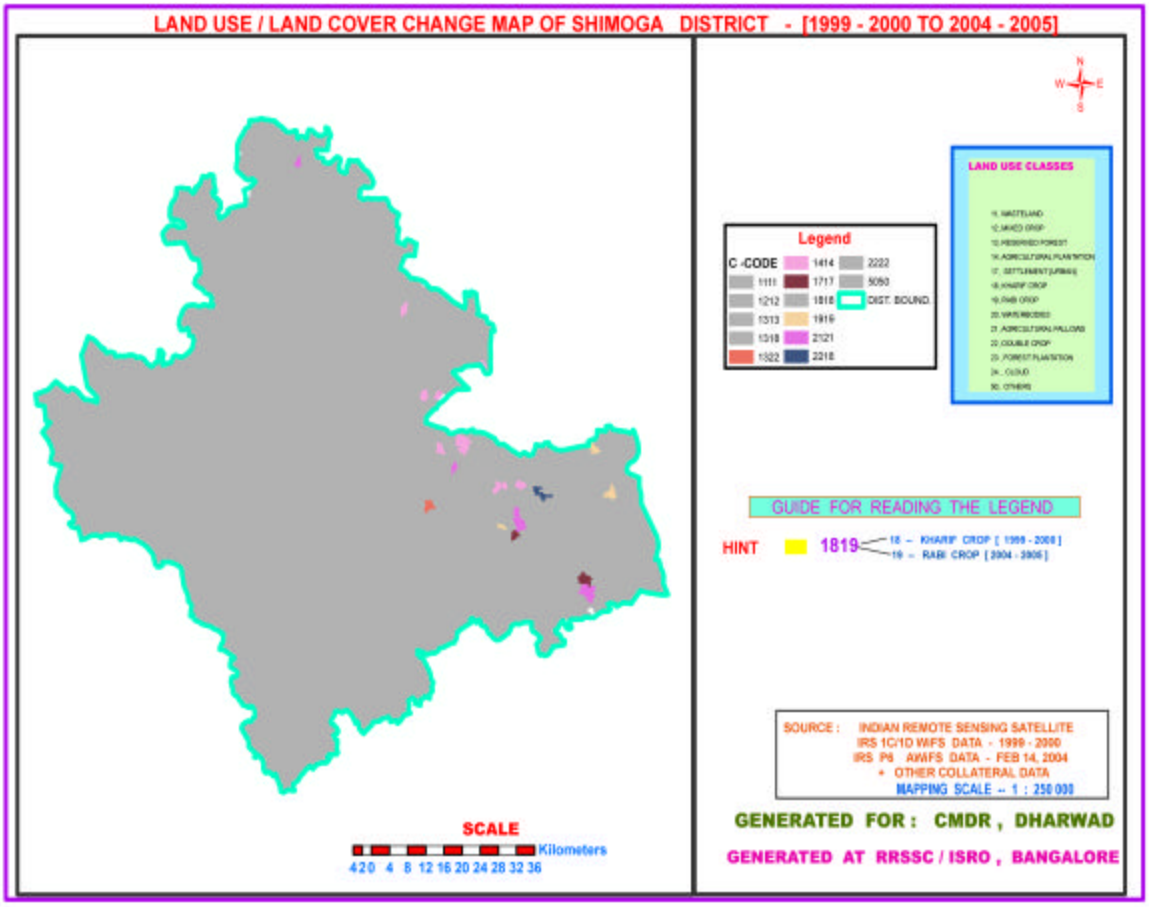


6.11.3 Shimoga District:

The district is located in the Central South-Western part of Karnataka. It is a very important industrial, commercial and educational Centre. The Western part of the district has superb tropical forests and beautiful hilly areas. The eastern region is less dense but has several tanks and river valleys. The district comes under the two agro-climatic zones of southern transition zone and hilly zone. The soils of the district vary from clay to red sandy loam in hilly zone and red and black soils in southern transition zone. Forest area covers about 31 % and net sown area is 30%. About 45% of net sown area is under irrigation. The major crops grown in the district are Paddy (51%), Ragi (12%), Jowar (7%) and Groundnut (4%). Sugarcane and Cotton are the major cash crops cultivated in the district.

The change analysis (Plate 6.6) carried out indicates that there is very little change in the western forest regions during the analysis period. The major changes observed in the eastern part of the district clearly show that there is a shift in agriculture cropping system. The farmers are converting single cropped areas to horticulture, agro-horticulture and agro-forestry systems. Depending upon monsoon and irrigation facilities, farmers are growing more cash crops such as sugarcane and cotton. Kharif paddy lands and upland scrub (wastelands) which co-exists. Hence all these classes are combined and classified as mixed cropping areas. Currently the farmers are adopting horticulture/agro-horticultural systems in the area and more Arecanut plantations have come up during last few years. Otherwise the forest area and cultivation pattern in the district is more or less the same in 1999-2000 and 2004-05.

Plate 6.6: LandUse/Land Cover Change Map of Shimoga District



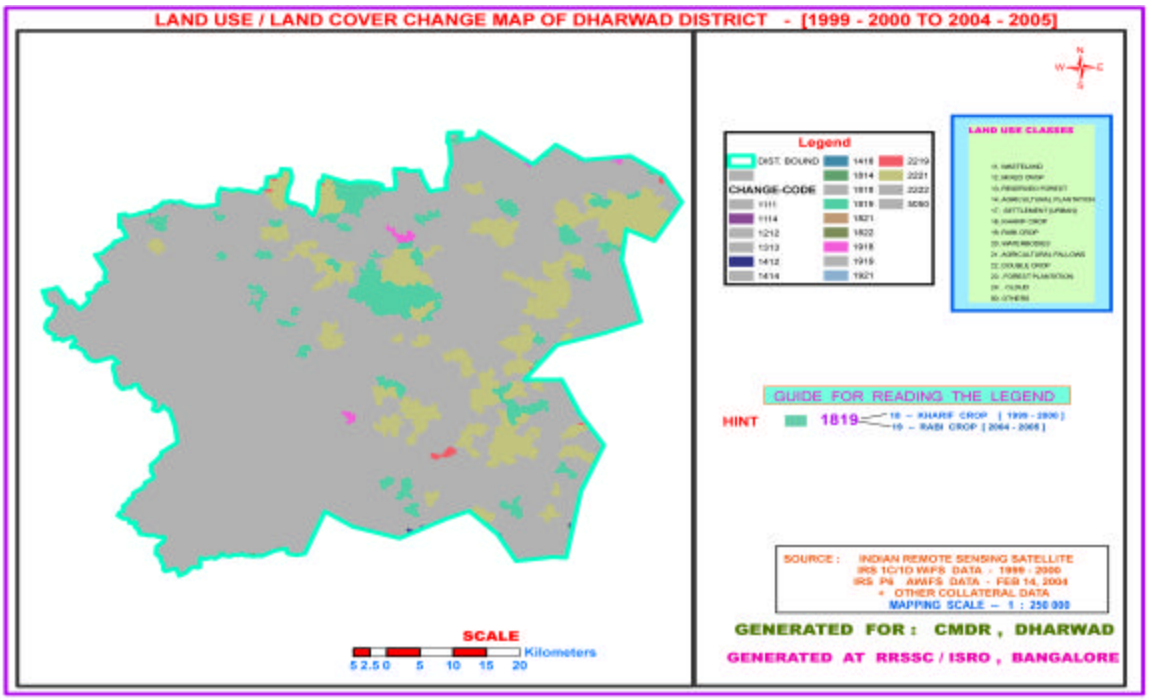
6.11.4 Dharwad District:

Dharwad, the district Headquarters is well known for its educational facilities with many reputed universities. Hubli is another major city with lot of industrial and commercial activities. The district comes under three agro-climatic zones of Northern transitional zone, Northern Dry zone and Hilly zone. The major soil types observed in the district are medium to deep black soils, mixed red and black soils and red sandy soils. The principal crops grown in the district are Jowar (23%), Paddy (7%), groundnut (13%) and cotton (3%). Vegetables are also grown in sufficient quantities in the valley regions close to the Hubli-Dharwad City. The net sown area is 81% and only 9% of net sown area is under irrigation. A small area is under dry deciduous/degraded forestlands. Wastelands comprises of scrublands, eroded lands and salt affected lands.

The change analysis carried out between 1999-2000 and 2004-05 indicate the following.

- No major development in horticulture or forestry plantations.
- Decrease in Kharif crop area may be due to prevailing monsoon conditions.
- No change in the Wasteland areas.
- Expansion of Hubli-Dharwad City/Towns.
- There is an increase in Rabi area and double-cropped area.

Plate 6.7: Land Use/Land Cover Change Map of Dharwad District

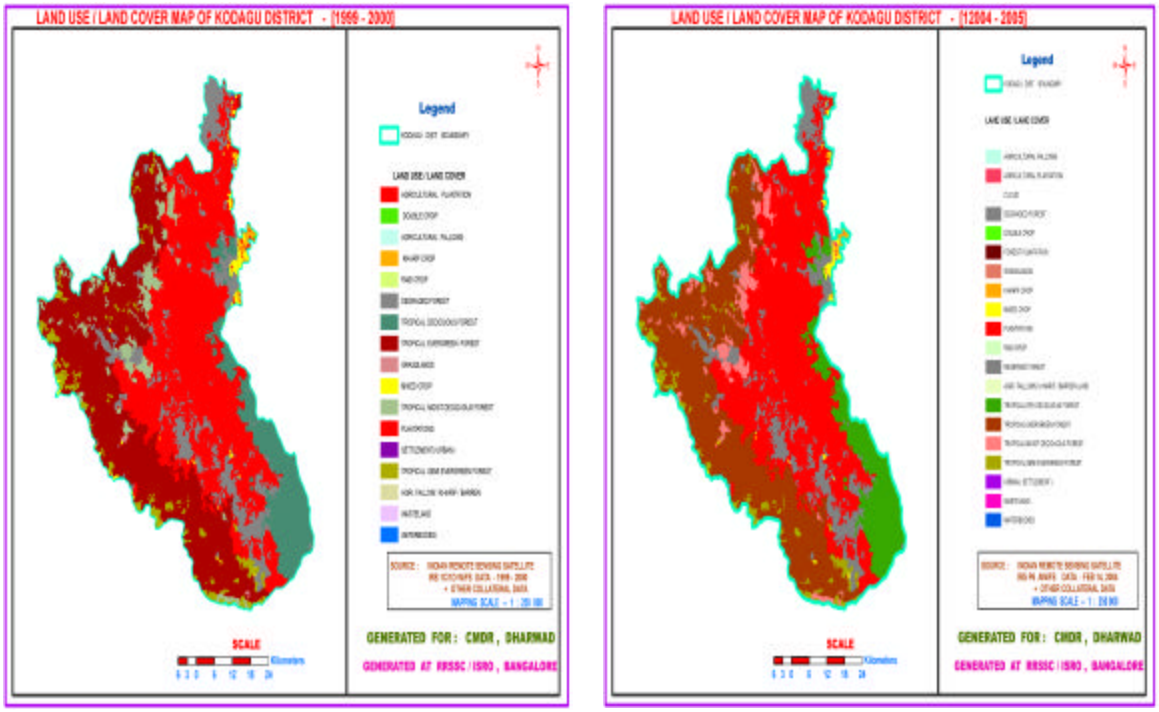


6.11.5 Kodagu District:

Kodagu is the smallest district and the most beautiful hill station of Karnataka. It is a home for bold and beautiful Kodava people. The district is filled with dense forests, rich coffee plantations, orange groves and paddy fields. The district falls under hilly zone of Agro climatic zone classification. The soils are mainly mixture of red loamy and clay soils. About 32.78% of area is under forest. Net sown area is 54.5 % and only 3% is under irrigation. The principal crop is paddy.

The change analysis indicates very minor changes in the forest categories may be mainly due to dates of acquisition and slow degradation of forest and coffee plantation areas. The other major change is the introduction of few arecanut plantations in the valley portions of the Central part of the district. Since no significant change was observed in Kodagu district, separate change map was not generated for this district. As there was no significant changes in the land use / land cover in Kodagu, the change map was not developed for the district.

Plate 6.8: LandUse/Land Cover Change Map of Kodagu District

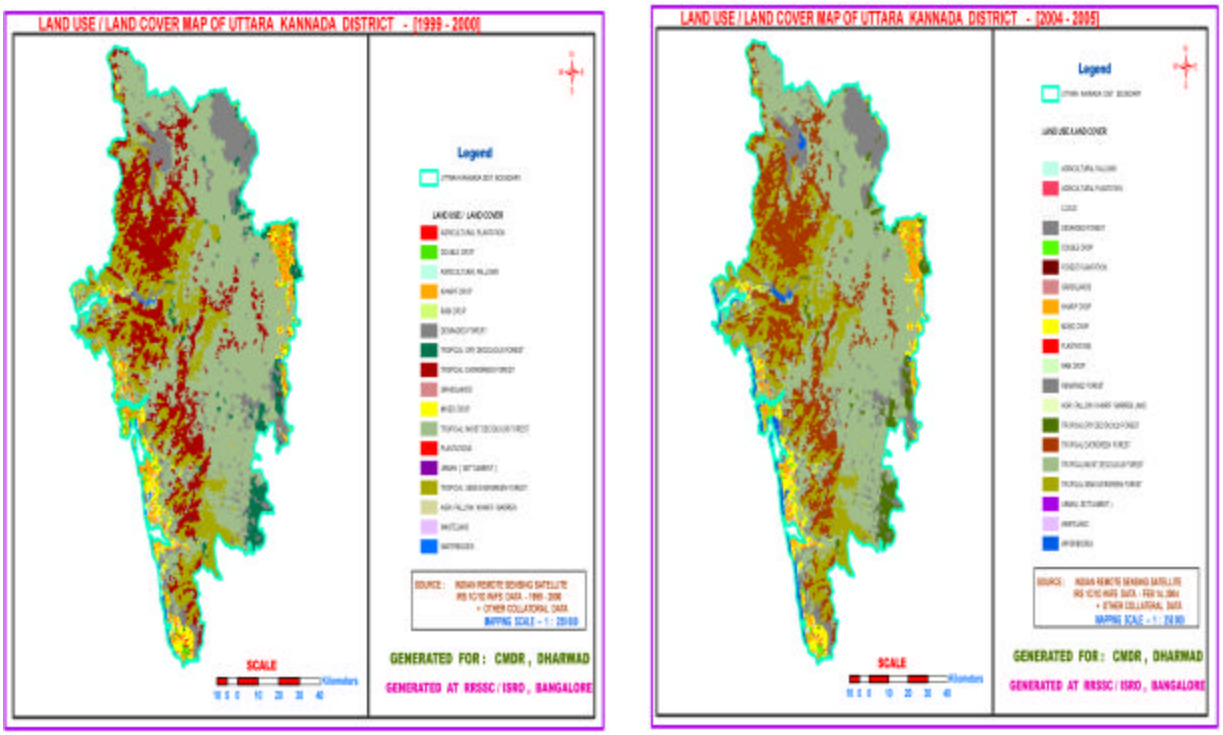


6.11.6 Uttara Kannada District:

The district located on the western coast, is a place of varied historical, cultural and religious place. The district attracts lot of tourists and is very close to Goa. Forest occupies about 81 % and net town area is only 11 %. 20% of net sown area is under the irrigation. Major crops grown in the district include paddy (70%), pulses (3%) and groundnut (3%).

No identifiable changes of significant magnitude were delineated in the District. Hence change map was not generated. It was observed that the forests are in good vegetative condition and no major degradation of these forest areas could be identified during 1999-2004.

Plate 6.9: LandUse/Land Cover Change Map of Uttar Kannada District



6.11.7 Dakshina Kannada & Udupi Districts:

Udupi is a newly bifurcated district. Mangalore is the district head quarters of Dakshina Kannada. It is a major export center for coffee and cashew nuts. It is a major seaport and ship building center. Mangalore is also an important educational and tourist center of Karnataka State. Udupi town is a very famous pilgrimage centre and famous for its Chandramouleshwara temple and mutts. The two districts come under Coastal Agro-climatic zone. They have mainly lateritic type of(soils. Forest area is about 27%. The net sown area is about 27 % and 30% of net sown area is under irrigation. The major crops grown in these districts are paddy (51 %) and Ipulses (5%).

No identifiable changes of significant magnitude were identified in the districts of Dakshina Kannada and Udupi. Hence change map was not generated. The agricultural Land Use I Land Cover Mapping of 8 Districts of Karnataka using RS & GIS land in the valleys is mostly used to raise paddy crops. With poor resolution data, it was not possible to separate Agricultural Plantation.

Plate 6.10: LandUse/Land Cover Change Map of Dakshina Kannada District

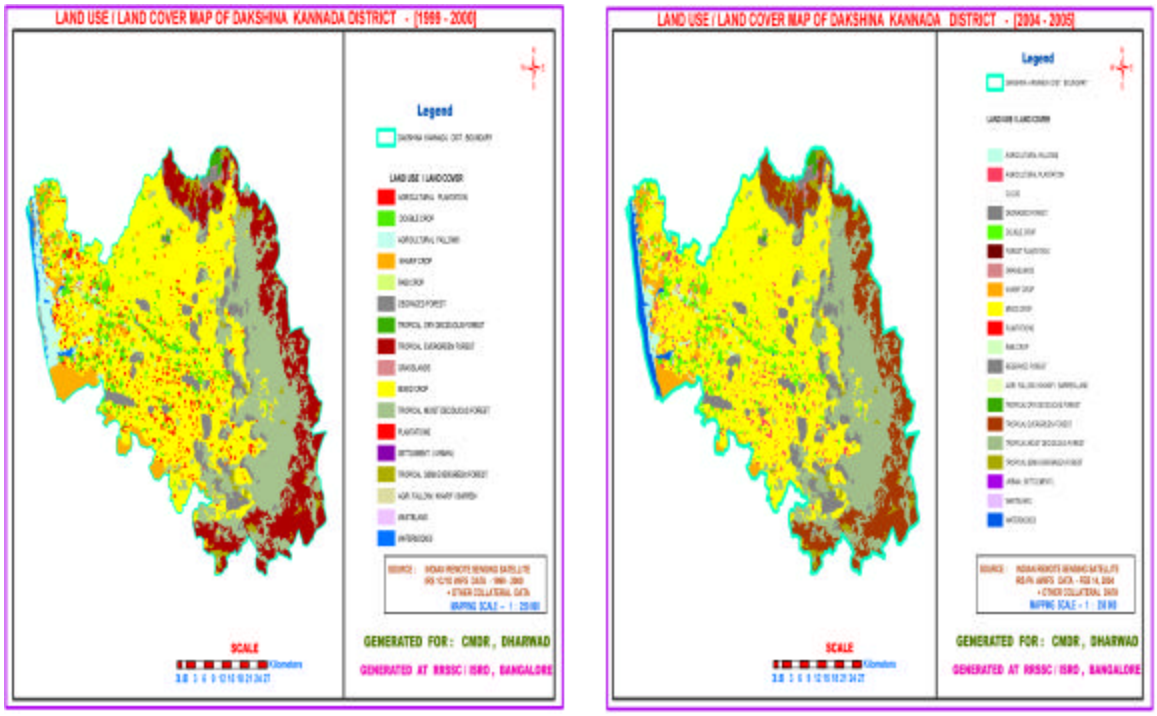
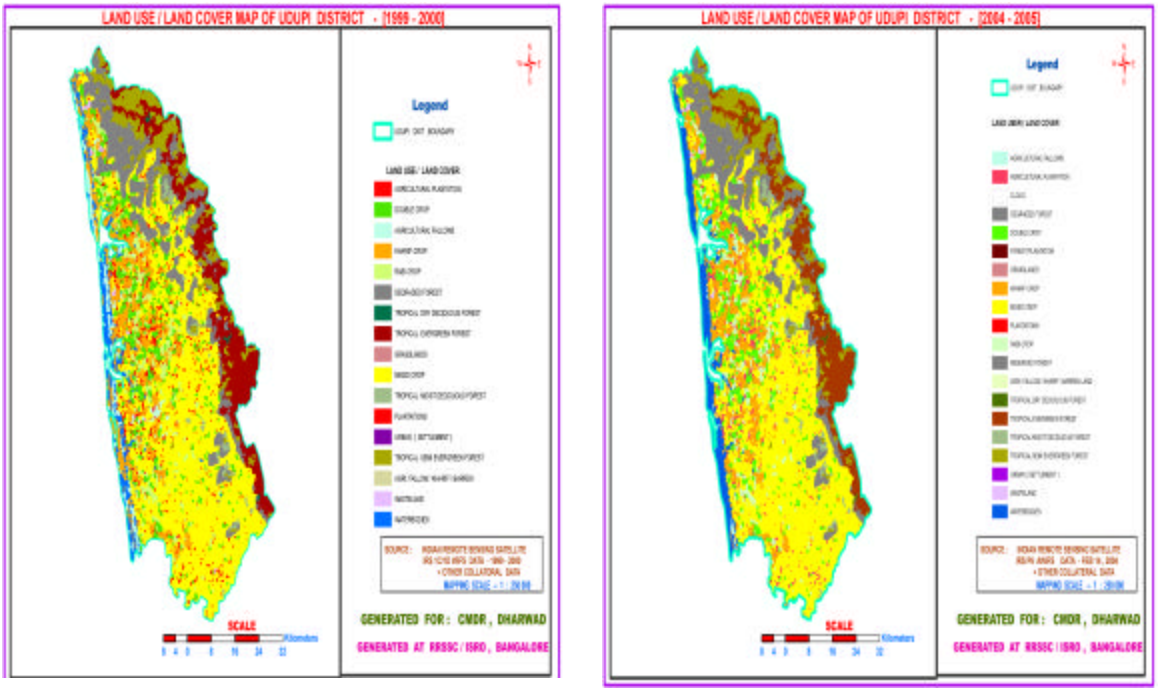


Plate 6.11: LandUse/Land Cover Change Map of Udupi District



6.11.8 Hassan District:

Hassan is a prominent tourist Centre because of proximity to Belur and Halebidu. It is also a Centre of transport and commerce. The district begins at the base of the Western Ghat and continues in to the gently rolling Deccan plateau. The two major physiographic regions are steep western ghat and the eastern plains with occasional hills. The Netravati, Cauvery, Yagachi, Hemavathi are the major rivers flowing in the district. The soils of Hassan are red sandy soils, lateritic soils and black cotton soils. Dharwad schists and granitic gneiss's are the two major rock types found in the district.

