Natural Resource Accounting in Goa Phase II

Project Report

March 2008




Integrated Research and Action for Development, New Delhi

IRADe Integrated Research and Action for Development

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Project Team

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Sponsored By

Central Statistical Organization
Ministry of Statistics and Programme Implementation,
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Preface

This report contains the "Natural Resource Accounting of Goa State" and the valuation of environment and forest ecosystem of Goa state.

In this report basic concepts on environmental accounting and different approaches of valuation are described.

More specifically report covers the valuation in the specific sectors viz., air, water, municipal solid waste, and forestry. Chapter 1 describes the introduction of Goa state and provides the key indicators, Gross State Domestic Product, economic development of the state, land use and human development indicators.

Chapter 2 carries out a study of municipal solid waste management and provides the approach for sector and method to calculate the loss incurred due to solid waste. This chapter deals with the solid waste generated by hotels, households and market places and economic and environmental loss due to uncollected solid waste.

Chapter 3 describes the air and water pollution due to industries, households and transport. Air pollution abatement costs are considered and methodology has been developed. Water pollution status of various rivers are described and pollution for industries.

Chapter 4 describes forestry sector of Goa state. Forests cover more than 50 percent of land area. As the forests are not valued properly, here calculations are made for economic valuation of forest and indirect benefits from the forests, which are generally unaccounted.

Chapter 5 describes the Conceptual Framework for the green accounting and calculation of overall Green SNP (System of National Products) for Goa as a whole. This chapter describes pitfalls, problems, and some solutions for methodologies for economic valuation of environment.

The unique elements are: the treatment of Municipal Solid waste analysis done for the first time in the context of natural resource accounting of a state, the treatment of hotel industries- a service sector and tourism, corrected state domestic product after environmental adjustments etc.

We hope that this study will show the feasibility as well as the need for carrying out the environmental accounting and valuation. Kindly give us your feedback.

Jyoti Parikh

Executive Director, IRADe

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PROJECT TEAM

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List of Abbreviations

APC	:	Air Pollution Control
BIS	:	Bureau of Indian Standards
BOD	:	Biological Oxygen Demand
COD	:	Chemical Oxygen Demand
CNFA	:	Culturable Non-Forest Area
CSO	:	Central Statistical Organization
CPCB	:	Central Pollution Control Board
CVM	:	Contingent valuation method
DS	:	Dissolved Solids
ETP	:	Effluent Treatment Plant
GSDP	:	Gross State Domestic Product
HPM	:	Hedonic Pricing Method
HPU	:	Heavy Polluting Units
HRACC	:	Hotel and Restaurant Approval and Classification Committee
IRADe	:	Integrated Research & Action for Development
MC	:	Municipal Councils
MOSPI	:	Ministry of Statistics and Programme Implementation, GoI.
MoEF	:	Ministry of Environment and Forests
MSW	:	Municipal Solid Waste
NSDP	:	Net State Domestic Product
NWFPs	:	Non Wood Forest Products
NO_2	:	Nitrogen Dioxide
NTFPs	:	Non-timber Forest Products
RSPM	:	Respirable Suspended Particulate Matter
SNP	:	System of National Product
SPCB	:	State Pollution Control Board
SS	:	Suspended Solids
SO_2	:	Sulpur Dioxide
SPM	:	Suspended Particulate Matter
TCM	:	Travel Cost Method
TEV	:	Total Economic Valuation

Units

mg / L	:	Milligram per Litre
ppm	:	Parts per million
$\mu g / m^3$	:	Micro gram per cubic metre

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1

GOA PROFILE

1.1 Introduction

Goa is the smallest state in terms of area, located on the west coast of India and fourth smallest state in terms of population. It is situated on the slopes of the Western Ghats. It is bounded on the North by Sindhudurg district of Maharashtra, on the East by Belgaum, on the South by Karwar Districts of Karnataka, and on the west by Arabian Sea. It has scenic natural beauty, attractive beaches, and distinctive architecture, feasts and festivals of a unique culture.