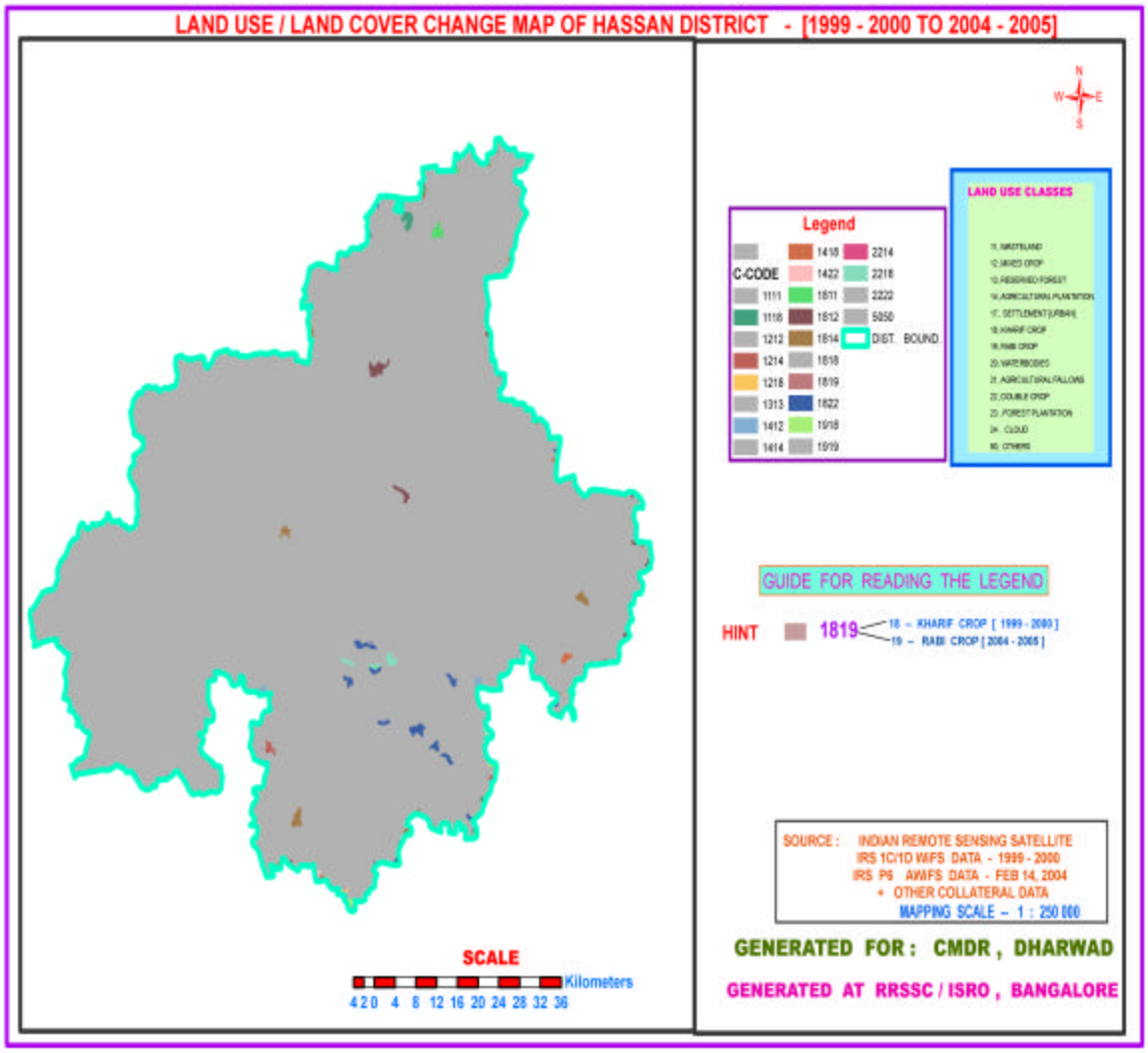
The district has 542 sq. km. of forest. Evergreen/Semi-evergreen forests with small patches of moist deciduous forests are seen in western ghat region and dry deciduous forest and thorny scrub vegetation is found in the eastern parts of the district.

The district comes under the four different agro-climatic zones of hilly zone, the south transition zone, southern dry zone and Central dry zone. Forest cover is about 8 per cent. Agriculture/horticulture and forestry are the basis to the economy of the district. Paddy (10%)

and pulses (11%) are the major crops. Tobacco is increasingly grown in Arkalgudu taluk. Western Ghat is the home for coffee, cardamom, pepper, orange and tea. The district is rich with coconut and coffee plantations followed by Arecanut, mango and tea plantations. In the dry land areas, plantations like Acacia, Eucalyptus have been raised under various forestry and watershed development programmes. The net sown area is 3,65,570 ha (56 %) and the area irrigated is 73,399 (11 %) of the total geographical area.

The change analysis carried out between 1999-2004 (Plate 6.12) clearly indicates that there is a changing cropping pattern and increase in cropping intensity in the command areas of Hemavathi, Watehole and Yegachi projects. The farmers are converting single cropped (Kharif) to Horticulture or Agro-Horticulture or Agro-forestry systems. The District headquarters Hassan and Channarayapatna are the major towns growing in urban extent with all infra structural development. The analysis also indicates that there is a dynamic change in the forest plantation indicating positive as well as negative changes. Very few land degradation processes observed viz. Quarrying and clay mining.

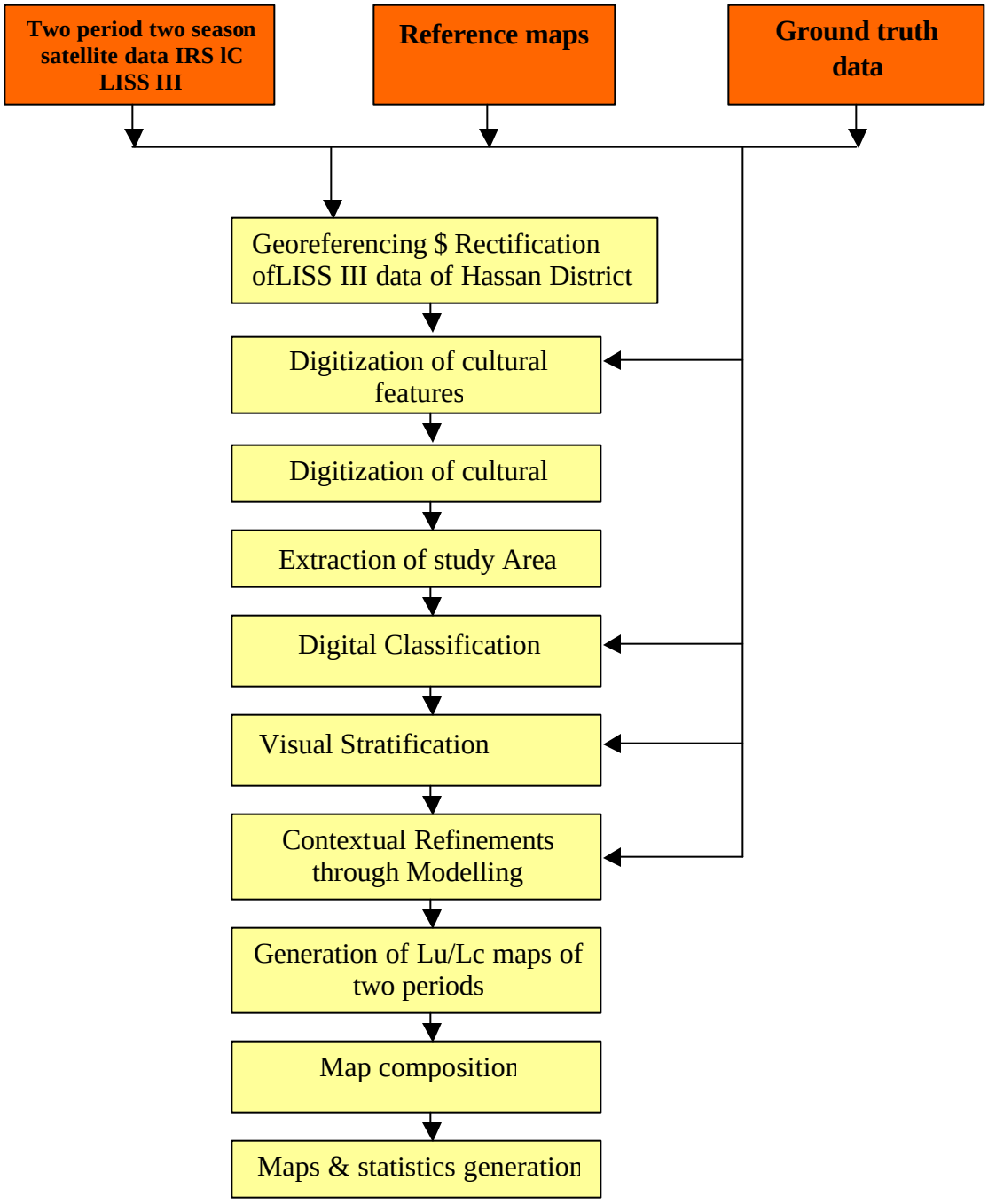
Plate 6.12: LandUse/Land Cover Change Map of Hassan District



6.11.8 (i) Land use/Land cover of Hassan District

Methodology: land use/land cover map of Hassan district was generated by digital approach. Brief methodology adopted for land use mapping is presented in flow chart given below.

Fig. 6.1 : Methodology adopted for Land use / Land cover mapping



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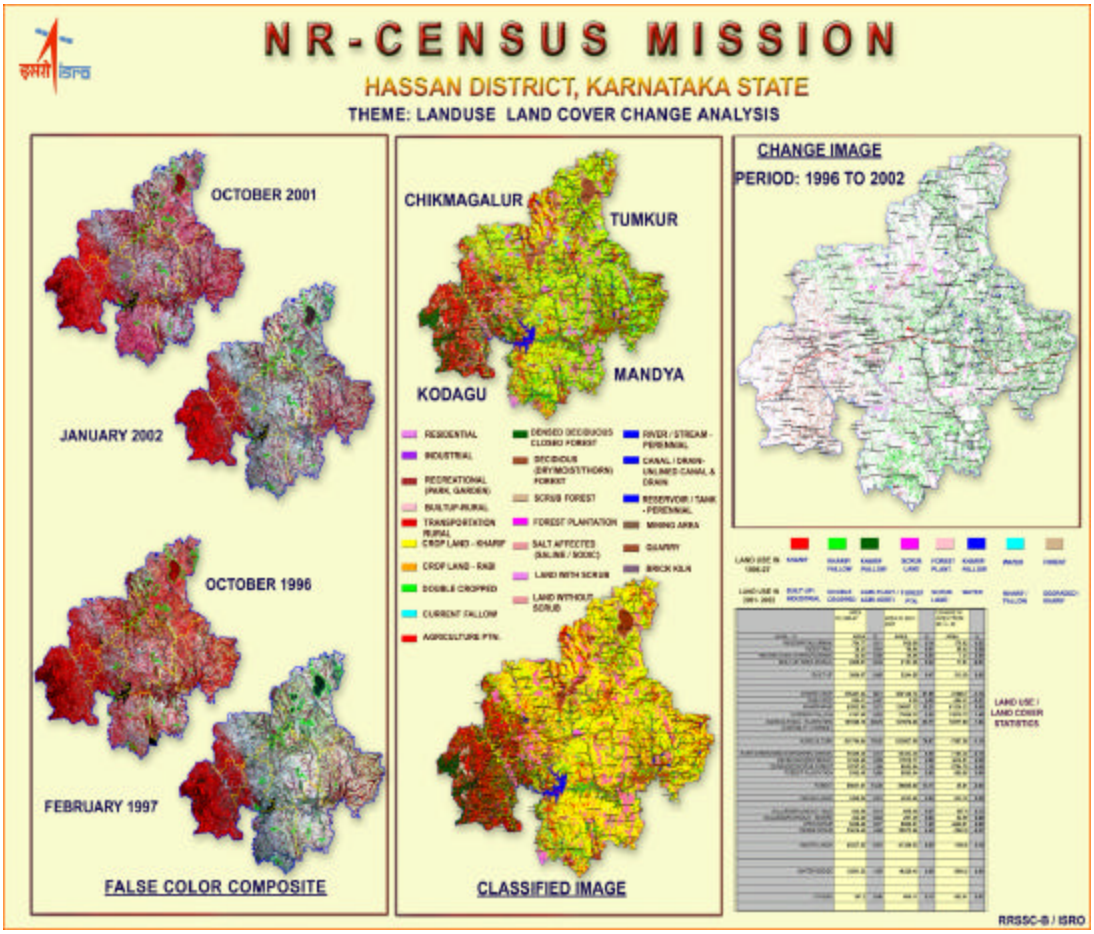
The image processing of two periods 1996-97 and 2001-02 and two seasons viz., Kharif and Rabi was carried out at Regional Remote Sensing Service Centre (RRSSC), Bangalore using EASI/PACE, ERDAS and Arc-Info software packages. The classification system as given in NR Census guidelines provided by NRSA, Hyderabad under this project was used. A trio of supervised classification of Kharif and Rabi data for each period; contextual refinement techniques and stratification (visual) were used for generating land use/land cover maps for the two periods 1996-97 and 2001-02. The SOl topomaps on 1 :250,000 and 1 :50,000 scale have been referred to delineate district, taluk, forest boundaries and other base line features like roads, railway line, canals etc. The ground truth data was collected during August/September 2003. The methodology followed is explained with an example of Hassan district using multi-date Remote Sensing data in Plate 6.3, which covers the period 1996-2002 to reflect the change in land use and land cover.

Plate 6.13: Multi-date Remote Sensing for Land Use/Land Cover Change: Hassan District



The methodology followed consisted of

1. Geo referencing of satellite data with respect to SOl topomaps,
2. Digital classification with a trio of supervised classification, contextual refinements and stratification (visual based),
3. Generation of land use / land cover maps of periods 1996-97 and 2001-02
4. Change analysis to generate land use /Iand cover change map using spatial modelling techniques,
5. Map composition and
6. Maps and statistics generation. –

6.11.8 (ii) Description of different land use classes and their extent

Land use/land cover classes such as built-up land, agriculture land, wastelands, water bodies and others have been classified at level 1. These level 1 classes have been further classified into level 2 and level 3 classes as per the guidelines given under NR-Census Mission project. The classification system adopted under this project for land use/land cover mapping is given in Table 6.3.

The detailed land use/land cover statistics of the district for the years 1996-97 and 2001-2002 is given in Table 6.3. A number of land use /Iand cover classes could be mapped in Hassan district. The major land use/land cover classes are described below. The maps generated under land use /Iand cover theme are

- land use/land cover map of Hassan district -1996-97 (Fig 6.1)
- land use/land cover map of Hassan district -2001-02 (Fig.6.2)
- land use/land cover map of NR 57C/04 -1996-97(Fig 6.3)
- land use/land cover map of NR 57C/04 -2001-02 (Fig. 6.4)
- land use/land cover change assessment of Hassan district for the period 1996-2002 (Fig. 6.5)
- Satellite data depicting urban changes of Hassan district for the year 1998 (Fig 6.6)
- Satellite data depicting urban changes of Hassan district for the year 2002 (Fig 6.7)

Fig 6.1 - Land use/land cover map of Hassan district -1996-97

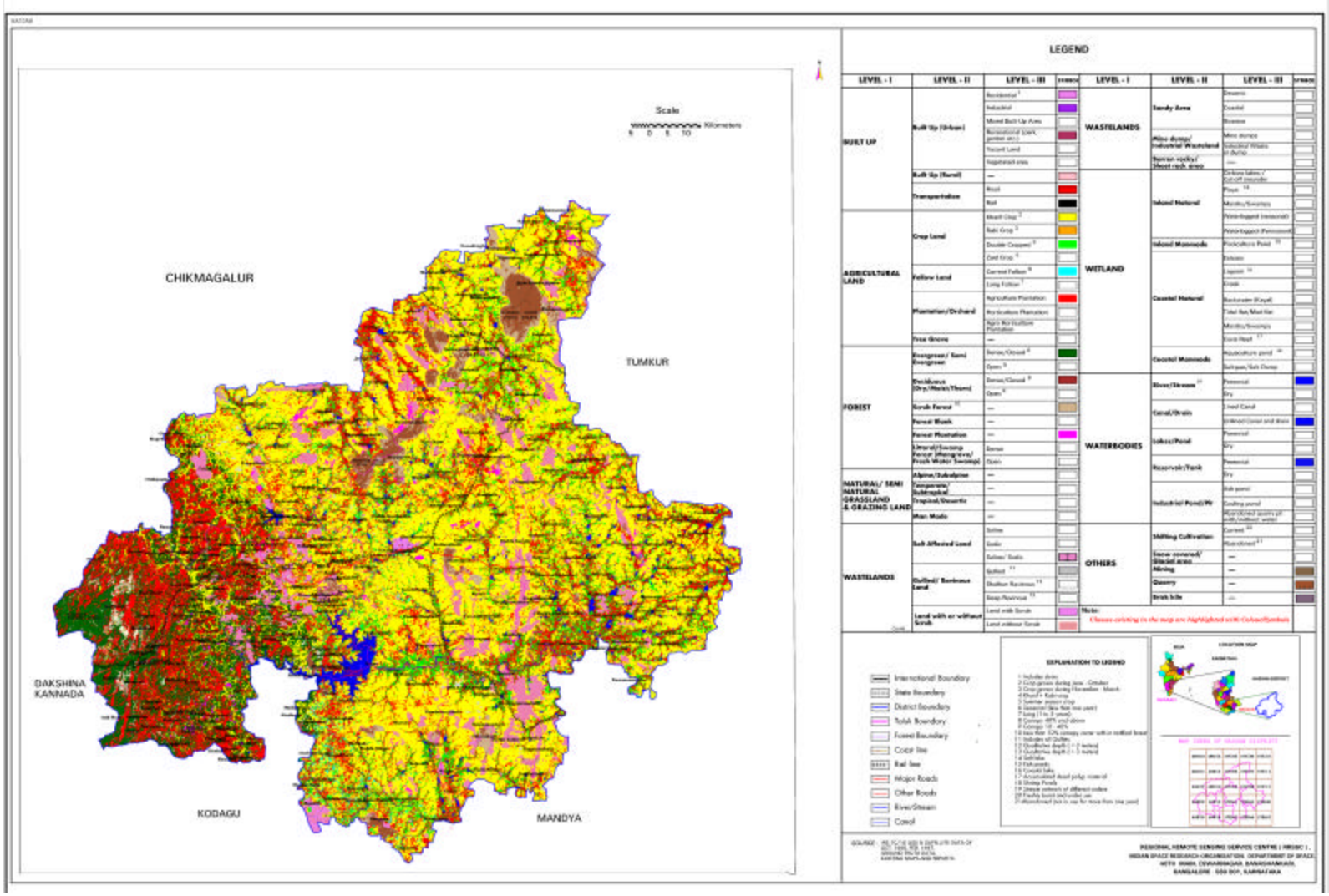


Fig.6.2 - land use/land cover map of Hassan district -2001-02

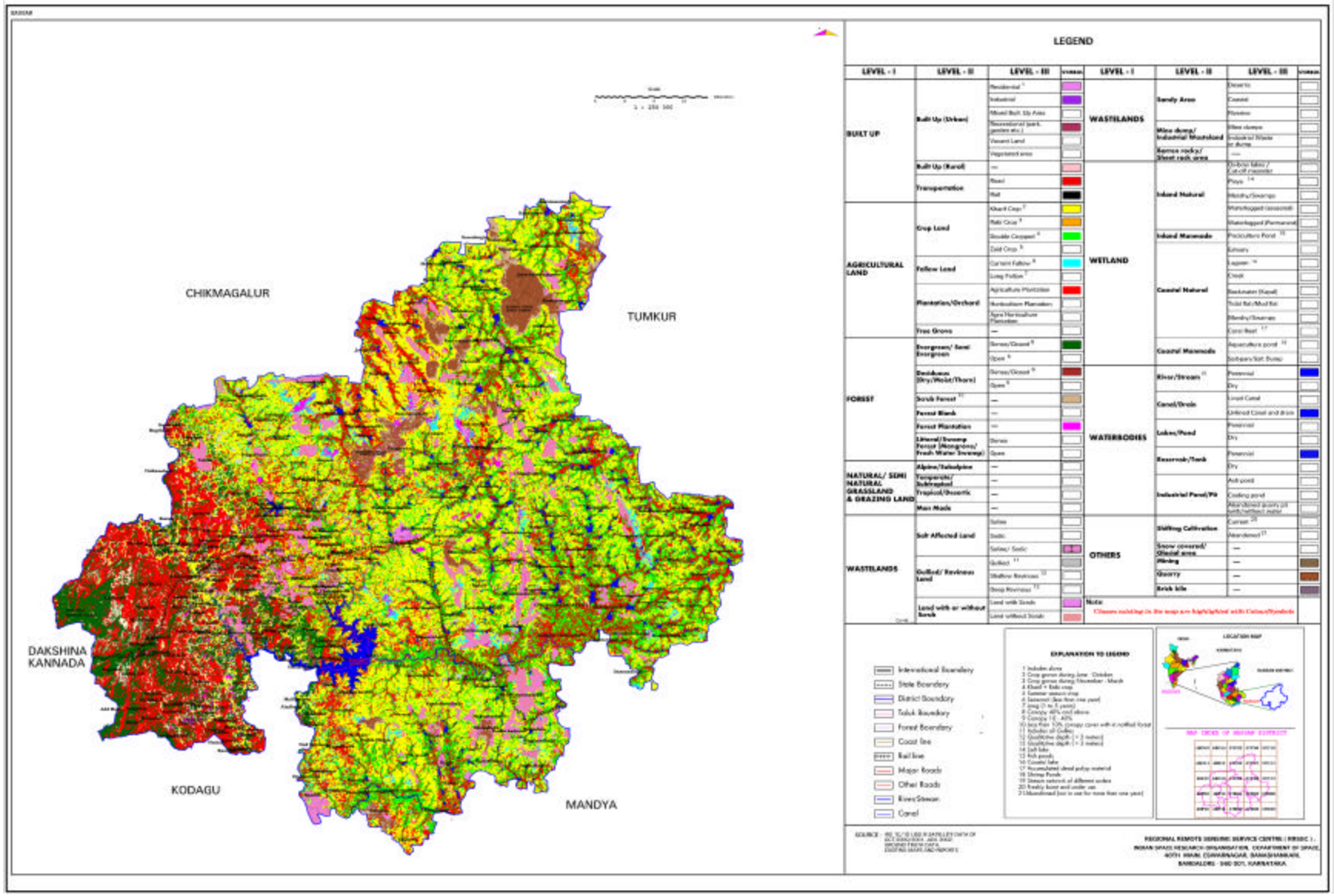


Fig 6.3 - Land use/land cover map of NR 57C/04 -1996-97

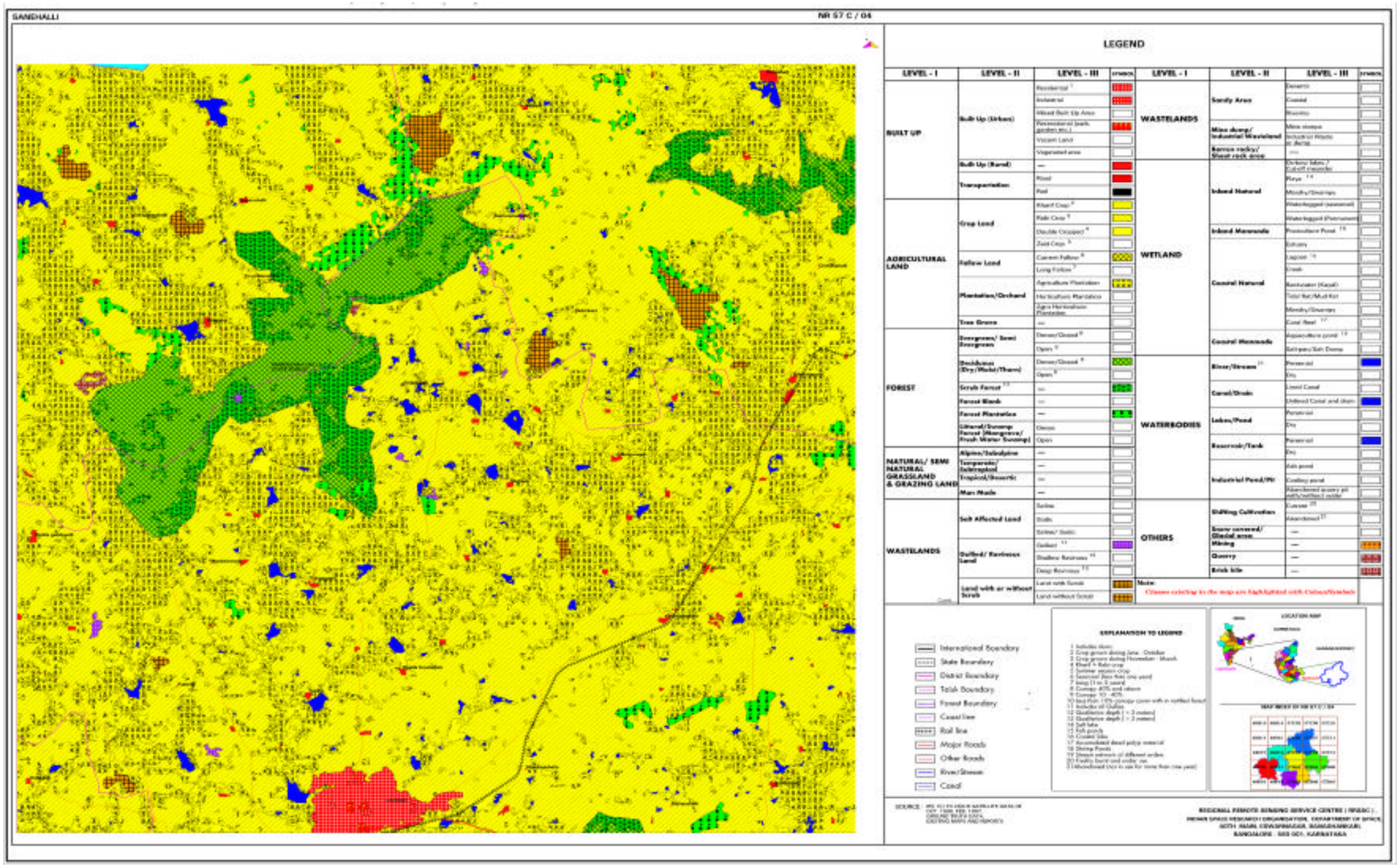


Fig 6.4 - land use/land cover map of NR 57C/04 -2001-02

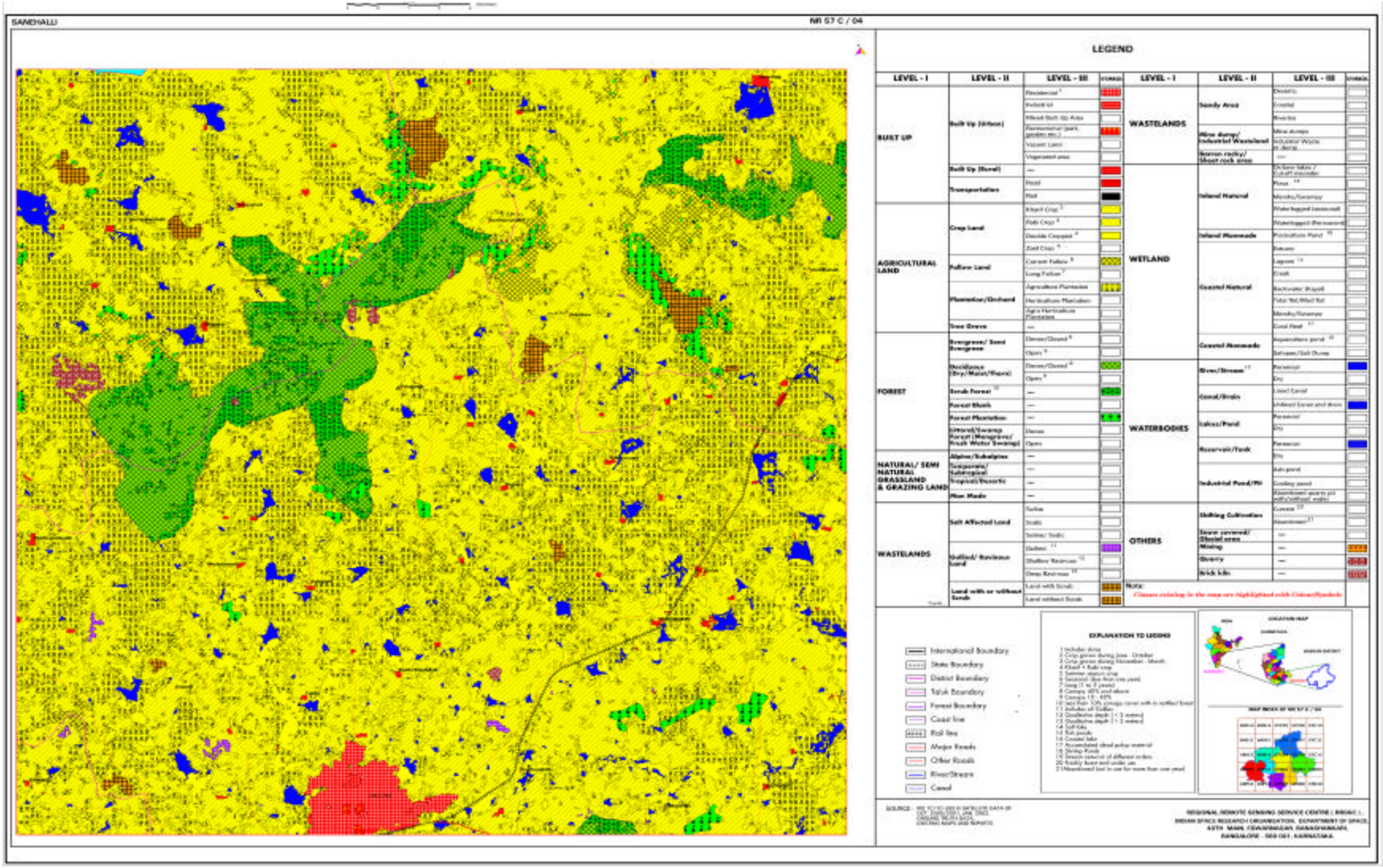


Fig. 6.5 Land use/land cover change assessment of Hassan district for the period 1996-2002

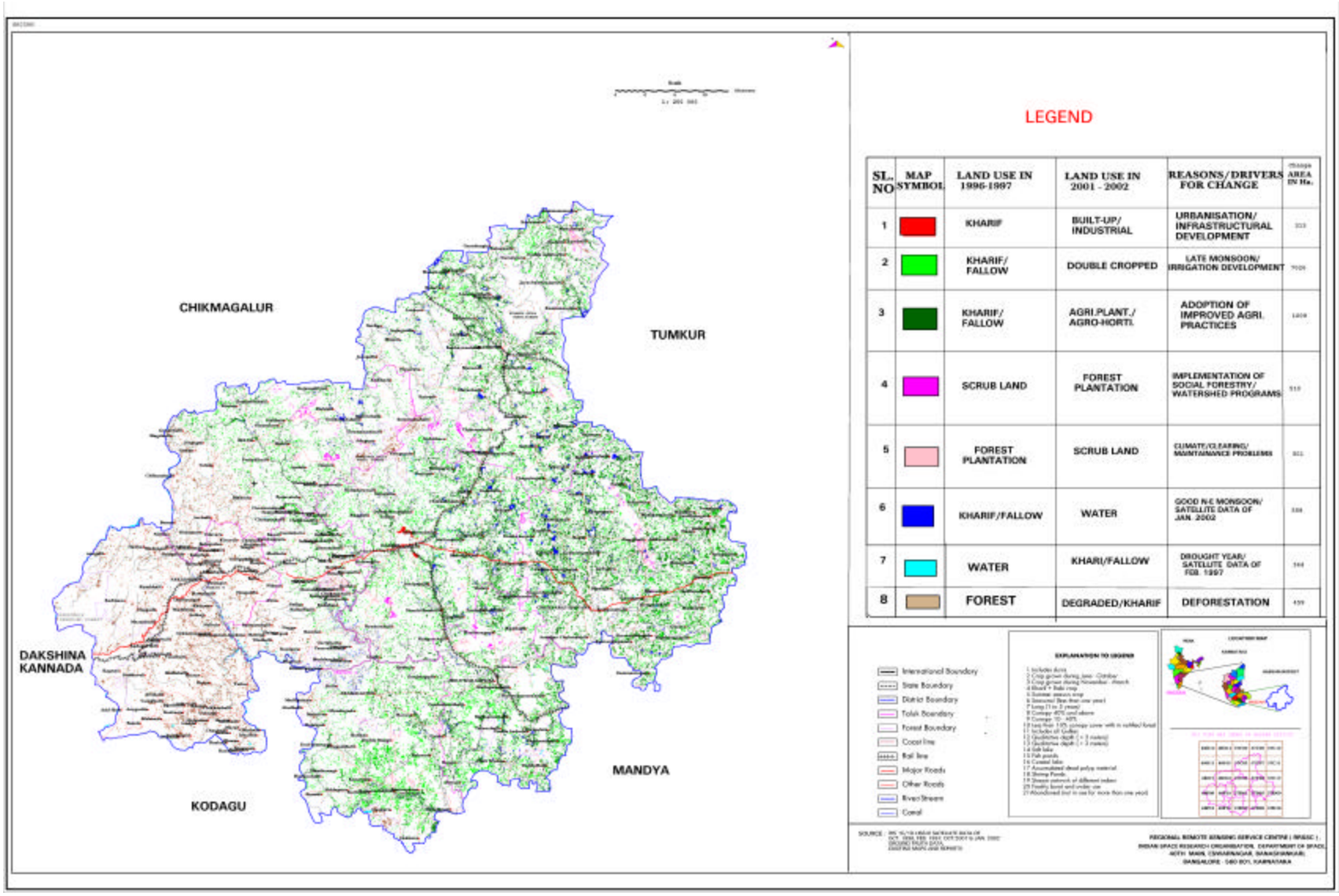


Fig 6.6 & Fig 6.7 - Satellite data depicting urban changes of Hassan district for the year 1998 & 2002

Fig 6.6

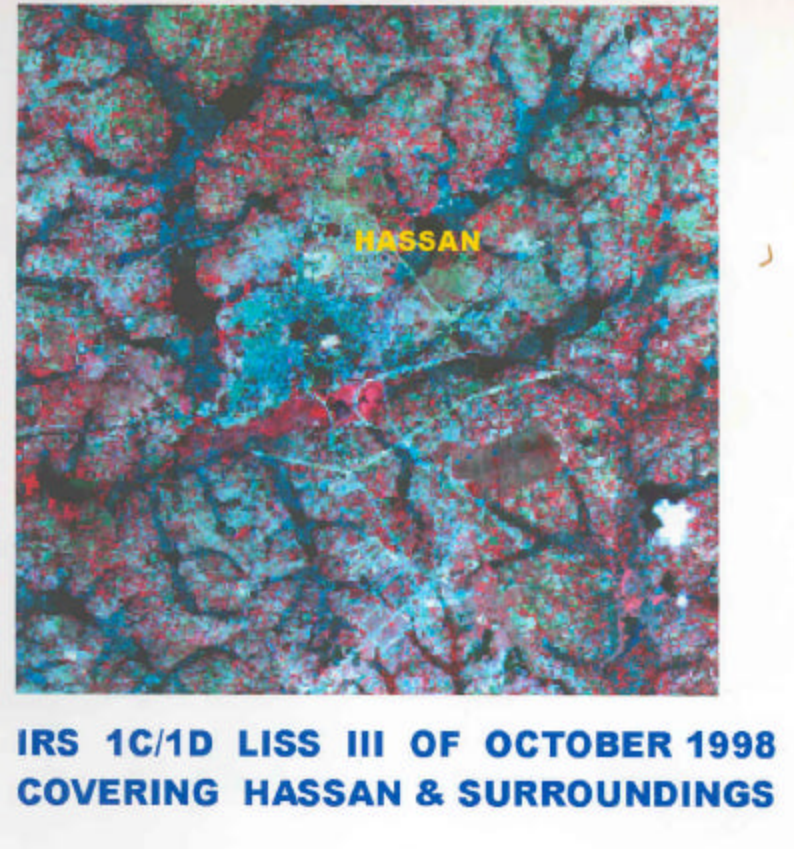
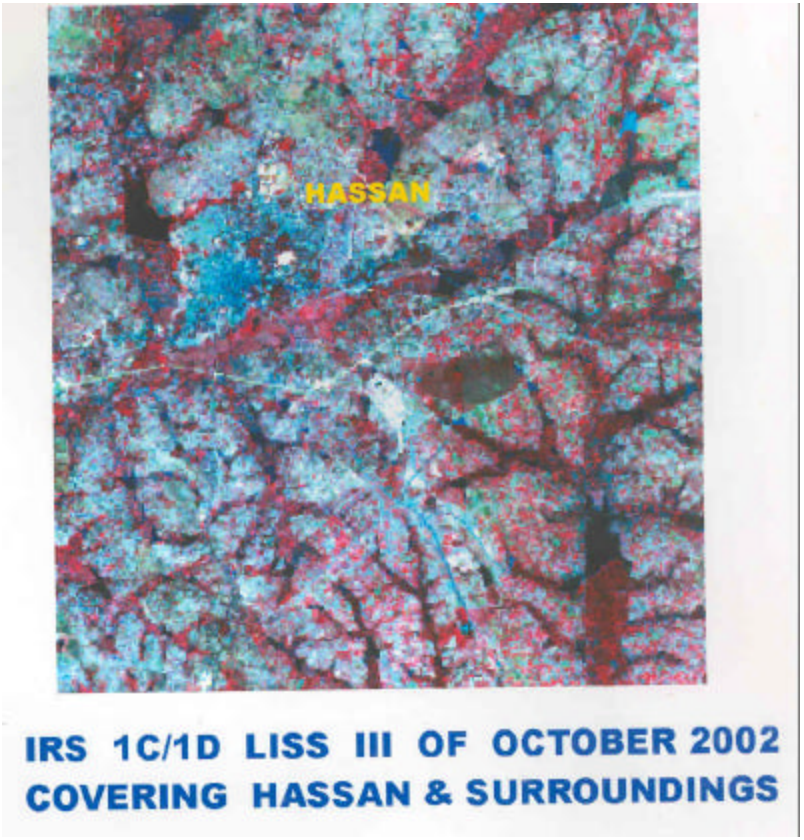


Fig 6.7



Built up land: Built up land comprises of all type of urban / rural structures, houses, industries, playgrounds parks etc. The major urban settlements like Hassan district headquarters, major towns and villages could be identified and mapped while others were identified but could not be mapped due to scale limitations specifically in the eastern part of the district while some could not be mapped in the western half of the district because they are surrounded by thick evergreen forests and plantations. The area under this category has been estimated as 3086.9 hectares or 0.45 per cent of the total geographical area of the district during 1996. Similarly the area under this category has been estimated as 3244.55 hectares or 0.47 per cent of the total geographical area of the district during 2001-2002.

Agricultural lands: Cropping activities are seen during Kharif and Rabi seasons in Hassan district. The Kharif season is from May-June to September and Rabi season is from October to February. The prevailing cropping patterns are the results of Physiography, climate and irrigation resources availability. The main food crops grown are paddy in irrigated conditions and ragi, jowar, pulses, vegetables etc., under dryland conditions. Generally mixed cropping and some times monocropping pattern is followed in the district.

Crop land of Kharif season: The satellite images of October month clearly reveals the spatial distribution of Kharif crops grown in the district. The field visits. during this period reveal that kharif crops include paddy, ragi, jowar and pulses. The prospects of kharif crops in the state mainly depend on the regularity of monsoon and to some extent on irrigation facilities. The area covered by this category has been estimated as 375421.44 hectares or 55.1 per cent of total geographical area of the district during 1996-97 and similarly the area covered by this category has been estimated as 354140.74 hectares or 51.95 per cent of total geographical area of the district during 2001-2002.