The state has a geographical area of approximately 3,702 sq km. Estuary entrances and rocky capes along the palm-fringed beaches are the typical geographical feature of Goa. Also, there are wetlands at Carambolim. It has six rivers - Tiracol, Chapora, Mandovi, Zuari, Sal and Talpona. They originate from the Sahayadri mountain ranges and flow westward into the Arabian Sea. It has long coastline with a length of 105 kms.

Figure 1: ***Map of Goa***

The state is distributed among its two districts and 11 talukas (local sub districts). Each of the State's thirteen tehsils (revenue centers) has an industrial estate, an industrial training institute and higher secondary level education facilities. The capital city of Panjim is located on the banks of the Mandovi River. Vasco, Margao, Mapusa and Ponda are the other major towns.

1.2 Goa's Development

Goa has emerged as the most progressive State in the country and is ranked No.1 by the Eleventh Finance Commission as the Best Placed State in the Country in terms of infrastructure facilities. The National Population Commission has ranked Goa as the First State amongst all States/UTs in terms of 12 indicators (composite index) on quality of life. CRISIL has declared Goa as the second fastest growing State in the country. Various human development indicators of Goa are given in Tables 1.1 and 1.2.

Table 1.1: Key Indicators of Goa

Sr.No.	Item (General)	Goa	India
1	Population* (in lakhs)	13.48	1028.61
2	Density of population (persons per sq.km).	363	324
3	Sex ratio* (females per 1000 males)	960	933
4	Urban population to total population* (%)	49.76	38.4
5	Decadal Growth Rate (1999-2001)	14.89	21.34
6	Geographical area (sq.km)	3702	3166285.0
7	Coastline (km.)	101	7,000
8	Total Forest Area (sq.km)	1,224 (33.06%)	774,740 (23.57%)

Source: *Census, 2001. *2001-02

Economic development brings about improvement in health and social factors. An analysis of Table 1.1 gives us some important facts about the status of Goa in comparison to India. Goa has a sex ratio of 960, which is much better than the national average of 933. Goa is the smallest state in India but the forest area 33.06% and that is much better than national forest area of

23.57%. The run of coastline of Goa is 101 km. The decadal growth rate of Goa is 14.89 that is in a balanced position than other states of India.

Table 1.2*: Human Development Indicators for Goa*

Sr. No.	Human Development Indicators	Goa	India
1	Population served per Hospital (2004)	9054	61810
2	Hospital beds (per 1000 population)	3.79	.70**
3	Birth Rate	15.95	26.4
4	Death Rate	7.46	8.8
5	Infant Mortality Rate	12.40	70.5
6	Literacy Rate (male)	88.88	75.96
7	Literacy Rate (female)	75.51	54.28
8	Literacy Rate (total)	82.32	65.38

Source: *Directorate of Planning, Statistics & Evaluation, Panaji–Goa. & Census 2001*

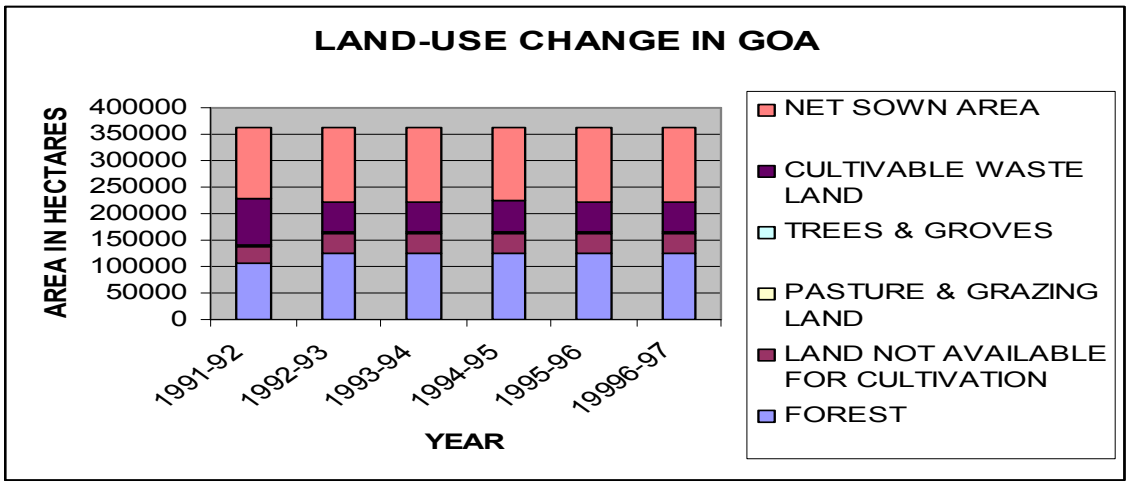
Table 1.2 gives human development indicators for Goa.The Birth rate is among the lowest in the country, which has been declining consistently. The death rate is also very low at 7.7 per thousand as compared to National average of 8.7 (2002). The infant mortality rate i.e. number of deaths per thousand children before they attend the age of six years was 12.48 against the national average of 70. A good indicator for health access to citizens is the Hospital beds per thousand populations. In Goa this figure was around 3.79 per 1000 population as compared to 0.70 for the All India average.