Crop land of Rabi season: The satellite imagery of January/February month was used for delineating Rabi cropped areas. Generally the Rabi crops are raised under irrigation conditions such as canal, tank and well systems. The major crops grown during Rabi season are ragi, jowar, pulses and vegetables etc. The area under this category has been estimated as 63439.30 hectares or 9.28 per cent of the total geographical area of the district during 1996-97. Similarly the area under this category has been estimated as 124087.12 hectares or 18.21 per cent of the total geographical area of the district during 2001-2002.

Double Cropped Area (Kharif and Rabi): The analysis of the two season data clearly indicates that the double cropped areas are mostly concentrated in the command areas. The double cropped areas are found under canal, tank and well irrigation conditions. Generally paddy, jowar, sugarcane, groundnut and vegetables are found in double cropped areas. The paddy crop under canal irrigation system is largely grown in Arkalgud taluk.

Fallow land: Fallow land is an agricultural land left uncultivated during both Kharif and Rabi seasons. An analysis of two season data reveals that certain amount of fallow land is found in Hassan district. The area under this category is estimated as 4187.60 hectares during year 1996-97 and 16980.51 hectares during 2001-2002.

Agricultural Plantations: Areas under perennial bushy or tree crops and various fruit crops are included under this class. Coffee and coconut are the major plantation areas observed in the Hassan district. Tea, Cardamom, areca nut, mango and tamarind plantations are also seen as small gardens or patches during field visit. Coffee and tea plantations are concentrated in Alur and Sakleshpur taluks in the Western Ghat areas of the district. Mostly coconut plantations are observed in the valleys of the eastern plains. The Rabi and summer season data helps in discriminating plantation areas. The area under this category has been estimated as 151599.19 hectares during 1996-97 and 161976.99 hectares during 2001-2002.

Forests: In Hassan district, we have Evergreen/Semi-evergreen forests in the Western Ghat area. The different forest types that have been mapped are Evergreen/Semi-evergreen, Deciduous (moist/dry/thorny), scrub forest and forest plantations. Forest boundaries were digitized using 1 :250,000 and 1 :50,000 scale SOl toposheets.

Evergreen/Semi-evergreen forests: The Western Ghat region in Sakleshpur and Alur taluks have good Evergreen forests (southern tropical wet evergreen forests). Shola vegetation found among the grassy peaks is also classified under this category. The zone of semi-evergreen vegetation consists of rich mixture of evergreen species with deciduous trees. They are found on the lower half of the steep western slopes of the Western Ghat and adjacent to coffee plantations. This category has been mapped using multidate satellite data and limited field checks. The Evergreen/semi- evergreen forests are seen in Sakleshpur taluk of Hassan district. The area under this category has been calculated as 59489.48 hectares during 1996-97 and 58303.38 hectares during 2001-2002.

Deciduous forests (Dry/Moist/Thorny): Dry deciduous forests are found in eastern plains and extensive stretches are seen in Hassan and Arasikere taluks. Most of these deciduous forests are put to changed land use with Eucalyptus and Acacia plantations. Mainly deciduous type of forests is observed within semi- evergreen forests along the lower elevations in the Western Ghat region. Multitemporar satellite data adjusted to phenologic cycle (Kharif and Rabi) of predominant species helps in discrimination of these forest areas. The area under this category is estimated as 14162.26 hectares during year 1996-97 and 17576.77 hectares during *2001-2002.*

Scrub forest: The forest area irrespective of floristic composition is considered to be degraded when the areal crown density of the community falls below 10 percent. Hill top grasslands in Western Gnat region within notified forest area is classified as scrub forest. The stunted, pricky vegetation found in degraded forest of eastern plains are due to dry climate and poor soil conditions, grazing pressure and biotic interference. The area estimated under this category within notified forest area is 10797.42 hectares during the year 1996-97 and 8042.64 hectares during *2001-2002.*

Forest Plantations:- These are the forest areas artificially planted with trees, either in the open degraded forest areas or by clearing areas within good forest areas by clearing economically inferior species. Scrub forests are afforested with teak, acacia, eucalyptus or glyricidia plantations under various schemes like social forestry, watershed development programme, wasteland development programme etc, The area calculated under this category is 5382.45 hectares during 1996-97 and 5883.04 hectares during *2001-2002.*

Natural Grasslands: The hill top grasslands are common along the Ghat forests where the steep hills are devoid of tree cover and occupied by sub climax temperate/sub tropical grasslands hosting a number of grass species at higher elevations. They appear distinctly with pink coloured sooth textures areas higher elevations in the Kharif season data. The area estimated under this category is 3480.50 hectares during 1996-97 and 4023.68 hectares during 2001-02.

Wastelands: Wastelands refer to degraded land, which can be brought under vegetation cover with reasonable effort. These lands are not productive currently due to various problems such as soil erosion, salinity, water logging etc. The various types of wasteland categories identified

in Hassan district include Gullied/Ravinous land, land with / without scrub, sandy area, barren rocky/story waste and mine dumps and industrial waste. The area estimated under this category is 40227.92 hectares during 1996-97 and 41388.52 hectares during 2001-02.

Land with or without scrub: These are found as patches of various dimensions either on uplands slopes of hills/mountains or along stream courses. Sometimes they are also found along the fringes of the notified forest regions. The most common scrub species observed in Hassan district are *Cathium parciflora, Dodnea vericosa, Cassia auriculate, Toddelia asiatica, Acacia leucophloea etc.* Succulents and herbs of various species are also seen in dense scrub areas. In the dryland areas, plantations of Eucalyptus and Acacia have been raised under various social forestry/watershed development programmes.

Barren rocky/stony waste: They are mostly found in small patches either on hill summit or steep slopes or uplands. They are unproductive and can also be observed within notified forest boundaries. They can be easily identified due to their distinctive appearance on satellite data.

Sandy area: This category appears bright white in colour and appears linear in pattern along the riverbeds and within reservoir/tanks.

Gullied/Ravinous lands: Only few small patches of gullied and ravinous lands have been observed in the districts mainly in the taluks of Hassan and Arkalgud. Few mine dumps/industrial wastelands could be mapped in the district.

Waterbodies: This class consist of areas of surface water either impounded in the form of ponds, tanks, reservoirs or flowing as rivers, canals, streams etc. These features can be readily extracted during digital classification due to their distinct appearance on the image. Some canals are digitized and overlaid on the classified output. The area estimated under this category is 12581.23 hectares during 1996-97 and 18229.43 hectares during 2001-02.

Rivers/streams: Krishna, Cauvery, Netravathy, Yagachi, Hemavathy rivers with their network of streams drain the water from the district. Most of the streams in Western Ghat are perennial.

Reservoirs and tanks: Apart from major irrigation reservoirs like Hemavathy, Yagachi and Watehole, there are quite a large number of big and medium sized irrigation tanks which could be mapped using IRS LISS III imagery.

Natural lakes and ponds are not observed in the district. The canals and major streams and river courses were classified based on the presence of water in them. No major industrial ponds/pits were observed in the district.

Others: A few patches of mining, quarries and brick kilns have been identified and mapped based on distinctive tones on the raw FCC and extensive field checks.. The areal extent of this category is estimated as 397.2 hectares during 1996-97 and 900.11 hectares during 2001-02.

6.11.8 (iii) land use/land cover change assessment: The NR census mapping would be carried out once in five years and the change in most of the themes would be assessed for change detection from second cycle of NR census mapping. The change analysis/assessment for land use/land cover maps of two periods 1996-97 and 2001-02 was carried out digitally by image spatial modelling techniques. Since all the maps are in digital form/domain, the overlaying techniques and differencing of images are used for generating change maps and computing area statistics. The ground verification of such hot spots (bio- diversity/Western Ghat) or sensitive areas (built-up, improved agriculture/irrigation) are carried out and the changes are shown in the change map. The change area statistics are given in Table 6.2. It is also proposed that these hot spots or sensitive areas would be monitored more intensely and mapped on 1 :25 000 scale using (LiSS III & PAN) hybrid data. The assessment of these HOT spot areas would include a status assessment and also the causatives for the deterioration.

Built-up land: The change analysis indicates that the areal extent of categories like built-up land (urban and rural) and industrial land has increased between the periods 1996-97 to 2001-2002. The increase in urban built up land is estimated as 175.82 hectares and industrial area is estimated as 58.44 hectares. The drivers for such change are (1) increase in urban sprawl around Hassan city, other taluk centres and important towns and (2) development of infrastructural facilities like highway/bypass and industrial area development around the Hassan city.

Agricultural land: In all the taluks, these are no major changes observed in croplands. Due to commissioning of canal system from reservoirs like Hemavathy, Watehole and Yagachii, additional Kharif lands have been brought under irrigation and area under double crop has increased mainly in the taluks of Arkalgud, Holenarasipura and Channarayanapatna taluks.

The farmers of the district have accepted the advanced agricultural practices like horticulture, agro-horticulture and agro-forestry systems and hence there is an increase in Agricultural/Horticultural plantation area from 151599.19 hectares during 1996-97 to 161976.99 hectares during 2001-2002 indicating an increase of 10377.80 hectares during this period. The change is very well noticed in the C R Patna taluk. Otherwise, the change in agricultural pattern is not much in other taluks.

Though reports indicate more lands being brought under coffee, cardamom and tea plantation in Alur and Sakleshpur areas, it was difficult to identify such small pieces of lands brought under plantation areas due to scale and sensor limitations. Field data collected indicates increase in coffee areas in Belur taluk as more uplands are brought under coffee plantation at lower elevations in the foot hills of Western Ghat region.

Forests: During the period from 1996-97 to 2001-02, there are insignificant changes in areal spread of different classes of forest categories except for forest plantations. The degraded forest lands and other wastelands have been brought under afforestation under different social forestry and watershed development programmes. The analysis indicates dynamic change in this particular case. Both positive and negative changes are observed. The area under forest plantation category is estimated as 5382.45 hectares during 1996-97 to 5883.04 hectares during 2001-02 indicating an increase of 500.56 hectares during this period.

Wastelands: Open/dense scrub category is the only major wasteland category, which is undergoing change. Due to implementation of social forestry and watershed development programmes, some patches of the scrublands have been afforested with Eucalyptus or Acacia plantations. The change area in wasteland is estimated as 40227.92 hectares during 1996-97 to 41388.52 hectares during 2001-2002 indicating a change of 1160.6 hectares during this period.

Waterbodies: No significant change in waterbodies is observed in the district. The change in waterspread area under different classes of waterbodies is mainly due to variation in rainfall pattern during the years of analysis. Field investigations also indicate insignificant changes under this category.

Others: The classes like mining areas, quarries and brick kilns were identified during both the periods of analysis. It indicates marginal increase in numbers and areas of these classes during

this period. The increase in area may be due to more and more demand for construction materials from growing Hassan and other taluk centres as well as industries.

The detailed statistics of land use and land cover change of Hassan District is presented in Table 6.2.

The revised remote sensing classification on land use / land cover is provided in Table 6.3.

Table 6.2

LAND USE/LAND COVER AND CHANGE STATISTICS OF HASSAN DISTRICT GENERATED USING IRS LISS III SATELITE DATE

Level III	Area in 1996-97		Area in 2001-02		Change in area from 96-02	
	Area	%	Area	%	Area	%
Residential (Urban)	754.77	0.11	930.59	0.14	175.82	0.03
Industrial	38.43	0.01	93.84	0.01	58.44	0.00
Recreational (Parks/Garden)	24.63	0.00	25.86	0.00	1.23	0.00
Built-up area (Rural)	2269.07	0.33	2346.88	0.34	77.81	0.01
Built-Up	3086.07	0.45	3244.55	0.47	313.30	0.04
Kharif crop	375421.44	55.1	354140.74	51.95	-21280.7	-3.15
* Rabi crop	63439.31	9.28	124087.12	18.21	60647.81	8.93
Kharif + Rabi (double)	62852.90	9.21	124087.12	18.21	61234.22	9.00
current fallow	4187.60	0.62	16980.51	2.48	12792.91	1.86
agricultural plantation (coconut + coffee)	151599.19	22.23	161976.99	23.77	10377.80	1.54
Agriculture	531794.64	78.02	523651.97	76.85	-8142.67	-1.17
Ever Green/Semi evergreen (Dense)	59489.48	8.73	58303.38	8.55	-1186.48	-0.18
Deciduous (Dry/Moist)	14162.26	2.09	17576.77	2.58	3414.51	0.49
Degraded/Scrub forest	10797.42	1.58	8042.64	1.18	-2754.78	0.40
Forest plantation	5382.45	0.80	5883.04	0.86	500.56	0.06
Forest	89831.61	13.20	89805.80	13.17	25.81	-0.03
Grass Lands	3480.5	0.51	4023.68	0.59	543.18	0.08
Gullied & Ravinous -Mild	942.58	0.14	850.48	0.27	907.9	0.13
Gullied & Ravinous -Severe	242.40	0.04	297.39	0.04	54.99	0.00
Open Scrub	5226.46	0.77	8666.97	1.29	3440.51	0.52
Dense Scrub	33816.48	4.96	30573.68	4.49	-3242.8	-0.47
Waste Lands	40227.92	5.91	41388.52	6.09	1160.6	0.18
Water Bodies	12581.23	1.85	18229.43	2.68	5648.2	0.83
Others	397.2	0.06	900.11	0.13	502.91	0.07
Total	**681400**	**100**	**681400**	**100**		

*****The Omission & Commission errors within subclasses of Agriculture, Forest and Wasteland is mainly due to late acquisition of rabi season data during 2002 (after harvest) mainly due to cloud cover problem

Table 6.3

REVISED REMOTE SENSING BASED COMPREHENSIVE LAND USE / LAND COVER CLASSIFICATION SYSTEM FROM SATELLITE DATA*(Contd..)*

LEVEL	LEVEL-1	LEVEL-II	LEVEL-III
SCALE	1:1 Million	1:250,000	1:50,000
01	[@1]Built Up	▪ Built Up (Urban) [+1]	[@1] Residential Industrial Mixed Built Up Area Recreational (park,garden etc.) Vacant Land [@2]Vegetated area
		▪ Built Up (Rural)[+2]	Built Up area (Rural)
		▪ Transportation	Road Rail
02	Agricultural Land	▪ Crop Land[+3]	▪ [@3] Kharif Crop ▪ [@4] Rabi Crop ▪ Kharif + Rabi [@5] ▪ (Double Cropped) ▪ [@6] Zaid Crop
		▪ Fallow	▪ [@7] Current Fallow ▪ [@8] Long Fallow ▪ [@9] Agriculture Pint
		▪ Plantation/Orchard Tree	▪ Horticulture plant ▪ Agro Horticulture Plant.
		▪ Groves	▪ Tree Groves
03	[@2]Forest	▪ Evergreen/ Semi Evergreen	[@10] Dense/Closed [@11] Open
		▪ Deciduous (Dry/Moist)	Dense / Closed Open
		▪ Scrub Forest	Scrub Blank[@12]
		▪ Forest Blank	Forest Plantations
		▪ Forest Planatations ▪ Littoral / Swamp Forest (Mangrove / Fresh Water Swamp)	Forest Plantations [@13] Dense Open

Table 6.3
REVISED REMOTE SENSING BASED COMPREHENSIVE LAND USE / LAND COVER CLASSIFICATION SYSTEM FROM SATELLITE DATA *(Contd..)*

LEVEL	LEVEL-1	LEVEL-II	LEVEL-III
SCALE	1:1 Million	1:250,000	1:50,000
04.	[@3]Natural/ Semi Natural Grassland & Grazing land	[+4]Alpine/Sub-Alpine [+5]Temperate/Sub- Tropical [+6]Tropical/Desertic [+7] Man made Grasslands	▪ Alpine/Sub-Alpine ▪ Temperate/Sub-Tropical ▪ Tropical/Desertic ▪ Man made Grasslands
05	Wastelands	▪ Salt-affected land	▪ Saline ▪ Sodic ▪ Saline/ Sodic
		▪ Gullied/ Ravinous land	▪ [@14] Gullied ▪ [@15] Shallow Ravinous ▪ [@16] Deep Ravinous
		▪ Land with or without Scrub	▪ Land with scrub ▪ land without scrub
		▪ Sandy area	▪ Desertic ▪ Coastal ▪ Riverine
		Mine. dumps /Industrial Waste or dumps	▪ Mine dumps ▪ Industrial Waste dumps
		Barren rocky! - Stony waste/ Sheet rock	▪ Barren rocky/ Stony waste / Sheet rock
06	Wetlands	Inland Wetland	Natural ▪ Ox-bow lakes / ▪ Cut-off meanders ▪ [@17] Playas ▪ Marshy/Swampy ▪ Waterlogged (seasonal) ▪ Waterlogged (Permanent) Manmade ▪ [@18]Pisciculture ponds
		Coastal Wetland	Natural ▪ Estuary ▪ [@19]Lagoon ▪ Creek ▪ Backwaters (Kayals) ▪ Tidal Flat / Mud Flat ▪ Marshy / Swampy ▪ [@20]Coral Reefs Manmade ▪ [@21] Aquaculture ponds ▪ Salt-pans / Salt Dumps

Table 6.3
REVISED REMOTE SENSING BASED COMPREHENSIVE LAND USE / LAND COVER CLASSIFICATION SYSTEM FROM SATELLITE DATA *(Concld.)*

LEVEL	LEVEL-1	LEVEL-II	LEVEL-III
SCALE	**1:1 Million**	**1:250,000**	**1:50,000**
07	Water Bodies	[+8] River / Streem	[@22] Parennial Dry
		Canal / Drain	Lined / Unlined / Canal and drain
		Lakes / Ponds	Perennial Dry
		Reservoir / Tanks	Perennial/ Dry
		[+9]Ashpond / cooling pond or reservoir	Ash pond Cooling pond
		Abandoned quarry pits	Abandoned quarry pits with or without water
08	Others	Shifting cultivation	[@23]Current Abandoned
		[+10]Snow covered / Glacial area	Snow covered/Glacial area
		Mining	Mining
		Quarry	Quarry
		Brick kilns	Brick kilns

Notes :

- *This is a general-purpose comprehensive classification scheme where land use classes are comparable and compatible with the Nine-fold Revenue Land use classification. .This classification is amenable for use with remotely sensed satellite data at various scales.*
- *Level-I: IRS (LISS-I); Level-II: IRS (LISS-II); Level-III: IRS (LISS-III) for general land use;*
- *Level-I on need basis may be mapped using IRS (LISS-I)/IRS (WiFS)/data on compatible scale on 1: 1 Million and small*
- *Specific land use/cover classes can be grouped to suite the region/local area requirements like Desert region, Coastal region and hilly region, considering the terrain, climate and cultural practices.*
- *Inputs from ACZP National land use /Iand cover classification, Wasteland classification, Wetland classification and Nation-wide Grassland /Grazing land classification also referred.*

6.11.8 (iv) Hot Spots/Sensitive Areas in Hassan District

The analysis of two period data of 1996-97 and 2001-2002 with a gap of 5 years to generate information on natural resources of Hassan district brought out the following:

1. Western Ghat area is considered as one of the hot spot areas by the forest department and many projects have been initiated to study the bio-diversity of the area. The studies have so far brought out that there is tremendous pressure from biotic interference, grazing and encroachment for raising coffee, cardamom and other forest plantations. There are about 33 endangered species and 15 rare endangered species in Western Ghat area. Hence a good census of the data at frequent intervals will help in arriving at strategies to provide adequate protection, arrest fragmentation and stop further degradation of very precious evergreen forests containing many important medicinal, aromatic and other useful trees/plants. Hence there is a need to monitor the biodiversity of evergreen forests in Sakleshpur and Alur taluks.

2. The improvement in irrigation facilities through the construction of Hemavathy, Watehole and Yagachi reservoirs with their canal system has encouraged farmers to change from dryland agriculture to new improved Horticulture, Agro-horticulture and Agro-forestry systems. The study has clearly shown continuous development of such areas in Hassan, Arkalgud, Belur, Channarayapatna and Holenarasipur taluks. Hence continuous monitoring is required for proper functioning of these irrigation systems.

3. The district administration have implemented afforestation, social forestry and watershed development programmes to green the open/dense scrub wasteland and degraded/underutilized scrub forests to raise plantations of economic value. The study of two periods i.e. 1996-97 and 2001-2002 satellite data clearly brings out the dynamic change in forest plantation category indicating positive as well as negative changes. This shows the data generated under natural resources census will provide a good data base to understand the dynamic changes occurring in this category and to initiate more programmes to bring more and more wastelands and scrub forests under afforestation programmes leading to better utilization of these lands.

4. The Built-up lands, which include cities, towns and big habitats, have shown horizontal growth with time. The Hassan city has spread in all directions and new infrastructural

facilities in the form of highways / bypass and new industrial area have increased total area under this category.

5. The major part of the district is under dryland agriculture. The frequent updation of natural resources may help the district administration to understand the problems of dryland agriculture and suggest suitable advanced technology based packages to farmers under various national and state funded projects to improve the socio-economic status of the farmers of the district.

Chapter-7

A SUMMARY OF OBSERVATIONS AND FINDINGS

Valuation of natural resources involves a number of issues about which experts have been debating without consensus. Various steps involved here are quite subtle and complex. The reasons are manifold. *First*, these may be in the form of non-produced assets and hence property rights over these assets are far from completely defined. *Second*, these may be exhibit properties of public goods and hence, application of market principles is not feasible. *Thirdly*, methodologies may not be applicable in a particular context. In the absence of a market, it is difficult to get the preferences of economic agents revealed. A way out of this problem is to apply the stated preference method, *i.e.*, contingent valuation method. In this method, the stakeholders are required to state their preferences in hypothetical markets which are set up by the researchers in the form of questionnaires or interview schedules. The respondents have to express their willingness to pay for obtaining an environmental product/service or towards its conservation. Alternatively, the respondents are required to state their willingness to accept compensation for the loss of environmental product/service. The method is controversial as the setting up of the bidding procedure for willingness to pay or willingness to accept may suffer from the initial or starting point bias. A more important limitation of this methodology is that it may not be applicable in situations where ability to enjoy environmental goods/services is limited by the lack of purchasing power. In such situations, the willingness to pay can be approximated by the number of hours or other contributions which the stakeholders are willing to make. If the valuation using by the CV method for environmental resources can reliably be obtained, then these can be incorporated either into the national income accounts or can be used for augmented national income or satellite accounts for natural resources.

The present study has provided some interesting insights about the valuation of national resources accounting particularly with reference to Karnataka. These insights are likely to be useful in understanding the composition of state domestic product and also suggest

useful leads for the future policy making. We also wish to add that since this study is an initiative probably one of the earliest one in the frontier area there are still a number of gaps which need to be addressed in the future initiatives in the area.

Following are the observations with respect to some of the salient aspects of the study:

- As regards the framework for operationalizing the integration of environmental accounts with economic accounts, we need to prepare both 'physical and monetary accounts' for environmental assets which are broadly divided into three categories by SEEA 2003. These are natural resources (consisting of mineral and energy resources, soil resources, water resources and biological resources), land and ecosystem. The accounts for environmental assets are in the nature of stocks. In addition to preparation of the environmental asset accounts, we must also prepare the flow accounts, which will depict changes in stocks of environmental assets. Again this needs to be done in terms of both physical and monetary terms. The magnitude of difference between the opening stock and the closing stock depicts the flow, i.e., the change in environmental assets. New discoveries of minerals, natural growth of plants and animals, land reclamation, etc., will be in the nature of addition to the stocks, whereas, extraction of minerals, soil erosion, loss of capacity of reservoirs due to silting, harvesting of plants and animals, natural death of plants and animals will constitute the subtraction from the stock. The official agencies will have to undertake regular inventories of the stocks of natural resources in as detailed a manner as possible. A relevant example here for Karnataka would be to estimate inventory of various plant species in forests of Karnataka. This can give us the physical accounts both in stock and flow terms. Prices (or proxy for prices) of these species can then be used for preparation of monetary accounts. Also a more explicit record of transactions which pertain to depletion/degradation of natural resources and the defensive expenditure to prevent the same should be collected and should be included in the satellite accounts for natural resources. Compilation of database on the above lines suggested by SEEA 2003 is a Herculean task. Numerous difficulties will abound the process.

- The problem of obtaining information about appropriate prices for conversion of physical into monetary account is one such example. For many environmental assets, neither the property rights are defined completely nor are the markets complete. In such cases, alternatives, such as, travel cost method, contingent valuation method, *etc.*, have to be applied. Here, it is necessary to mention that such methods need to be applied with caution as the cultural context cannot be ignored in operationalizing such methods. Another crucial problem which cannot be ignored is that of the existence of externalities. To give an example, externalities emanating from forest spill over to other states and also to other countries. The benefits emanating from sink functions of forests cannot be incorporated within the state resource accounting framework, due to their global benefits. These interactions have been highlighted in SEEA 2003.

- In India, the income originating from forestry and logging sector is included in a rather incomplete manner. The timber produce harvested on land under forest departments is taken care of in the flows of national income accounts. However, the other non-timber forest products/services are inadequately accounted for in the national and state domestic products.

- In Karnataka, the activities of mining and quarrying, energy and forestry activities are putting high pressure on forest resources. As regards land, it is the industrial activity, mining and quarrying activity, urban planning, water supply and sanitation, forestry and agricultural activities which are exerting high pressure on land resources.

- As regards accounting for forests in Karnataka, the data on forests can be obtained from three sources: (i) Ministry of Agriculture (land-use statistics based on revenue records); (ii) Ministry of Environment and Forests (based on the data provided by the State Forest Departments and primarily classified by the legal status of the land); and, (iii) Forest Survey of India, classified according the canopy cover and compiled by using the satellite imageries using remote sensing technology. There are discrepancies in the data obtained from the three different sources. The first two sources report the data almost without any change across the years. The definitions used here pertain to

property rights to forests rather than to the vegetation cover. Hence FSI data may be more useful than the data from these two sources. However, there are also problems of comparability of data across the various assessment rounds of FSI, due to the changes in sensors and scales used across various assessment periods. Official agencies should collect data which are comparable across at least for some length of time. We find that in Karnataka, the area under forest cover in Karnataka has declined in 2003 as compared with 2001 and that this decline has been caused by severe decline in the dense forest cover, part of which has gotten converted into open forests. The decline in dense forests of Uttar Kannada has been almost half of the decline in dense forests of the Karnataka state as a whole.

- India has been in the forefront of information technology. It will be in order for the state governments to profile and publish the resources of state (such as forest cover, land quality, water resources, *etc*.,) with the systematic frequency by using remote sensing technology. The effort has begun in the form of SFR. However, at present, due to changes in sensors and scales, the data are incomparable over any longer span of time. Especially for environmental resources, the data have to be in the nature of a time-series for any meaningful analysis.

- Eight case studies were conducted to get an idea of the contribution of forests in Karnataka to the State Domestic Product of Karnataka. The main findings of these case studies are:

- The study on value of NTFPs reveals that the unrecorded value of NTFPs (Rs 1649.7 crores) is about 47 times that of the recorded value (Rs 35.3 crores) for 2002-03. The SDP originating from forestry and logging in 2002-03 is reported to be Rs 1912 crores. In other words, about 86 % of unrecorded NTFPs (to the reordered value) is escaped from the national income accounting of GSDP originating from forestry and logging sector. **This unrecorded value of NTFPs constituted about 1.45 percent of GSDP of the state at current prices for 2002-03.**

- Various types of forests of Karnataka provide grazing facility to its livestock population **which amounted to about 0.50 percent of SDP of Karnataka at current prices in 2002-03.** However, the adjustments on the negative side have to be made for the

expenses in running the forest department and also the degradation in land quality and productivity of land due to grazing of animals in forests.

- Karnataka possess a rich wild-life resource and is known for its wild-life sanctuaries. The case study on Dandeli Sanctuary reveals that the recreational value of the Sanctuary was about 1.8 crores in 2004-05 and is more than the revenue earned by the state. The magnitude of consumers' surplus is a measure of economic welfare which also should be noted in devising the environmental policies. Using travel cost method and based on primary data we estimated the recreational value of forests for the state constitutes **0.02 % of GSDP at current prices for 2002-03.**

- Making use of the other published literature in the area of carbon sequestration benefits of forests, the study highlighted these benefits in the context of Karnataka. We calculated the carbon content of forests of Karnataka using secondary data. The estimated value of carbon content in the forests of Karnataka is Rs. 16659.79 crores. **This is about 14.6 % of GSDP at current prices in 2002-03 which seems to be very significant. However, carbon stored due to sequestration benefits is a stock concept and hence, can be used in accounting for stocks and not to be incorporated in national income**. A better and detailed annual inventory of various plant species in Karnataka will enable the researchers to accurately estimate the carbon sequestration benefits.

- The value of fuel wood used by the local industries in the study area of the Uttar Kannada district amounted to about Rs. 49 lakhs. The sale of fuel wood by government depots is already accounted for in the national income accounts. Therefore, adjustments of this value for SDP have not been made for the sheer fact of avoiding double counting.

- The forest resources of Karnataka in particular and of India in general, are used for medicinal purposes. The state machinery should take steps to integrate the traditional knowledge regarding medicinal plants with the advances in the field of chemical engineering and bio-sciences. This can be a very important source of state domestic product with its backward and forward linkages. The case study reveals the traditional knowledge of medicinal plants which are collected and used locally. **The share of**

medicinal plants in GSDP for the year was estimated to be 0.01 percent for the year 2002-03.

- As regards the sacred groves, the cultural context and the changes therein are very important. We estimated **the share of sacred groves in GSDP as 0.001 per cent for the year 2002-03 on the basis of the willing ness to pay by the households.**
- The case study on watershed benefits of forests indicates that due to the financial gains from watersheds, the contingent valuation method may be a more useful methodology and people are likely to state their preferences much more explicitly than was observed in the case of sacred groves case study. We estimated **the willingness to pay for the preservation of watershed for state as Rs 43.23 crore for the year 2002-03 based on the sample study which constitutes 0.04 percent of GSDP.**
- The core of accounting for land resources lies in getting information on land use and land coverage (both stock and flow matrices). For Karnataka, we have fairly satisfactory data on land use pattern in physical terms. Conversion of the same in monetary terms requires the corresponding price matrix which is rather difficult to get due the facts that land markets are rather thin and also the reported prices for land transactions are more often than not are grossly under-reported due to tax related reasons. Both in India and Karnataka, water erosion and agricultural activities have taken a toll on the land resources. We have identified the impacts of land degradation; both environmental and socio-economic, in a PASIR framework for the state. By using the physical accounting method (SEEA,2003) we have developed the physical flow of accounts of land resources (Table 5.5). As soil is one of the most important determinants of land quality for agricultural purposes, we have provided an in-depth overview of the soil resources of the state and also provided estimates of restoration of soil based on restoration cost approach. These estimates are used to estimate the adjusted SDP in the agriculture sector of the state which was 19.5 % as against 20.3 %without adjustment of land degradation. There is a need to classify land in the state on a regular basis with respect to the intensity of degradation and the types of degradation. The format provided by the FAO is worth emulating in this regard as such data can provide a good guide to the policy making

- The use of remote sensing data has been more of a demonstration of how such data are useful and have to be in the public domain. As the censors and scales have been changing, it has been difficult to make use of images to arrive at the land use and land cover matrix. However, this is more reliable method as it is also based on ground truthing, as compared to the official land records, which are just repeated in successive years. As the comparable data on satellite images will become available for a longer time-series, the methodology of estimating physical accounts of forest and land resources will become more reliable. In areas where land use and land cover is changing rapidly, there is need to maintain records of such images on a more frequent basis.

BIBLIOGRAPHY

ADB (1998): 'Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS): India'. Asian Development Bank. Manila.

Adger and others (2002): 'Tropical forest values in Mexico' in Valuing the Environment in Developing Countries- Case Studies, Edited by David Pearce, Corin Pearce and Charles Palme

Bhat D M, Murali K S and Ravindranath N H (2001): 'Joint Forest Planning and Management in Uttara Kannada; A Review' *Fores trees and people*, 11; 233-250.

CADA, TBP Mumirabard.- Official Documents (Unpublished)

Census of India, (2001): 'Primary Census Abstract- Karnataka' Census of India.

Chandran and Gadgil (2005): 'Sacred Groves and Sacred Trees of Uttara Kannada' available on http://www.ignca.nic.in/ed_08008.htm

Chopra K. and G. Kadekodi (1997): 'Natural Resource Accounting In The Yamuna Basin: Accounting For Forest Resources', IEG Monograph, New Delhi.

Chopra Kanchan and Adhikari Saroj Kumar (2002): 'Environment Development Linkages: Modelling A Wetland System for Ecological and Economic Value' Institute of Economic Growth, Delhi.

Chopra, K (1993): 'The Value of Non-Timber Forest Products: An Estimation for Tropical Deciduous Forests in India' Economic *Botany*, Vol-47, No-3, Pp-251-257.

CSO (2003) (by Jitender Kumar, Gulab Singh and Aloke Kar): 'On Compilation of the Estimates of State Domestic Product in India- A Treatise' in 'Domestic Product of States in India 1960-61 to 2000-01, EWP Research Foundation, 2003, P-81

Emerton lucy and Mogaka Hexron (1996): 'Participatory Environmental Valuation of Forest Resources in the Aberdares, Kenya' PLA Notes, London.

Forest Survey of India (FSI, 2001): 'State of Forest Report' Government of India, Dehradun

Forest Survey of India (FSI, 2003): 'State of Forest Report' Government of India, Dehradun

Government of Karnataka (1996): 'State Forestry Action Programme (1997-2017) Karnataka Forest Department' Govt of Karnataka, Bangalore.

Government of Karnataka (2003): 'Economic Survey' Planning and Statistics Department, Government of Karnataka, Bangalore.

Government of Karnataka (2003): Livestock Census 2003' Director of Animal Husbandry and Veterinary Services, Government of Karnataka, Bangalore.

Government of Karnataka (2004): 'State of the Environment Report and Action Plan-2003' Department of Forest, Ecology and Environment, Government of India, Bangalore.

Government of Karnataka (Various Issues): 'Annual Administration Report of Karnataka Forest Department' Principal Chief Conservator of Forests, Government of Karnataka, Bangalore.

Government of Karnataka (Various Issues): 'Karnataka At a Glance' Directorate of Economics and Statistics, Government of Karnataka, Bangalore.

Government of Karnataka website. www.kar.nic.com

Gummagolmath K C (2000): 'Economic Dimensions of Soil Salinity and Sater Logging in Tunga Bhadra Project Command Area- Karnataka' Ph.D Thesis on Soil Science, UAS, Dharwad.

Gunatilake, H.M, Senaratne, D.M.A.H and P.Abeygunawardena (1993): 'Role of Non-Timber Forest Products in the Economy of Peripheral Communities of Knuckles National Wilderness Area of Sri Lanka: A Farming Systems Approach' *Economic Botany*, Vol-47, No-3, Pp-275-281.

Haripriya G (2000): 'Integrating Forest Resources into System of National Accounting in Maharastra, India' *Environmental and Developmental Economics*, 6(2) Pp 237-258

Haripriya G S (2000): 'Estimates of Biomass in Indian Forests' *Biomass and Energy*, 19(4), Pp 245-258.

Haripriya Gundimeda (2003): "Carbon Budget of Indian Forests" *Climate Change*, 56(3) P-191-319.

Hotelling C.S (1973): 'Resilience and Stability of Ecological Systems. *Annual Review of Ecological Systems*, 4; 1-24.

Hotelling C.S (1992): 'Cross-Scale Morphology, Geometry and Dynamics of Ecosystems, Ecological Monographs, 62: 47-52.

Hotelling C.S.D.W. Schindler, B. H. Walker and J.Roughgarden (1995): 'Biodiversity in the Functioning of Ecosystems: An Ecological Synthesis, in C. Folke, C.S.Holling, B.O.Jansson and K.G.Maler (Eds) *Biological Diversity: Economic Ecological Issues*, 44-48, Cambridge; Cambridge University Press.

Holling, Harold (1949): 'Letter to the Director of the National Part Service' in Roy A. Prewitt, The Economics of Public Recreation. The Prewitt Report. Washington, D.C. Department of the Interior. Letter dated June 18, 1947.

Howard, P (1995): 'The Economics of Protected Areas in Uganda: Costs, Benefits, and Policy Issues' Unpublished Dissertation, University of Edinburgh, Summarized in Bagri, A., Blockhus, J., Grey, F. and F. Vorhies (eds), 1998. Economic Values of Protected Areas: A Guide for Protected Area Managers, IUCN: Gland.

IPCC (1992): Intergovernmental Panel on Climate Change, available at http//www.ipc.ch

Jodha N S (1992): 'Common Property Resources and Rural Poor in Dry Regions of India' in Managing India's Planning Vol-II. Edited by S N Chary and Vinod Vysulu. Printwell Publishers. Jaipur, P-366.

Karnataka State Land Use Board (KSLUB, 2001): "Perspective Land Use Plan for Karnataka 2025" Government of Karnataka, Bangalore.

Karnataka State Remote Sensing Application Center, Bangalore

Kulkarni (2003): 'Soils in Karnataka' Paper Presented in University of Agriculture Science, Dharwad.

Kushalapa Kidira A (2003): 'Draft Final Report- Land and Forest Degradation Sector' for State of Environment Report and Action Plan 2002-03, Government of Karnataka.

Lal, J.B (1990): 'Economic Value of India's Forest Stock' *Van Vigyan* (Journal of the Society of Indian Foresters), Vol-28, No-3, Pp-63-72.

Lescuyer and Guillaume (1996): 'Monetary Valuation of the Non-Timber Forest Products (NTFPs): Does it Contribute to Determine a Sustainable Management of those Resources?' 6th IASCP Conference, California.

Logo and Brown (1992): 'Tropical Forests as Sinks of Atmospheric Carbon' *Forest Ecology and Management*, 54: 239-255

NBSS and LUS (1998): 'Soil of Karnataka for Optimizing Land Use" NBSS & LUP Publication, No-47, Nagpur.

Palm Matilda, Ostwald Madelene, Berndes Goran and Rabindranath N H (2002): 'Forest Based CDM Projects in India' 9th Ph.D Workshop on International Climate, Viterbo, Italy, 15-16 October 2004.

Parikh K.S. and Ghosh. V (1995): 'Natural Resources Accounting for Soils: Towards an Empirical Estimates of Costs of Soil Degradation for India'

Rabindranath N H and Hall (1995): 'Biomass Energy and Environment' Oxford, Oxford University Press.

Rabindranath N H, Somoshekhar B S and Gadgil M (1997): 'Carbon Flows in Indian Forest' *Climatic Change*, 35(3), 297-320.

Rai S N (2000): 'Estimation of Biomass in Western Ghats in Karnataka' –Ph. D thesis

Ramachandra, T.V, G, Kanakshi, B.V. Shruthi (2004): Bioresource Status in Karnataka, *Renewable and Sustainable Energy Reviews*, Vol-8, pp-1-47.

Reddy V Ratna (2003): 'Land Degradation in India –Extent, Costs and Determinants' *Economic and Political Weekly*, Vol-38, No-44, P-4700-4713

Saxena and Pofali (1999): 'Soil Degradation in Karnataka' *Journal of Indian Society of Soil Science*, Vol-51, (4) Pp-388-408.

Sudha P: 'Biomass and Carbon Stock Changes in Regenerating Forests Under JFM' Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

System of National Accounts (SNA, 1993): Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank, United Nations, available at http://unstats.un.org/unsd/sna1993/introduction.asp.

TERI (1998): 'Green India 2047: Looking Back to Think a Head' TATA Energy Resource Institute, Bombay.

Trice A H and Wood S E (1958): 'Measurement of Recreation Benefits' *Land Economics*, Vol-32, Pp-195-207.

U.S Dept. of Agriculture (1969): 'Soil Survey Manual' Handbook No-18

United Nations (2003) / (SEEA, 2003): Handbook of National Accounting 'Integrated Environmental and Economic Accounting 2003' European Commission/ International Monerary Fund/ Organisation for Economic Co-operation and Development /World Bank. Available on; http://unstats.un.org/unsd/envAccounting/seea2003.pdf

Warran Archana Patawardhan Ankur: 'Carbon Sequestration Potential of Trees in and around Pune City' Available on; http://www.ranwa.org/carbanpune.pdf.

Watson, Robert T., et al, eds: 'The Regional Impacts of Climate change: An assessment of Vulnerability. Cambridge, UKL Cambridge University Press, 1998. SL QC 981.8 C5 R425 1998.

Wong, Jemy L P, Thereseira Gery (2001): For Thy Carbon Sink Remembered Such Wealth Brings That Then I Scorn to State My Policy on Sinks' (unpublished). Available on; whwwa.de/publikationen/discussion paper/2002/198.pdf.

World Commission on Environment and Development (Brundtland Commission) (1987): 'Our Common Feature' Oxford, Oxford University Press.