Thus, we can infer from the above table that Goa has a very good record in terms of health indicators.

1.3 Land use Pattern in Goa

The figure below gives the picture of land use pattern in Goa. Net sown area is about 40%, cultivable wasteland is about 12%, land not available for cultivation is about 10% and the contribution of forest is about 35%.

Fig 1.1: Land Use Change in Goa, 1991-97



1.4 Economic Growth

Progress achieved by Goa based on per capita net state domestic product at current prices during the last four financial years is very strong and fluctuating each year. It is evident from the table 1.3 that per capita NSDP at current prices which was Rs.51, 073 in 2001-02 rose steeply to Rs. 60, 787 in 2002-03 but drop down in 2003-04 to Rs.57, 369 but again improved by a margin in 2004-05. Per capita NSDP at current prices of Goa stand far ahead of the national average per capita NSDP, which was Rs.20, 171 in 2001-02 whereas, it was Rs.51, 073 for Goa. Though national average showed signs of improvements, Goa is still ahead by a large margin.

Table 1.3: Per Capita Net State Domestic Product at Current Prices (Rupees)

Sl. No.	State	2001-02	2002-03	2003-04	2004-05
1.	**Goa**	**51073**	**60787**	**57369**	**58184**
2.	Punjab	25868	26395	28607	30701
3.	Maharashtra	24044	26858	28848	32170
4.	Haryana	24883	26818	29504	32712
5.	Himachal Pradesh	21570	22902	25059	27486
6.	Kerala	20287	22778	24492	27048
7.	Gujarat	19713	22624	26672	28355
8.	Tamil Nadu	20326	21740	23358	25965
9.	Karnataka	18091	19578	21238	23945
10.	West Bengal	17499	18494	20548	22497
11.	Andhra Pradesh	17932	19087	21372	23153
12.	Arunachal Pradesh	15577	16916	19029	19724
13.	Meghalaya	15813	16803	18135	19572
14.	Rajasthan	13621	12841	15738	16212
15.	Madhya Pradesh	12209	11500	13722	14069
16.	Assam	11423	12247	12821	13833
17.	Orissa	9879	10164	12645	13601
18.	Bihar	5004	5606	5362	5772
19.	Chandigarh	47734	53886	60105	67370
20.	Delhi	44286	45679	49494	53976
21.	Pondicherry	37926	45431	50936	56034
22.	Sikkim	17644	20013	22062	24115
23.	Tripura	17383	18550	20357	NA
24.	Manipur	12683	12878	13732	14901
25.	Jammu & Kashmir	13444	14507	15318	16190
26.	Uttar Pradesh	9320	9983	10637	11477
27.	Jarkhand	10129	11139	11999	13013
28.	Chattisgarh	12032	12369	14983	15073
29.	Mizoram	19704	22207	NA	NA
30.	Nagaland	18911	20748	NA	NA
31.	Uttaranchal	13466	14947	16982	19652
32.	Andaman & Nicobar Islands	25999	28340	NA	NA

Source: Central Organization based on Directorate of Economics & Statistics of respective State Governments (as on 21-11-2005)

1.5: Goa's Contribution to the National Economy:

Though, Goa is the smallest state in India, it contributes significantly to the national exchequer. Every year about 2 million tourists (both Domestic and Foreign) visit Goa. Domestic tourism also gives rise to economic activity and income in the state. Almost 15% (about Rs.1500 crore) of the foreign exchange earnings from tourism are generated in Goa annually. Over 60% of the total iron-ore exported from the country is from Goa alone, which is worth nearly Rs.1000 crore per annum. Royalty from minerals like iron-ore also add revenue to the central kitty. Approximately, 0.66% of the combined collection of income tax, excise duty and customs are generated in Goa. Per capita contribution of the State from iron ore export, tourism, customs revenue, central excise and income tax is referred to Table 1.4.

Table 1.4: Small State - But - Contribution to the Nation is significant-Goa:

S. No.	Particulars	Amount (Rupees in crore)	Per capita (in Rupees)
1	Customs Revenue (2001-02)	301.48	2243
2	Central Excise (2001-02)	626.98	4665
3	Income Tax (2001-02)	232.60	1731
4	Iron Ore Export - Foreign Exchange Earnings (2001-02)	939.94	6899
5	Foreign Exchange Earnings from Tourism (1999)	1500	11062

Source: Economic Survey of Goa, 2003-04

1.6 State Income

The Gross State Domestic Product (GSDP) of the State at constant prices (1993-94) has registered an annual compound growth rate of 8.7% during the period 1993-94 to 2001-02.

Tertiary sector contributes the highest amount to GSDP at 54.6 percent, followed by secondary sector at 33.4 percent and the primary sector contributes only 12 percent.

Table1.5: Sectoral composition of GSDP at current prices (per cent)

Sl.No	Sector	1970-71*	1980-81	1990-91	2000-01
1	Primary Sector	30.9	24.3	19.9	12.0

2	Secondary Sector	26.5	29.9	28.6	33.4
3	Tertiary Sector	42.6	45.8	51.5	54.6
4	**GSDP**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Economic Survey of Goa, 2003-04

Primary sector

The contribution of primary sector to the GSDP is continuously on the decline (see table 1.6). The share of primary sector in the GSDP has declined from 30.9% in 1970-71 to 12.0% in 2000-01. At the national level too it has declined from 31% to 24% during 1993-94 to 2001-02. The value added from agriculture in GSDP has declined from 16.5% in 1960 to less than 7% in 2000-01. Waning agriculture activity in the State is also evident from the declining trend of work participation in this sector. The percentage of workers in this sector has declined from 60% in 1960 to 27.5% in 1991 and to 16.6% in 2001 population census. This may be attributable to small land holdings and pressure on land due to heavy urbanization leading to less economic viability in relative terms. However, the Employment Generation Strategy unveiled by the Government of Goa during 2003-04, is expected to help in the revival of agriculture and increase in its contribution to GSDP in the State.

The value added from Forestry & Logging in GSDP has been declining in real terms. This can be directly attributed to the steps taken under Forest Conservation Act, 1980 of Government of India & Goa, Daman & Diu (Preservation of Trees) Act, and 1984 of Government of Goa. Both the acts have put a ban on cutting of trees in public and private forests. The value addition from this sector is on account of dead, dying and fallen trees from government forests salvaged departmentally, major forest products comprising industrial/fuel wood and minor forest products like bamboo, cane etc.

Secondary Sector

During the last four decades the industrial sector (secondary sector of the economy) in Goa has grown considerably and their share of value addition in SDP has increased from about 8% at the time of liberation to over 33% now. At the time of liberation there were a very few industries like cashew processing, fruit and fish canning, laundry soap making, etc. Now the State has over 6000 small-scale industrial units and 154 medium and large industries in the organized sector.

Manufacture of chemicals and chemical products occupies a significant proportion in the industrial pie of the state; its contribution goes to 54% followed by 14% from manufacture of food products & beverages. Manufacture of rubber and plastic products stands third major contributor with a share of 5%. On the whole the secondary sector has registered an annual compound growth rate of 7.4% at constant prices (GSDP) during the period 1993-94 to 2000-01 (table 1.6).