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ANNEXURE

Table AI.1: VALUATION METHODS USED AND RESULTS

Case Study	Methods Used	Results
NTFP	The sample of 500 households from 10 villages was selected based on the extent of forest area and type of forest from Uttar Kannada, Chikmangalur, Dakshin Kannad, Hassan and Tumkur districts for getting detailed information regarding quantity and value of NTFPs collected. *The local price method* was adopted for valuing the unrecorded NTFPs which was escaped from the SDP of the state (Chapter-4).	The estimated value of unrecorded NTFP in Karnataka constituted 1.45 percent of GSDP for the year 2002-03.
Grazing	The same sample size as in the case of NTFP was used for assessing the value of detailed information regarding the dependence of animals units on forests for grazing. The fodder supplied by the forests for the animal units was estimated to assess its contribution to the state economy (SDP) using local price of the fodder. The study did not consider the adverse impact of grazing on land quality which may affect the estimation of grazing services to a certain extent. We estimated the value of fodder as follows: • Using the average grazing intensity in different types of forests of Karnataka we estimated the fodder supplied by various forest types in the state as Rs. 635.91 crore in 2004-05. • The contribution of grazing services provided by various types of forests of Karnataka was estimated to be about 0.50 percent of SDP of Karnataka at current prices in 2002-03.	The estimated value of fodder supplied by forests in Karnataka contributes about 0.50 percent of GSDP for the year 2002-03.
Recreational Value of Wildlife Sanctuaries	We used *travel cost method* for estimating the recreational value of forests. Primary data was collected from 300 sample visitors from Dandeli Wild Life Sanctuary out of 1800 visitors visited the park during the year of survey. Based on the primary data, we estimated the total recreational value for Karnataka using the recreational value for Dandeli Wild Life Sanctuary which was estimated through multiple log linear model. The reference period of the study was only for one year. The contribution of wild life sanctuary to the state economy was estimated as follows: • We estimated revenue earned from the wild life sanctuary as Rs.176.43 lakhs. Taking the area of Dandeli wild life sanctuary we estimated the total recreational value of Dandeli wildlife sanctuary as Rs. 37142.86 per Sq Km. • We got total recreational value for Karnataka as follows: Rs 37142.85 X 6319.33 = Rs 23.47 crores (we multiplied recreational value of Rs. 37142.86/ Sq Km) by wildlife sanctuary area of the state (i.e. 6319.33 Sq Km). and we got the value as Rs 23.47 crores for the year 2004-05) . • After adjusting the inflation rate we arrived at the value as : Rs 21.12 crores for the year 2002-03 which has not been recorded under the forest resource accounting. Therefore one may consider the travelers for a period of time and different seasons in the year covering a larger sample.	The total recreational value of wildlife sanctuaries in Karnataka was estimated as Rs. 21.12 crores for the year 2002-03. The share of recreational value in GSDP is 0.02 percent in 2002-03 at current prices.

Table AI.1: VALUATION METHODS USED AND RESULTS ***(Continued)***

Case Study	Methods Used	Results
Valuation of Medicinal Plants	Four (4) villages were selected from Sirsi taluk. A sample of 30 households was selected for getting the detailed information on the willingness to pay for preservation of medicinal plants in the selected villages by using stated preference method. The total willingness to pay for Karnataka, was estimated to be Rs. 8.09 crore for the year 2002-03. The method followed was: • Willingness to pay for preservation of medicinal plants in the selected villages was found to be is Rs.8220/-. To get willingness to pay for the state of Karnataka, we multiplied willingness to pay per Ha (i.e. Rs.23.48) by total forest area 3828430 Ha. • The total willingness to pay for Karnataka was Rs. 8.99 crore for the year 2004-05. The adjusted value for year was 2002-03 was Rs. 8.09 crore. This value was used to estimate the share of medicinal plant value to GSDP of the state.	The adjusted value was used to estimate the share of medicinal value of forests in GSDP and it was found to be 0.01 per cent at current prices for the year 2002-03.
Valuation of Sacred groves	Two (2) villages were selected from Siddapur taluk. Total of 30 households was selected for getting detailed information in respect of willingness to pay for preservation of sacred groves in the selected villages. • To get total willingness to pay for Karnataka, we multiplied willingness to pay per Ha (i.e. Rs.7280.18) by total sacred groves area in Karnataka (2550 HA). • The total willingness to pay for Karnataka is Rs. 1.85 crore for the year 2004-05. The adjusted (for inflation) value for year 2002-03 is Rs. 1.67 crores. This value was used to estimate its share in GSDP for the year 2002-03.	The adjusted (for inflation) value for year 2002-03 is Rs. 1.67 crore which constituted 0.001 percent of GSDP in 2002-03 at current prices.
Valuation of Watershed benefits	Three (3) villages were selected from Sirsi taluk covering a sample of 32 households for getting detailed information on the willingness to pay for preservation of watershed in the selected villages. To get total willingness to pay for Karnataka, we multiplied average willingness to pay collected from the sample HHs to total forest area of Karnataka. The result was as follows: • Willingness to pay for preservation of watershed in the selected villages: Rs. Rs.125.45 per Ha. • Total willingness to pay for Karnataka: Rs.125.45 X total forest area 3828430 HA.= Rs. 48.03 crores for 2004-05 • After adjusting to inflation it was Rs. 43.23 crores for 2002-03	Using the adjusted value of watershed benefit we estimated its share in GSDP as 0.04 percent in 2002-03 at currect prices.

Table AI.1: VALUATION METHODS USED AND RESULTS ***(Concluded)***

Case Study	Methods Used	Results
Carbon Sequestration	We have assumed that the forests in Karnataka have biomass density of 92t/Ha (Haripriya 2000). Per Ha biomass density (i.e. 92t) has been multiplied by total forest area (i.e. 382830 Ha) to get the total biomass in forests of Karnataka. The estimated biomass of forests of Karnataka was 352215560 tons. The biomass data are converted to Carbon values by assigning a Carbon content of 0.5mg C Mg over dry biomass (i.e. 352215560 tons X 0.5mg = 176107780 t). We have valued Carbon at the rate of US$20/metric ton of Carbon (Haripriya 2000) with appropriate adjustments for INR.	The estimated value of Carbon content in the forests of Karnataka is Rs. 16670.36 crores for the year 2002-03. The contribution of value of Carbon sequestration in GSDP is 14.63 percent.
Valuation of Soil Degradation	We estimated value of land degradation based on the reclamation cost of soil. These estimates were derived after consultation with Agriculture department and State Soil Survey department of government of Karnataka which were obtained on the basis of market prices of inputs and labour. The reclamation cost per Ha was multiplied by total area degraded in Karnataka. The total reclamation cost for Karnataka was Rs. 441.79 crores for 2002-03 current prices.	This cost of degradation has been deducted from the value of agricultural production (i.e. Rs. 23174 crores) to get adjusted value of agricultural production. The share of agriculture in SDP is reduced from 20.3 % to 19.95 % of GSDP at current prices for the year 2002-03.

TABLE AI. 2: DATA REQUIREMENTS, DATA SOURCES AND DATA GAPS

Components used in the Study	Data Requirements	Data Sources	Data Gaps & steps taken by the study to meet the same
Land Resources (excluding mining)	Land use & land cover classification data	• Directorate of economics & statistics. • Directorate of Agriculture • Karnataka State Land Use Board (KSLUB) • Dept. of Forests • Revenue Dept. • Rural Development & Panchayatraj Dept.	• The Data given in the report is the latest data available. • The study has used the latest data available so far.
	Settlement records	Town and Country Planning Directorate	• Not Accessible to the general public. • We used the published data which is available and accessible.
	Urban & rural land use pattern	Commissioner of land records	• Land use data collected by revenue and Agriculture Dept. does not seem to be correct. • We used the data from KSULB for 2001 which is the latest data available.
	Change in Productivity of land	• Directorate of Agriculture • Watershed department	• Not Maintained the records, hence not accessible • The study made use of the published data by the govt of Karnataka even if it is not updated.
	Degraded land area records	• National bureau of soil survey (NBSS) and land use planning • Survey of India • Indian Remote Sensing Centre, Bangalore	• Available only on special request not for general access • The study used the data published by NBSS
	Real estate prices (urban/rural) and trends	• Sub registrar office • Primary study of real estate markets	Not Published & not accessible.
	Cropping pattern, irrigated and un irrigated area	• Directorate of economics & statistics. • Directorate of Agriculture	• Data are quite old. • Data differs when sources are different for the same indicator. • We used the data published by the Directorate of economics and statistics, Karnataka.
	Source wise irrigated area (Gross/Net)	• Directorate of economics & statistics. • Directorate of Agriculture	• Data not updated • Data used in this study are taken from Karnataka at a glance published by the Govt of Karnataka.

TABLE AI.2: DATA REQUIREMENTS, DATA SOURCES AND DATA GAPS (continued)

Components of the Study	Data Requirements	Sources of Data	Data Gaps & steps taken by the study to meet the same
Land Resources (excluding mining)	Fertilizer demand and other Inputs	• Directorate of Economics & Statistics. • Directorate of Agriculture	• Not in the published form (except fertilizer). • The study used the data published in Karnataka at a Glance, govt of Karnataka publication
	Input costs	• Central Agricultural Engineering Institute • Primary studies • Agricultural Market Bulletins	• Not in the published form • We used the data of NBSS and LUP, Dept of Agriculture, GOK, 1998 which is the latest available data
	Output prices/revenues	• Agricultural market bulletins • Directorate of Agriculture	• Market prices are not available. • We have only shown the physical accounts of Land but not the monetary accounts of land in the study.
	Soil Degradation	• Central soil & waters conservation & training institute • National Bureau of Soil Survey & Land Use Planning (NBSS & LUP) • All India Soil & Land Use Survey • Institute of soil sciences	• Data are quite old and not published regularly.
Forest Resources	Forest area- according to type of forest and changes in area.	• Forest Survey of India • Annual Administration Report of Forest Department, Govt of Karnataka. • Forest survey of India. • State of Forest Report.	• Methodology used by FSI for data generation is different for 2003 and 2001. Therefore, it is somewhat difficult to compare these data. • The present study used the data of FSI.

TABLE AI.2: DATA REQUIREMENTS, DATA SOURCES AND DATA GAPS (concluded)

Components of the Study	Data Requirements	Sources of Data	Data Gaps & steps taken by the study to meet the same
Forest resources	Timber extraction	• Administration Report of Forest Department, Govt of Karnataka. • Forest survey of India. • Directorate of Economics & Statistics.	No data gap, since satisfactory data available.
	NTFP collection	• Directorate of Economics & Statistics, Govt of Karnataka • National Sample Survey Organization (NSSO) • Central Statistical Organization (CSO) • Forest Department.	• NTFPs collected at the household level are not recorded and accounted for. Only recorded NTFPs are included in the published records. • The study used the data collected through primary survey conducted by CMDR.
	Carbon sequestration potential	• State Pollution Control Board • Primary studies at micro level	• Data not available for use • The study has used the estimated value of GOK and other researchers.
	Area of Sacred Groves	• Forest Survey of India • Micro level studies	• Not available at t he state level • We have used the data collected through primary survey conducted by CMDR.
	Medicinal Plants Area, Number of plants, medicinal value of such plants, etc of	• Forest Survey of India • Administration Report of Forest Department, Govt of Karnataka. • Micro level studies	• Non-availability of secondary data from concerned department of government. • We have used the data collected through primary survey conducted by CMDR.
	Quantity and value of fodder (Grazing services)	• Forest survey of India. • Administration Report of Forest Department, Govt of Karnataka. • Micro level studies	• Information regarding grazing is not available with concerned departments. • Primary used by the study collected by CMDR
	Cost of Wild Life Sanctuaries	ro level studies	• No secondary data is available regarding number of visitors and their cost to visit the sites. • The study used Primary data collected by CMDR
	Watershed Benefits	• Watershed department • Micro level studies	• Secondary data are not available • The present study used primary data collected by CMDR.

Fuel wood : No reliable estimate is available for this purpose. We have used the primary data collected form the firms using fuel for different purposes.

CENTRE FOR MULTI-DISCIPLINARY DEVELOPMENT RESEARCH (CMDR)

Jubilee Circle, Dharwad-580001, Karnataka

Research Project On

Natural Resource Accounting in Karnataka in Forest Sector & land Sector (Excluding Mining)

Sponsored By

Central Statistical Organization (CSO), Govt. of India

HOUSEHOLD QUESTIONAIRE

I. Identification Data							
Schedule No		House No		Date of filling this form		Time of filling this form	
Village		Taluka/Tehsil/ Block		District		State	
Full Name of Investigator filling out this form							
Full Signature of Investigator filling out this form							
Validating Signature by Team Leader							

II. Household Information

Name of the head of the Household

Name of Respondent (*Note: Respondent should **not** be a temporary visitor to the household*)			
Religion (Hindu-1 Muslim-2 Christian-3 Others-4)		**BPL card holder** (Yes=1; No=2)	
Social Group (ST=1, SC=2, OBC=3, Religious Minorities=4 Others=5)		**Type of the house** (Hut=1, Kutcha=2, Semi-Pucca=3, Pucca=4)	

Details of Land Assets (Area in Acres)	Type of Land	
	Irrigated	Rainfed
Own land holding - Total		
Own cultivated land		
Own land Leased-out		
Fallow land		
Leased-in land		

Assets held other than Land (Put a tick-mark in the appropriate box)							
Tractor	Cooking gas stove	Refrigerator	Television	Motor cycle	Telephone	Irrigation pump	Others (Specify)

III. General Information About The Household Members

Sl No	Name	Relation to the head of the household (see code list) 1	Sex (see code list) 2	Age (in number of years)	Education (in number of years)	Occupation (see code list) 3		Net Annual Income (Rs) during last Ag. Year (for members in salaried jobs annual income for 2003-04 may be reported)	
						Main	Subsidiary	Main	Subsidiary

1 Code list for relation to the "Head of the household" = Head-1, Wife-2, Mother-3, Father-4, Son-5, Daughter-6, Grandson-7, Grand daughter-8, Niece-9, Nephew-10, Son-in-law-11, Daughter-in-law-12, Brother-13, Sister-14, Father-in-law-16, Others-17.

2. Code for Sex = Male-1 & Female-2, **3**.Code for "occupation" = Self employed in agriculture-1, Agricultural labour-2, Casual labour-3, Regular wage / salaried-4, Self employed in non-agriculture-5 (Livestock rearing –5.1, Fishing-5.2, Collection and sale of forest produce-5.3, Petty business-5.4, Artisans-5.5), Others-6 (Specify)

IV. Dependence On Forest Resources For NTFPs

1. Collection of NTFPs

1.1 Did you collect NTFPs from the forest last agricultural year (from Kharif 2003 to Rabi 2003-04)?: (Yes-1 No-2)

IF 'NO' GO TO 2

If yes, give details about NTFPs collected as follows

NTFP code	Local Unit*	Average collections per month during last Ag. year			Sales during last Agricultural year								
					Rainy			Winter			Summer		
		Rainy	Winter	Summer	Av. Qty sold per month	Sales price/unit	Av.Selling costs / month	Av. Qty sold p er month	Sales price/unit	Av.Selling costs / month	Av. Qty sold per month	Sales price/unit	Av.Selling costs / month
Fuelwood													
Fodder													

Note to investigators: * Please state the conversion to standard unit (Kgs/ Quintals / Tones)

2. Dependence on Forest for Grazing of Cattle

2.1 Do you own livestock? (Yes-1 No-2):

IF 'NO' GO TO 3

2.2. What is the present practice of feeding your livestock?:
Grazing in forest area-1
Grazing in non-forest area-2
Collecting fodder from forest and stall feeding-3
Collecting fodder from non-forest sources and stall feeding-4
Market purchases-5

2.3. If grazing in the forest area, give details

Livestock	Dependence on Forest for Grazing of livestock								
	Rainy			Winter			Summer		
	Nos	Av. Hrs of Grazing/Day	No of Days/Month	Nos	Av. Hrs of Grazing/Day	No of Days/Month	Nos	Av. Hrs of Grazing/Day	No of Days/Month
Bullocks									
Buffalo									
Cow									
Calf									
Goat									
Sheep									
Others (Specify)									

2.4 Non-forest sources of fodder used for livestock during last agricultural year

Source	Quality of fodder*	Quantity	Local unit	Price / unit
Private land				
Market				
Common non-forest land				
Others (specify)				

* As compared to fodder collected from forest (worse=1 better=2)

2.5. Did you employ hired labor for collecting fodder from forest?:
(Yes-1 No-2)

If yes, give details

Days/wages	Rainy	Winter	Summer
Total no of man days used with hired labor			
Average wage / man day (Rs.)			

2.6. Do you pay any fee to collect fodder (Yes-1 No-2): __

2.7. If yes, how much per year? (Rs) : To whom ?:

3. Sources of fuel for home consumption (last agricultural year)

Uses / Types of fuel*	Unit of quantity	Average quantity obtained during last Ag. Year according to different sources of fuel			
		Collections from forest	Non-forest sources (own land, other private land, common land, etc)	Purchased from market	Any other (Specify)
Cooking					
Lighting					
Other domestic use					
Commercial					
Any Other (specify)					

* Wood-1, Dung-2, Thatch/grass-3, Charcoal-4, Kerosene-5, LPG-6, Electricity-7

3.1. Did you employ hired labor for collecting fuel wood from forest?:
(Yes-1 No-2)

If yes, give details

Days/wages	Rainy	Winter	Summer
Total no of man days used with hired labor			
Average wage / man day (Rs.)			

3.2 Did you pay any fee to collect fuel wood (Yes-1 No-2):

3.3. If yes, how much per year? (Rs): To whom ?:

4. **Dependence on Forest for Timber / Bamboo / Cane**

4.1 Did you use timber / bamboo / cane for any of the following uses during last 3 years?

(Yes-1 No-2)

Purpose	Timber	Bamboo	Cane
1. Domestic			
Home construction			
House improvement/fencing			
Agricultural implements			
Furniture			
Other domestic uses			
2. Commercial			
Agricultural implements			
Furniture			
Any other (specify)			

4.2 Do you have a 'timber / bamboo / cane 'rights' from the forest department?:

(Yes-1 No-2)

If 'NO' go to 4.3

If yes, give details as follows for last 3 years

Timber/ Bamboo	Species name	Received as 'right'					
		2003-04		2002-03		2001-02	
		Quantity (Specify unit)	Price/unit (Rs)	Quantity (Specify unit)	Price/unit (Rs)	Quantity (Specify unit)	Price/unit (Rs)
Timber							
Bamboo Cane							

4.3 What are the sources for timber / bamboo/cane used by you in the last 3 years other than received as 'rights'

Timber / bamboo/ cane	Source code*	Timber species	Total quantity	Unit	Price/ unit (Rs)
Timber					
Bamboo					
Cane					

* From own land/other private land / common land=1
Purchased from forest department/market=2
Any other (specify)=3

5. Dependence On Forest For Occupations (Excluding collection & sale of NTFPs; for example, rope making, leaf plates, cane furniture, etc)

5.1 Do you depend on forest for occupation? (Yes-1 No-2):
If yes, give details

Occupation	Av. No of days worked during last Ag. Year in the occupation			No of HH members involved			No of hired workers involved			Payment to hired workers (Rs/person)			Net annual income from occupation in last Agricultural Year (Rs)
	M	F	C	M	F	C	M	F	C	M	F	C	

6. Dependence On Forest For Medicinal Plants And Herbs, Etc

6.1. Do you use any plant species from forests for medicinal purpose? :
(Yes-1 No-2)

6.2. If yes, name the herbs and their local medicinal use:

Name of the Herbs used	Local medicinal use of herb	Total quantity collected in last Ag. Year by the HH (specify unit)	Is there any alternative available from market to the herb? If yes, mention	Market value of the alternative (Rs / unit; specify unit)

6.3 If you do not get herbs as a medicine, what substitute would you use:
(Allopathic-1 Homeopathic -2 Any other-3)

6.4. Please mention the following

Do you go to a doctor (Yes-1 No-2):

If yes, how many times in month or year?:

6.5 What fees do you pay for each visit and for medicines per visit or during last month / year?

Visiting fee Rs: Cost of medicine Rs :

V. Details of time and distance to be covered for collection of NTFPs

NTFP code	Type of collection (Individually-1 Jointly-2)	No of collection days per month	Distance from home to source area in the forest (in Kms	Number of members involved in collection			Time taken to reach the source area in the forest (in hours)			Mode of transport to go to source area in the forest (Walking-1 Bicycle-2 Bullock cart-3 Others-4)			Time spent in collection (hours/unit)		
				M	W	C	M	W	C	M	W	C	M	W	C
fuelwood															
Fodder															

VI. Willingness To Accept

1. How much are you willing to accept (WTA) per year as a compensation for Keeping away from fuel wood and fodder collection from the forests.