Tertiary sector

Tertiary sector registered a CAGR of 9.5 % during the period 1994-2001 at constant prices GSDP. Tourism contributes the major share in the tertiary sector. Tourism as such is not taken into consideration in the System of National Accounting directly, but we can look into other sectors like Hotels & Restaurants, Trade and transport, which are mainly related to tourism sector. The section "Trade, Hotels & Restaurants" contributes around 16.1% of NSDP at constant prices (see table 1.7) in 2001-02.It has increased its share from about 9.3 percent in 1993-94 to 13.9 percent in 2001-02 of GSDP at factor cost at constant prices.

Other activities, which are closely related to tourism in tertiary sector, include Financing, Insurance, and Real Estate & Business Services, which contribute around 18.2 percent.

Table 1.7: Gross State Domestic Product at Factor Cost by Industry of origin 1993-94 to 2001-02 at Constant Prices (Rs. in lakh)

SN	Sector	1993-94	1995-96	1997-98	2000-01	2001-02
1	**Agri, Forestry & Fishing**	14.8	9.0	9.5	8.2	8.3
1.1	Agriculture	10.5	7.1	7.8	6.4	6.6
1.2	Forestry & Logging	0.5	0.2	0.2	0.2	0.3
1.3	Fishing	3.9	1.7	1.5	1.6	1.5
2	**Mining & Quarrying**	6.3	5.2	3.8	3.4	3.0
	Sub Total - Primary	21.1	14.2	13.2	11.6	11.3
3	**Manufacturing**	23.9	26.5	29.6	29.0	29.5
3.1	Registered	19.0	22.0	24.9	24.3	22.9
3.2	Unregistered	5.0	4.5	4.7	4.7	6.6
4	**Electricity, Gas and Water Supply**	1.8	1.7	1.7	1.7	1.9
5	**Construction**	4.4	5.1	5.1	6.2	6.1
	Sub Total - Secondary	**30.2**	**33.3**	**36.4**	**37.0**	**37.6**
6	**Trade, Hotels and Restaurants**	9.3	16.4	13.1	14.7	13.9
7	**Trans, Storage & Comm.**	**15.2**	**10.8**	**10.3**	**10.1**	**10.3**
7.1	Railways	0.2	0.3	0.3	0.3	0.3
7.2	Transport by other means	14.4	9.8	9.2	8.8	9.0
7.3	Storage &Communication	0.5	0.8	0.8	1.0	1.1
8	**Financing, Insurance, Real Estate & Business Services**	**12.7**	**15.9**	**17.3**	**16.9**	**16.9**
8.1	Banking & Insurance	5.8	10.5	11.6	11.0	10.7
8.2	Real Estate, Ownership, of dwel & Business Services	6.8	5.4	5.7	5.9	6.2
9	**Comun. Social & Per.Serv**	11.6	9.4	9.7	9.8	10.0
9.1	Public Administration	4.4	4.4	4.3	4.1	4.1
9.2	Other services	7.1	5.0	5.4	5.7	5.9
	Sub Total - Tertiary	48.7	52.5	50.4	51.4	51.1

10	**Total GSDP**	**239668**	**393188**	**401462**	**429741**	**456701**

Source: Economic Survey of Goa 2003-04

Table 1.7: Net State Domestic Product at Factor Cost by Industry of origin from 1993-94 to 2001-02 at Constant Prices (Rs. in lakh)

Sl. No.	Sector	1993-94	1995-96	1997-98	2000-01	2001-02
1	**Agriculture, Forestry & Fishing**	15.9	10.0	10.7	8.8	8.9
1.1	Agriculture	11.3	8.1	9.0	7.3	7.5
1.2	Forestry & Logging	0.5	0.2	0.3	0.3	0.3
1.3	Fishing	4.1	1.7	1.4	1.2	1.2
2	Mining & Quarrying	5.6	4.5	3.3	3.0	2.6
	Sub Total - Primary	21.5	14.5	14.0	11.8	11.5
3	**Manufacturing**	25.8	25.8	28.8	28.1	28.7
3.1	Registered	22.7	21.1	23.9	23.2	21.6
3.2	Unregistered	3.1	8.1	10.1	10.4	9.7
4	**Electricity, Gas and Water Supply**	1.0	1.1	1.1	1.1	1.5
5	**Construction**	5.0	5.8	5.8	7.2	7.0
	Sub Total - Secondary	31.9	32.7	35.7	36.3	37.1
6	**Trade, Hotels & Restaurants**	10.7	19.3	15.4	17.3	16.1
7	**Transport, Storage & Communication**	10.4	6.6	6.0	5.8	6.3
8	**Financing, Insurance, Real Estate & Business Services**	13.4	17.1	18.8	18.3	18.2
9	**Community, Social & Personal Services**	12.2	9.8	10.2	10.4	10.7
	Sub Total - Tertiary	46.7	527.8	50.3	51.8	51.4
10	**Total Net State Domestic Product (NSDP)**	**200186**	**328458**	**333373**	**356844**	**383798**
11	**Per Capita NSDP (In Rs.)**	**16558**	**25364**	**25371**	**26730**	**28304**

Source: Economic Survey of Goa 2003-04.

1.7 Natural Resource Accounting for Goa

Measures of national income and output provide estimates of the value of goods and services produced in an economy. The use of system of national accounts or national accounting was first developed during the 1940s. Some of the more common measures are Gross National Product (GNP), Gross Domestic Product (GDP), Gross National Income (GNI), Net National Product (NNP), and Net National Income (NNI).

The need to focus on the development of environmental and resource accounts in the national accounting framework can be explained by a number of factors. First, the national accounting framework is well-established, having a history of more than 50 years of implementation around the world. Second, the national accounts are a very influential source of economic information. Environmental information linked with the national accounts can, therefore, be quickly and easily integrated into existing economic decision-making processes. Third and perhaps the most important reason is the desire by statistical agencies to address the long-standing environmental criticisms of the national accounts. Briefly, they include neglecting to measure the contribution of the environment to national wealth; treating the receipts from the depletion of natural resources as current income rather than capital depletion; measuring the benefits of the use of the environment but not the costs; and including expenditures to protect the environment as part of gross production. Many of these criticisms are controversial and not all are accepted as legitimate by all parties of the debate. Many countries have attempted to address one or more of them in their environmental and resources accounts.

Some experts argue that so-called defensive expenditures should not be included in GDP because they do not contribute to well-being but are, in fact, a cost of maintaining social order. GDP is not intended to measure well-being and therefore should not be adjusted to correct for a failure to do so. GDP is intended to measure the aggregate value of output in the economy, even if this output is considered “regrettable” in the eyes of some. Arbitrarily leaving some kinds of output out of the calculation would distort the picture of economic development and make it impossible to study the relationship between revenue and expenditure in the economy.

Natural capital is generally considered to be divided into three principal categories: natural resource stocks, land and environmental systems (or ecosystems). All are considered essential to the long-term sustainability of the economy. Natural resource stocks are the source of raw materials used in the production of manufactured goods. Land is essential for the provision of space in which economic activity can take place. Ecosystems are essential for the services that

they provide directly and indirectly to the economy, including cleansing of polluted air and water; provision of productive soil; provision of biodiversity; provision of a predictable and relatively stable climate; protection from harmful effects of incident solar radiation; and provision of reliable flows of renewable natural resources.

The natural resource stock measures that we present reflect those resources that can be profitably exploited given today's prices and technologies. As the reserves are depleting, we keep on searching for new ones to replace them. But all resources are ultimately finite, so this process of replacement becomes gradually more difficult over time. For some resources (like sand and gravel) there might be no foreseeable real limit on supply. For others, like conventional crude oil and natural gas, the depletion of major reserves is already predicted for the first half of this century. This makes it worthwhile tracking their evolution in physical terms. Another reason motivates the monetary measure of these resources. This is that the wealth they represent can make a very substantial difference in the economic position of the government that owns them. And because the prices of resource commodities fluctuate widely and are determined by market forces outside of state's control, this wealth can vary from one year to the next. All-in-all, tracking the evolution of country's natural resource stocks makes sense from an environmental and an economic viewpoint.