Item	In Cash	In employment/job alternate site (what wage/salary)
Fuel wood		
Fodder		

2. How much kerosene (Lts / week) would you have to buy if you are kept away from fuelwood collection?

3. How much dry fodder per animal (qntl/week) would you have to buy if you are kept away from fodder collection?

4. If not, why?
   a) fodder availability from own land
   b) No retail outlet or shop close by

VII. Willingness To Pay

1. How much would you contribute towards the capital cost?

	Fuel wood	Fodder	NTFP	Any other
In money: Rs. (once for all)				
In labor time: days (once for all)				

2. How much towards maintenance expenditure

	Fuel wood	Fodder	NTFP	Any other
In money: Rs. (Annual)				
In labor time: days (Annual)				

3. If you do not want to contribute on both capital and maintenance costs,
Is it because of:

Income shortage -1
No unit in village-2
Lack of confidence in committee-3
Any other (specify)-4

4. If income is the constraints then,

Suppose your income increases by Rs._____ per year once for all due to protection of forest by the community, would you then be willing to pay out of that increased income towards the capital cost? (Yes-1 No-2):

If yes, then,

	Fuel wood	Fodder	NTFP	Any other
How much for capital cost				

5. Suppose your income increases by Rs._____ per month mainly due to the protection of forests by the community, would you be willing to pay part of that increased income for maintenance? (Yes-1 No-2):

If yes, then,

	Fuel wood	Fodder	NTFP	Any other
How much for maintenance				

CENTRE FOR MULTIDISCIPLINARY DEVELOPMENT RESEARCH (CMDR)

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Valuation of Watershed benefits (Village Level Questionnaire)

1. Location

Village: District:

Taluk: State:

2. Approaches to Watershed:

2.1 Accessibility (<4 kms-1; >4 kms –2) :

2.2 Road Type (Mud - 1; Tar – 2) :

2.3 Bus Stop (Distance in kms) :

2.4 Railway Station (Distance in kms) :

3. Village Level Information:

3.1 Total Number of households in the village :

3.2 Population of the village :

3.3 Health Facilities :

(Government Hospital –1; Private Hospital/clinic – 2; Community Health Centre – 3; Primary Health Centre – 4; Non-existent –5)

3.4 Nearest Health Centre :

3.5 Dependence on medicinal plants :

(Very high – 1; High – 1; Medium – 3; Low – 4; Nil – 5)

3.6 Education Facilities :

(UG and PG College – 1; School (12th) – 2; School (8th) – 3; School (5th) – 4; Nil – 5)

3.7 Proportion of Educated Population :Men Women

% of Literates :

% who have education up to 5th std. :

% who have education up to 12th std. :

% who are graduates and above :

3.8 Village Amenities (Yes – 1; No – 2)

a) Drinking water :

(Private Taps – 1; Public Taps – 2; Handpumps/Borewells – 3; Open wells – 4)

b) Sanitation facilties :

(Private Toilets – 1; Public toilets – 2; None – 3)

c) Irrigation :

(Tubewell – 1; Open Well – 2; Canal – 3; Tanks – 4; Others -5)

d) Electricity :

(100% houses electrified – 1; 75 - 100% - 2; 50-75% - 3; 25-50% - 4; <25 % -5)

e) Market :

(APMC – 1; District level Market – 2; Taluk level Market – 3; Local Market – 4, Others - 5)

f) Post Office :

g) Any other amenities :

3.9 Housing Facilities :

(Pucca Houses – 1; Kutcha Houses – 2; If mixed then state the proportions)

3.10 Social Profile :

Social Communities	Number of Households	Main Occupation

3.11 Village landscape :

a) Mainly natural :

(Forest – 1; Water bodies – 2; Deserted – 3)

b) Seminatural :

(Combination of categories above and below)

c) Manmade :

(Agricultural – 1; Horticutural – 2; Forestry – 3; Barren – 4)

3.12 Any Government Scheme running in the village (If yes, name them)

(Completed scheme since 2000 – 1; On-going scheme – 2)

3.13 Details of specific government schemes in the village on watershed:

a) Operating :

b) Pending in history :

c) On-going :

d) Future :

3.14 Details of Social/Non-government Organizations working in the village:

Social organizations / NGOs	Work

3.15 Details of attempts by outsiders for conservation of natural resources

Attempts by outsiders about nature conservation research/awareness	Details of effects it had	Follow-up activities	Who were involved in research / awareness attempts?

4. Dependence on watershed

4.1 What is the geographical area (in hectares/ acres and percentage of total village area) of the village is in proximity to watershed (within 2 kms):

4.2 How much (ha/acres) of this area is irrigated:

4.3 What are the sources of irrigation (canal-1, watershed stream-2, open well-3, tube well-4, others-5):

4.4 How many households in the village are close to watershed (within 2 kms):

4.5 How many of these households have agricultural/horticultural land (nos.):

4.6 How many of these households work as agricultural labourers (nos.):

4.7 Ownership of the land under forest watershed (Community-1 Individual-2 Government-3 Trust-4):

4.8 Approximate area under watershed (Sq.M/Acre/Ha):

4.9 Terrain:

(Hilltop-1 Slopes-2 Foothills-3 Valley-4 Plains-5 Island-6):

4.10 Proximity to a perennial water source (Near-1 Far-2 None-3):

4.11 Proportion (%) of the original area under watershed:

4.12 Is the area under watershed reducing during few years:

4.13 If yes, what are the reasons:

(Cultivation has increased 1, forests have been cut 2, non-conservation 3)

5. Community awareness about conservation of watersheds

5.1 Whether people are aware that conservation of forest and watersheds benefits ecosystem services of protection to many of plants and animals species, and conserves soil and water resource (yes-1, no-2):

5.2 Are the people willing to conserve these forests and command areas for present and future generations (yes-1, no-2):

5.3 If yes, if conservation of forest for watershed is done by a trust/ charity/ village panchayat/ NGO, would you be willing to pay for the conservation (yes-1, no-2):

5.4 If yes, how much will you be willing to pay?

Mark one: Rs. 500, Rs. 400, Rs. 300, Rs. 200, Rs. 100.

5.5 What percentage of people would be willing to pay like you?

5.6 Are there any commercial units/ individuals from your village/ outside doing the conservation of watershed (yes-1, no-2):

5.7 Are the village people extending their cultivaton in the watershed area (yes-1, no-2)

5.8 Is there any awareness in the community at social level to restrict that?

5.9 If yes, is any group/individual being penalized for that?

5.10 What is your suggestion for conservation of watershed for benefits of the community?

CENTRE FOR MULTIDISCIPLINARY DEVELOPMENT RESEARCH (CMDR)

Jubilee Circle, Dharwad-580001, Karnataka

ICSSR Institute

Research Project on

Natural Resource Accounting in Karnataka in Forest Sector and Land Sector (Excluding Mining)

Sponsored by

Central Statistical Organisation (CSO), Government of India

Valuation of Watershed Benefits (Household Level Questionnaire)

Investigator: Date:

1. Location

Village: District:

Taluk: State:

Name of the respondent:

Name of the Head of the household:

2. Household's Socio-economic profile:

S.No.	Relationship with Head of the hh	Age	Gender	Education (years)	Occupation	Income

3. a) Type of House (Kutcha –1, Semi-pucca –2, Pucca):

b) Drinking water (Private tap-1, Public Tap-2, Borewell-3, Handpump-4, Open well-5, Others-6)

c) Sanitation (private toilet-1,public toilet-2, open-3):

d) Electricity (yes-1, no-2):

e) Cooking fuel (LPG-1, Kerosene stove-2, Fuelwood stove-3, coal-4):

f) Agricultural equipments (Tractor-1, Sprayer-2, Thresher-3, Other –4):

4. Agriculture details:

Crop	Area	Production	Quantity for home consumption	Quantity sold	Price
Kharif					
Rabi					
Orchards					
Fallow					

Livestock:

Livestock	Numbers	Price	Stall fed/ grazing
Cows			
Buffaloes			
Bullocks			
Goats			
Sheep			

5. Approach to watershed:

5.1 What is the total land holding (in ha):

5.2 How much is irrigated land (ha):

5.3 What is the source of irrigation (canal-1, watershed stream-2, open well-3, tube well-4, others-5):

5.4 How distant is your farm from the water shed (within 2 kms-1, between 2-4 kms-2, >4 kms-3):

6. Awareness about benefits of watershed:

6.1 Are you aware that the due to existence of forests and watershed in your village the biodiversity of plants and animal species, soil and water resources is conserved (yes-1, no-2):

6.2 Do you think that the area under forest and water shed is declining over the years (yes-1, no-2):

6.3 What are the reasons for the (Extension of agricultural land-1, felling of the forests for timber-2, other-3):

6.4 Are there any restraints at the society's level to stop more felling or disturbance of watershed (yes-1, no-2):

6.5 If yes, are you aware if any of the individual/ group has been penalized for not following that (yes-1, no 2):

7. Willing to pay:

7.1 If for the conservation of forest and watershed any NGO/trust/village panchayat comes forward, would you be willing to pay for the conservation (yes-1, no-2):

7.2 If yes, give details:

Willing to contribute through	Contribution in Rs.	
	Once only	Per annum
Trust		
Charity		
Village Organisation		
Panchayat		
NGO		
Government		
Other		

7.3 If no, would you be willing to contribute your time/labour for conservation of watershed (yes-1, no-2):

7.4 If yes, how many hours per year;

7.5 Would you be willing to contribute materials for preservation like torch, sticks, construction material for check dams, etc.) (yes-1, no-2):

7.6 If yes state the amount (in Rs.):

7.7 What is your suggestion for conservation of watershed and forest?

CENTRE FOR MULTIDISCIPLINARY DEVELOPMENT RESEARCH

(CMDR)

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ICSSR Institute
Research Project on
Natural Resource Accounting in Karnataka in Forest Sector and Land Sector (Excluding Mining)
Sponsored by
Central Statistical Organisation (CSO), Government of India

Valuation of Sacred Groves (Village Level Questionnaire)

1. Location

Village: District:

Taluk: State:

2. Approaches to Sacred Groves:

2.1 Accessibility (<2 kms-1; >2 kms –2) :

2.2 Road Type (Mud - 1; Tar – 2) :

2.3 Bus Stop (Distance in kms) :

2.4 Railway Station (Distance in kms) :

3. Village Level Information:

3.1 Total Number of households in the village :

3.2 Population of the village :

3.3 Health Facilities :

(Government Hospital –1; Private Hospital/clinic – 2; Community Health Centre 3; Primary Health Centre – 4; Non-existent –5)

3.4 Nearest Health Centre :

3.5 Dependence on medicinal plants :

(Very high – 1; High – 1; Medium – 3; Low – 4; Nil – 5)

3.6 Education Facilities :

(UG and PG College – 1; School (12th) – 2; School (8th) – 3; School (5th) 4; Nil – 5)

3.7 Proportion of Educated Population :Men Women

% of Literates :

% who have education up to 5th std. :

% who have education up to 12th std. :

% who are graduates and above :

3.8 Village Amenities (Yes – 1; No – 2)

a) Drinking water :

(Private Taps – 1; Public Taps – 2; Handpumps/Borewells – 3; Open wells – 4)

b) Sanitation facilties :

(Private Toilets – 1; Public toilets – 2; None – 3)

c) Irrigation :

(Tubewell – 1; Open Well – 2; Canal – 3; Tanks – 4; Others -5)

d) Electricity :

(100% houses electrified – 1; 75 - 100% - 2; 50-75% - 3; 25-50% - 4; <25 % -5)

e) Market :

(APMC – 1; District level Market – 2; Taluk level Market – 3; Local Market – 4, Others - 5)

f) Post Office :

g) Any other amenities :

3.9 Housing Facilities :

(Pucca Houses – 1; Kutcha Houses – 2; If mixed then state the proportions)

3.10 Social Profile :

Social Communities	Number of Households	Main Occupation

3.11 Village landscape :

a) Mainly natural :

(Forest – 1; Water bodies – 2; Deserted – 3)

b) Seminatural :

(Combination of categories above and below)

c) Manmade :

(Agricultural – 1; Horticutural – 2; Forestry – 3; Barren – 4)

3.12 Any Government Scheme running in the village (If yes, name them)

(Completed scheme since 2000 – 1; On-going scheme – 2)

3.13 Details of specific government schemes in the village on protection of medicinal plants:

a) Operating :

b) Pending in history :

c) On-going :

d) Future :

3.14 Details of Social/Non-government Organizations working in the village:

Social organizations / NGOs	Work

3.15 Details of attempts by outsiders for conservation of natural resources

Attempts by outsiders about nature conservation research/awareness	Details of effects it had	Follow-up activities	Who were involved in research / awareness attempts?

4. Sacred Nature

4.1 Name/s of various Sacred Element/s/ Practice/s :

4.2 Distribution in the village landscape :

(Everywhere-1 Specific location-2)

4.3 Ownership (Community-1 Individual-2 Government-3 Trust-4) :

4.4 Approximate area (Sq.M/Acre/Ha) :

4.5 Terrain (Hilltop-1 Slopes-2 Foothills-3 Valley-4 Plains-5 Island-6) :

4.6 Ground/water condition (Good-1 Poor-2 Medium-3) :

4.7 Proximity to a perennial water source (Near-1 Far-2 None-3) :

4.8 Proportion (%) of the original area, Still remaining as sacred :

4.9 Natural vegetation canopy (Dense-1 Medium-2 Sparse-3) :

4.10 Stature (Tall-1 Deep or low-2 Shallow-3) :

4.11 Species (Woody-1 Thorny-2 Nuisance-3) :

4.12 Is there any temple in the sacred grove :

4.13 Do village people assemble in these sacred groves for a specific event/

4.14 If so, how may people, and when?

5. Social Framework

5.1 Whether people in the village can be classified into

a) ***Strong believers*** (such as the priest or entire fishermen community or forest protection committee) that follow all rituals and restraints: (Yes-1 No-2) :

b) ***Believes but*** not particularly informed or followers (e.g., elderly people in specific or all communities) : (Yes-1 No-2) :

c) ***Non-believers*** who are indifferent or opponents (e.g., most of the younger generation or village contractors etc.): (Yes-1 No-2) :

5.2 Details of sacred elements and their value

Sacred elements	Value ascribed by different community believer groups		
	Community Name	Social values*	Degree**

*** Values:** Religious-1 Moral-2 Cultural-3 Subsistence use-4 Commercial-5 Future potential-6 Others-7

** **Degree**: High-1 Low-2 Medium-3

5.3 Do these sacred grove trees have markets? If yes, what is the price one can get for by selling a similar tree?

6. Communities / Believer values assigned to element
(Reply on a scale of 1 = Min 5 = Max)

6.1 To what extent different sections of the society depend on the sacred element for utilization?

Communities	Extent of Dependence

6.2 Details of alternative sources of fuelwood / NTFP /Fish / Others

Alternative sources	Products				
	Fuelwood	Fodder	NTFP	Fish	Others

6.3 What extent are these other sources under pressure?

Other Sources	Extent of Pressure

6.4 What impact the pressure on alternative sources has on sacred elements or practices?

6.5 How much importance such as wild bio-resources has in their life as a whole?

6.6 Are there any sort of restraints or local taboos in utilization of sacred groves:

6.7 a) Are taboos because of;

1. Because of deity / spirits
2. Just as a tradition without any known reasons
3. Governmental restriction
4. Remoteness
5. Ignorance
6. Neglect

b) Are these restrictions practiced?

c) Are there any individuals/group of people punished to break these restraints?

d) Is there any purpose behind these restraints, especially of nature conservation?

6.8 Whether people are aware conservation of sacred groves helps in soil and water conservation, benefits or other ecosystem services?

6.9 If the sacred grove is to be preserved by the present generation including you, how much are you willing to pay per year to a Trust/Charity/Village organization/Panchayat/NGO?

Mark one: Rs. 500, Rs. 400, Rs. 300, Rs. 200, Rs. 100, Rs. Nil

6.10 What percentages of the village people are perhaps willing to pay like you?

7. The Changing Framework

7.1 Are there any exceptions to the taboos (leading to only occasional tree felling in the grove only for the temple construction etc?). Under what conditions are the restrictions relaxed?

7.2 Are there any gradual changes (not strong violations) in the taboos/ practices /elements? What impact it has on plants, animals and people? For instance whether the area of the pond or grove or meadow is decreasing or whether canopy regeneration is being purposefully removed?

7.3 What are the reasons for this change? Whether people see this as a good or bad change? Do people from different sections especially generations differ in their perceptions?

7.4 Given the present realities and future trends, what fate does the sacred elements have according to people? Why?

7.5 In particular, what will happen to the rituals? Who will learn and perform them in future? In the absence of rituals what will happen to the element's conservation? What does young generation feel about this?

7.6 Do people feel that the continuation and even expansion of the sacred elements/ practices is essential/ useful? On what grounds? Religious, cultural, aesthetic, moral, ecological, utility, economic? Do people from different sections differ in this aspects?

7.7 How would people respond to economic rewards for conservation? Should such rewards be collective or individual? How should such rewarded persons be identified, honored? How to assess degree of conservation? What impacts it will have? In what way people relate it to crop/cattle damage compensation by wildlife?

8. Valuation of sacred groves

8.1 If the community wants to protect the sacred grove elements, what is it that you are willing to give up or sacrifice for the preservation?

Willing to give up/ Sacrifice	Amount (Rs)	
	Per Year	Once for all
a) In terms of money income willing to lose (from fruits, flowers, honey, etc)		
b) In terms of sacrifice measured as additional hardship in labor time (say in water collection)		
c)) Loss of Fuelwood, fodder, NTFPs, other products due to loss of groves		

8.2 On the other hand, if you are willing to pay for the preservation of the grove, how much?

Willing to pay in terms of	Amount (Rs)	
	Per Year	Once for all
a) Money		
b) Vigilance time as your contribution		
c) Material/goods for preservation (say, torch light, sticks, etc; Preferably in value terms)		

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Valuation of Sacred Groves (Household Level Questionnaire)

Investigator: Date:

1. Location

Village: District:

Taluk: State:

Name of the respondent:

Name of the Head of the household:

2. Household's Socio-economic profile:

S.No.	Relationship with Head of the hh	Age	Gender	Education (years)	Occupation	Income

3. a) Type of House (Kutcha –1, Semi-pucca –2, Pucca):

b) Drinking water (Private tap-1, Public Tap-2, Borewell-3, Handpump-4, Open well-5, Others-6)

c) Sanitation (private toilet-1,public toilet-2, open-3):

d) Electricity (yes-1, no-2):

e) Cooking fuel (LPG-1, Kerosene stove-2, Fuelwood stove-3, coal-4):

4. Agriculture details:

Crop	Area	Production	Quantity for home consumption	Quantity sold	Price
Kharif					
Rabi					
Orchards					

5. Approach to sacred groves:

5.1 Do you have sacred groves inside or near the village (yes-1, no-2):

5.2 Are you a Believer of the sacred groves? (strong believer-1, Believe but not a follower-2, Non-beliver-3)

5.3 Is there any temple in the sacred grove (yes-, no-2):

5.4 Do people assemble there for a specific event (yes-1, no-2):

5.5 Do you also visit sacred grove on this event (yes-1, no-2)

5.6 How far is the sacred grove (< 2 kms-1, 2-4 kms-2, >4 kms-3):

5.7 Are the sacred groves distributed (everywhere-1, specific location-2):

5.8 Who owns these groves (Community-1, individual-2, government-3, trust-4)

5.9 Approximate area of the sacred grove (sq.m/acres/ha)

5.10 How is the terrain (hilltop-1, sloves-2, foothills-3, valley-4, plains-5, island-6)

5.11 Groundwater condition (good-1, medium-2, poor 3):

5.12 Natural vegetation canopy (dense-1, medium –2, sparse –3):

5.13 Species (woody –1, thorny –2, others-3):

5.14 Do these sacred groves have market (yes-1, no-2):

5.15 If yes, what is the price one can get for by felling a similar tree:

5.16 Details:

Name of the grove (plant)	Type of grove (woody, shrub. Thorny, other)	Market price

6. Conservation of groves:

6.1 Do you think it is important to protect sacred groves for conservation of biodiversity (yes-1, no-2):

6.2 Are there any restraints in the society for utilization of sacred groves (yes-1, no-2):

6.3 If yes, are you aware of any punishment given to an individual/ group for not following the restraint (yes-1, no-2):

6.4 If the sacred groves are to be protected, and any NGO/trust/Village panchayat is willing to take up conservation, would you be willing to pay (yes-1, no-2):

6.5 If yes, give details

Willing to contribute through	Contribution in Rs.	
	Once only	Per annum
Trust		
Charity		
Village Organisation		
Panchayat		
NGO		
Government		
Other		

6.6 If no, would you be willing to contribute your time/labour for conservation of groves (yes-1, no-2):

6.7 If yes, how many hours per year;

6.8 Would you be willing to contribute materials for preservation like torch, sticks, etc.) (Yes-1, no-2):

6.9 If yes state the amount in Rs.:

6.10 Conservation of these species also helps in protection of ecosystem, in terms of conservation os soil, water, landslide protection, buffer from droughts, etc. If you do not contribute to the conservation of these groves then are you willing to sacrifice:

Willing to give up/ Sacrifice	Amount (Rs)	
	Per Year	Once for all
a) In terms of money income willing to lose (from fruits, flowers, honey, etc)		
b) In terms of sacrifice measured as additional hardship in labor time (say in water collection)		
c) Loss of Fuelwood, fodder, NTFPs, other products due to loss of groves		

6.11 In your opinion what should be done for the conservation of sacred groves by village community, NGO, government:

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Sponsored by

Central Statistical Organisation (CSO), Government of India

Valuation of Medicinal Plants (Village Level Questionnaire)

1. Location

Village: District:

Taluk: State:

2. Approaches to Medicinal Plants:

2.1 Accessibility (<2 kms-1; >2 kms –2) :

2.2 Road Type (Mud - 1; Tar – 2) :

2.3 Bus Stop (Distance in kms) :

2.4 Railway Station (Distance in kms) :

3. Village Level Information:

3.1 Total Number of households in the village :

3.2 Population of the village :

3.3 Health Facilities :

(Government Hospital –1; Private Hospital/clinic – 2; Community Health Centre – 3; Primary Health Centre – 4; Non-existent –5)

3.4 Nearest Health Centre :

3.5 Dependence on medicinal plants :

(Very high – 1; High – 1; Medium – 3; Low – 4; Nil – 5)

3.6 Education Facilities :

(UG and PG College – 1; School (12th) – 2; School (8th) – 3; School (5th) – 4; Nil – 5)

3.7 Proportion of Educated Population :Men Women

% of Literates :

% who have education up to 5th std. :

% who have education up to 12th std. :

% who are graduates and above :

3.8 Village Amenities (Yes – 1; No – 2)

a) Drinking water :

(Private Taps – 1; Public Taps – 2; Handpumps/Borewells – 3; Open wells – 4)

b) Sanitation facilties :

(Private Toilets – 1; Public toilets – 2; None – 3)

c) Irrigation :

(Tubewell – 1; Open Well – 2; Canal – 3; Tanks – 4; Others -5)

d) Electricity :

(100% houses electrified – 1; 75 - 100% - 2; 50-75% - 3; 25-50% - 4; <25 % -5)

e) Market :

(APMC– 1; District level Market– 2; Taluk level Market– 3; Local Market– 4, Others - 5)

f) Post Office :

g) Any other amenities :

3.9 Housing Facilities :

(Pucca Houses – 1; Kutcha Houses – 2; If mixed then state the proportions)

3.10 Social Profile :

Social Communities	Number of Households	Main Occupation

3.11 Village landscape :

a) Mainly natural :

(Forest – 1; Water bodies – 2; Deserted – 3)

b) Seminatural :

(Combination of categories above and below)

c) Manmade :

(Agricultural – 1; Horticutural – 2; Forestry – 3; Barren – 4)

3.12 Any Government Scheme running in the village (If yes, name them)

(Completed scheme since 2000 – 1; On-going scheme – 2)

3.13 Details of specific government schemes in the village on protection of medicinal plants:

a) Operating :

b) Pending in history :

c) On-going :

d) Future :

3.14 Details of Social/Non-government Organizations working in the village:

Social organizations / NGOs	Work

3.15 Details of attempts by outsiders for conservation of natural resources

Attempts by outsiders about nature conservation research/awareness	Details of effects it had	Follow-up activities	Who were involved in research / awareness attempts?

4. Dependence on medicinal plants :

4.1 The villagers depend on which forms of treatment:

(Allopathic – 1; Ayurvedic – 2; Homeopathic – 3, Local herbs – 4; Others - 5)

4.2 How many experts are in the village (specify in nos.):

Allopathy: Ayurvedic: Homeopathic: Traditional: Others

4.3 How many households use medicinal plants for treatment:

4.4 For which kind ailments people use medicinal plants:

(Stomach ailments – 1; Common Cold – 2; Mild fevers – 3; Skin diseases – 4; Bone injuries – 5; Respiratory infections – 6; other ailments, specify – 7)

4.5 What kind of ailments generally happen in the village:

(Stomach ailments – 1; Common Cold – 2; Mild fevers – 3; Skin diseases – 4; Bone injuries – 5; Respiratory infections – 6; other ailments, specify – 7)

5. Details about medicinal plants:

5.1 Names of various medicinal plants:

5.2 Ownership:

(Community-1 Individual-2 Government-3 Trust-4)

5.3 Approximate area (Sq.M/Acre/Ha):

5.4 Terrain :

(Hilltop-1 Slopes-2 Foothills-3 Valley-4 Plains-5 Island-6) :

5.5 Proximity to a perennial water source (Near-1 Far-2 None-3) :

5.6 Proportion (%) of the original area under medicinal plants:

5.7 Is the number of medicinal plants reducing during last ten years:

5.8 If yes, what are the reasons:

(Usage has increased 1, commercialization 2, non-conservation 3)

5.9 Are all these medicinal plants (herbs 1, shrubs 2, trees 3):

5.10 Is there any market for these plants:

5.11 Details of medicinal plants:

Name of the medicinal plant	Used for type of ailment	Market price, if any

6. Community awareness about conservation of medicinal plants

6.1 Whether people are aware that conservation of medicinal plants benefits ecosystem services of protection to many of plants and animals species? Yes/no

6.2 Are the people willing to conserve these species for present and future generations? Yes/no

6.3 If yes, if conservation of medicinal plants is done by a trust/ charity/ village panchayat/ NGO, would you be willing to pay for the conservation? Yes/no

6.4 If yes, how much will you be willing to pay?

Mark one: Rs. 500, Rs. 400, Rs. 300, Rs. 200, Rs. 100.

6.5 What percentage of people would be willing to pay like you?

6.6 Are there any commercial units/ individuals from your village selling medicinal plants from your village?

6.7 Is there any awareness in the community at social level to restrict that?

6.8 If yes, is any group/individual being penalized for that?

6.9 What is your suggestion for conservation of medicinal plants for the community, NGO, government?

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Valuation of Medicinal Plants (Household Level Questionnaire)

Investigator: Date:

1. Location

Village: District:

Taluk: State:

Name of the respondent:

Name of the Head of the household:

2. Household's Socio-economic profile:

S.No.	Relationship with Head of the hh	Age	Gender	Education (years)	Occupation	Income

3. a) Type of House (Kutcha –1, Semi-pucca –2, Pucca):

b) Drinking water (Private tap-1, Public Tap-2, Borewell-3, Handpump-4, Open well-5, Others-6)

c) Sanitation (private toilet-1,public toilet-2, open-3):

d) Electricity (yes-1, no-2):

e) Cooking fuel (LPG-1, Kerosene stove-2, Fuelwood stove-3, coal-4):

4. Agriculture details:

Crop	Area	Production	Quantity for home consumption	Quantity sold	Price
Kharif					
Rabi					
Orchards					

5. Approach to medicinal plants:

5.1 In case of illness of household members you go to:

(Government Hospital-1; Private Hospital/clinic-2; Community Health Centre-3; Primary Health Centre-4; None of these-5)

5.2 Alternative forms of treatments available in village:

(Allopathic-1; Ayurvedic-2; Homeopathic-3, Local herbs-4; Others-5)

5.3 For which kind ailments do you use medicinal plants:

(Stomach ailments-1; Common Cold-2; Mild fevers-3; Skin diseases-4; Bone injuries-5; Respiratory infections-6; other ailments, specify-7)

5.4 What kind of ailments generally happen in the village:

(Stomach ailments-1; Common Cold-2; Mild fevers-3; Skin diseases-4; Bone injuries-5; Respiratory infections-6; other ailments, specify-7)

6. Awareness about medicinal plants:

6.1 Names of various medicinal plants:

6.2 Is the number/avilability of medicinal plants reducing than earlier days:

6.3 If yes, what are the reasons:

(Usage has increased 1, commercialization 2, non-conservation 3)

6.4 Are all these medicinal plants (herbs 1, shrubs 2, trees 3):

6.5 Is there any market for these plants:

6.6 Details of medicinal plants:

Name of the medicinal plant	Used for type of ailment	Market price, if any

6.7 Who amongst the family members goes to identify and collect medicinal plants from the forest:

6.8 What is the accessibility of these plants (< 2 kms-1, 2-4 kms-2, >4 kms-3):

6.9 How many times in a year do you go to collect these plants/parts:

6.10 Do you collect these plants only for household need or do you sell it:

6.11 If yes, who buys the medicinal plants (Villagers-1, village medical stores-2, village doctors-3, outside individuals-4, outsider groups/ companies-5):

7. Community awareness about conservation of medicinal plants

7.1 Are you aware that conservation of medicinal plants benefits ecosystem services of protection to many of plants and animals species? Yes/no

7.2 Are you willing to conserve these species for present and future generations? Yes/no

7.3 If yes, if conservation of medicinal plants is done by a trust/ charity/ village panchayat/ NGO, would you be willing to pay for the conservation? Yes/no

7.4 If yes, how much will you be willing to pay?

Mark one: Rs. 500, Rs. 400, Rs. 300, Rs. 200, Rs. 100.

7.5 What percentage of people would be willing to pay like you?

7.6 Is there any commercial/ group who sells medicinal plants from the village?

7.7 Is there any awareness in the community at social level to restrict that?

7.8 If yes, is any group/individual being penalized for that?

7.9 What is your suggestion for conservation of medicinal plants for the community, NGO, government?

CENTRE FOR MULTIDISCIPLINARY DEVELOPMENT RESEARCH (CMDR)

Jubilee Circle, Dharwad-580001, Karnataka

ICSSR Institute

Research Project on

Natural Resource Accounting in Karnataka in Forest Sector and Land Sector (Excluding Mining)

Sponsored by

Central Statistical Organisation (CSO), Government of India

Valuation of Fuelwood (Village Level Questionnaire)

1. Location

Village: District:

Taluk: State:

2. Approaches to Fuelwood:

2.1 Accessibility (<2 kms-1; >2 kms –2) :

2.2 Road Type (Mud - 1; Tar – 2) :

2.3 Bus Stop (Distance in kms) :

2.4 Railway Station (Distance in kms) :

3. Village Level Information:

3.1 Total Number of households in the village :

3.2 Population of the village :

3.3 Health Facilities :

(Government Hospital –1; Private Hospital/clinic – 2; Community Health Centre – 3; Primary Health Centre – 4; Non-existent –5)

3.4 Nearest Health Centre :

3.5 Dependence on medicinal plants :

(Very high – 1; High – 1; Medium – 3; Low – 4; Nil – 5)

3.6 Education Facilities :

(UG and PG College – 1; School (12th) – 2; School (8th) – 3; School (5th) – 4; Nil – 5)

3.7 Proportion of Educated Population :Men Women

% of Literates :

% who have education up to 5th std. :

% who have education up to 12th std. :

% who are graduates and above :

3.8 Village Amenities (Yes – 1; No – 2)

a) Drinking water :

(Private Taps – 1; Public Taps – 2; Handpumps/Borewells – 3; Open wells – 4)

b) Sanitation facilties :

(Private Toilets – 1; Public toilets – 2; None – 3)

c) Irrigation :

(Tubewell – 1; Open Well – 2; Canal – 3; Tanks – 4; Others -5)

d) Electricity :

(100% houses electrified – 1; 75 - 100% - 2; 50-75% - 3; 25-50% - 4; <25 % -5)

e) Market :

(APMC– 1; District level Market– 2; Taluk level Market– 3; Local Market– 4, Others - 5)

f) Post Office :

g) Any other amenities :

3.9 Housing Facilities :

(Pucca Houses – 1; Kutcha Houses – 2; If mixed then state the proportions)

3.10 Social Profile :

Social Communities	Number of Households	Main Occupation

3.11 Village landscape :

a) Mainly natural :

(Forest – 1; Water bodies – 2; Deserted – 3)

b) Seminatural :

(Combination of categories above and below)

c) Manmade :

(Agricultural – 1; Horticutural – 2; Forestry – 3; Barren – 4)

3.12 Any Government Scheme running in the village (If yes, name them)

(Completed scheme since 2000-1; On-going scheme-2)

3.13 Details of specific government schemes in the village on watershed:

a) Operating :

b) Pending in history :

c) On-going :

d) Future :

3.14 Details of Social/Non-government Organizations working in the village:

Social organizations / NGOs	Work

3.15 Details of attempts by outsiders for conservation of natural resources

Attempts by outsiders about nature conservation research/awareness	Details of effects it had	Follow-up activities	Who were involved in research / awareness attempts?

4. Dependence on fuelwood:

4.1 What are the domestic purposes for which fuelwood is used by villagers (cooking-1, water heating-2, others-3):

4.2 To what extent different sections of the society depend upon the fuelwood brought from the forest:

Communities	Extent of dependence (%)

4.3 Is there any market for fuelwood in the village (yes-1, no-2):

4.4 If yes, then what are the prevailing market prices?

Type of fuelwood	Price per unit

4.5 What are the alternatives to fuelwood used in the village (LPG-1, kerosene-2, coal-3, electricity-4, others-5):

4.6 Generally who in the family collects the fuelwood? (Men-1, women-2, children-3):

4.7 Are there any commercial uses of fuelwood in the village (yes-1, no-2):

Type of unit	Number	Quantity of fuelwood required per day	Purchase-1, collect-2	Price

5. Fuelwood availability:

5.1 Ownership:

(Community-1 Individual-2 Government-3 Trust-4)

5.2 Approximate area (Sq.M/Acre/Ha):

5.3 Terrain :

(Hilltop-1 Slopes-2 Foothills-3 Valley-4 Plains-5 Island-6) :

5.4 Proximity to a perennial water source (Near-1 Far-2 None-3) :

5.5 Proportion (%) of the original area under fuelwood plants:

5.6 Is the availability of fuel woods reducing –1 or increcreasing-2:

5.7 If yes, what are the reasons:

(Usage has increased 1, commercialization 2, non-conservation 3)

5.8 Are all these fuel woods (herbs 1, shrubs 2, trees 3):

6. Community awareness about conservation of fuel wood plants:

6.1 Whether people are aware that conservation of fuelwood plants benefits ecosystem services of protection to many of plants and animals species? Yes/no

6.2 Are the people willing to conserve these species for present and future generations? Yes/no

6.3 If yes, if conservation of fuelwood plants is done by a trust/ charity/ village panchayat/ NGO, would you be willing to pay for the conservation? Yes/no

6.4 If yes, how much will you be willing to pay?

Mark one: Rs. 500, Rs. 400, Rs. 300, Rs. 200, Rs. 100.

6.5 What percentage of people would be willing to pay like you?

6.6 Are there any commercial units/ individuals from your village selling fuel wood from your village?

6.7 Is there any awareness in the community at social level to restrict that?

6.8 If yes, is any group/individual being penalized for that?

6.9 What is your suggestion for conservation of medicinal plants for the community, NGO, government?

CENTRE FOR MULTI-DISCIPLINARY DEVELOPMENT RESEARCH (CMDR)

Jubilee Circle, Dharwad-580001, Karnataka

ICSSR Institute

Research Project on

Natural Resource Accounting in Karnataka in Forest Sector & Land Sector (Excluding Mining)

Sponsored by

Central Statistical Organisation (CSO). Govt. of India

Valuation of fuelwood (Local Producer Questionnaire)

Investigator: Date:

1. Location

Village: District:

Taluk: State:

Name of the respondent:

Name of the Owner of the Bakery:

2. Information About The Bakery Owner

2.1 Address of the Unit:

2.2 Age of the Owner:

2.3 Education of the owner (number of years):
Technical education (related to business):

2.4 Religion (Hindu-1 Muslim-2 Christian-3 Others-4):

2.5 Social group (SC-1 ST-2 OBC-3 Minorities-4 Others-5):

2.6 Family size:

Members	Male	Female
Adults (> 60 years)		
Adults (< 60 years >18 years)		
Children (<14 years)		

2.7 Family Members working in the bakery Males: Females:

3. Information About The Bakery

3.1 Type of ownership:
(Family-1, Individual-2 partnership-3, co-operative-3 or other-4):

3.2 Is it a traditional or new enterprise? (Traditional-1 or new enterprise-2)

3.3 Year of establishment:

4. Number Of Workers

Particulars	Numbers		Wages
	Family labour	Hired labour	
Adult males			
Adult females			
Children			

5. Use of Fuel in Bakery

5.1

Type of fuel	Purpose	Source	Quantity/day (units)	Price/unit	Total value fuel used during last one year (Rs)
Fuelwood					
Agri.By-product					
Electricity					
LPG					
Others (Specify)					

5.2 Is all the fuelwood requirement of the bakery met through market (yes-1, no-2):

5.3 If no, how much proportion (%) of total demand is collected from the forest:

5.4 During which part of the year do you fall short of fuel wood supply (if any) (state the months);

5.5 Time consumed in collection of fuel wood (no. of persons x no. of hours per day):

6. Financial And Technical Assistance From The Government

6.1 Did you get any financial help from the government for purchasing Owen, etc? (Which can help in replacing use of fuelwood) Yes-1 No-2

If yes, give details

6.2 Total amount received (Rs):

6.3 Amount of subsidy (Rs):

6.4 Did you get any training to run the bakery business? (Yes-1 No-2):

Research Project: "NRA of Forest Resources of Karnataka"
Conducted by: Centre for Multi-disciplinary Development Research (CMDR), Dharwad
Sponsoring Agency: Central Statistical Organization (CSO), Ministry of Planning & Programme Implementation, Government of India

Interview Schedule for Indian Tourists to the Dandeli Wildlife Sanctuary

1. Name of the Respondent: _____

Contact Phone No. (please state area code) _____ email id (if any) _____

2. Whether you have come as an individual or as a family member or in a group? [ ]

(1 = individual, 2 = as a family member, 3 = in a group)

2.1 If 1, please answer the following, else go to 2.2.

Age (in completed years)	Years of Education	Occupation	Total Monthly Income/Earnings (in Rupees)	Residence			Distance (in Kms) from place of residence to Dandeli WS
				State	District	Village/ Town/City	

2.2. If 2, please answer the following, else go to 2.3

Family size and composition (number)			Age of Head of Family (in completed years)	Years of Education of Head of Family	Occupation of Head of Family	Total Monthly Income/Earnings (in rupees) of Head of family	Residence			Distance (in Kms) from place of residence to Dandeli WS
Male	Female	Children (below 14 years)					State	District	Village/ Town/City	

2.3. If 3, please answer the following.

Group size and composition (number)			Age of Group Leader (in completed years)	Years of Education of Group Leader	Occupation of Group Leader	Total Monthly Income/Earnings (in rupees) of Group Leader	Residence			Distance (in Kms) from place of residence to Dandeli WS
Male	Female	Children (below 14 years)					State	District	Village/ Town/City	

3. How did you come from yourplace of residence to the Dandeli WS?
(1=directly from place of residence to Dandeli, 2=made halting points during the journey) [ ]

3.1 If 1, answer the following, else go to 3.2:

Mode of travel to reach to the site (public transport=1; Private vehicle=2; Both=3)	**Total Travel Expenses** on journey from place of residence to Dandeli WS **(In Rupees)**	**Time taken** to travel from place of residence to Dandeli WS **(In Hours)**	Number of days planned to stay at Dandeli WS	**Site cost component**			
				In case you have chosen a **Package Tour**, please **(In Rupees)** if not, go to next column	Expenses incurred in case of Non-package Tour of the Dandeli WS **(Rupees per person)**		
					Stay(per person per day)	Food (per person per day)	Total Site costs (e.g. entry fees, safari chages, etc)

3.2. If i.e., you made halting points during the journey, please give the following details relating toyour last major halting point (with a staying period for maore than 24 hours):

Mode of travel to reach the site (Public transport=1; Private vehicle=2; Both=3)	Name of the last major halting place	Purpose of halting (please see code** below)	**Total travel expenses** from place of residence to last major halting place **(in Rupees)**	**Total Travel Expenses** on journey from last major halting place to Dandeli WS **(In Rupees)**	**Time taken** to travel from last major halting place to Dandeli WS **(in Hours)**	Number of days planned to stay at Dandeli WS	**Site cost component**			
							In case you have chosen a **Package Tour**, please state the total package cost per person **(In Rupees)** If not, go to next column	Expenses incurred in case of Non-package Tour of the Dandeli WS **(Rupees per person)**		
								Stay(per person per day)	Food (per person per day)	Total Site costs (e.g. entry fees, safari chages, etc)

** code: (1=recreational purpose, 2=travel, 3=attending conference, 4=business, 5=visiting friends or relatives, 6=others.)

4. How many other sites outside of the dandeli WS have you planned to visit during your period of stay here? [ ]

5. What is your opinion about the Dandeli WS in terms of the following indicators?

5.1 Site amenities for stay, food and travel etc. [ ]
(1-Very poor, 2=Poor, 3=Fair, 4=Good, 5=Excellent, 6=Not good)

5.2 Site richness (quality: e.g forest density, species' size/strength, etc). [ ]
(1-Very poor, 2=Poor, 3=Fair, 4=Good, 5=Excellent, 6=Not good)

5.3 Site diversity (variety of flora and fauna) [ ]
(1-Very poor, 2=Poor, 3=Fair, 4=Good, 5=Excellent, 6=Not good)

Thank you for your kind cooperation

Date:
Signature of the Investigator: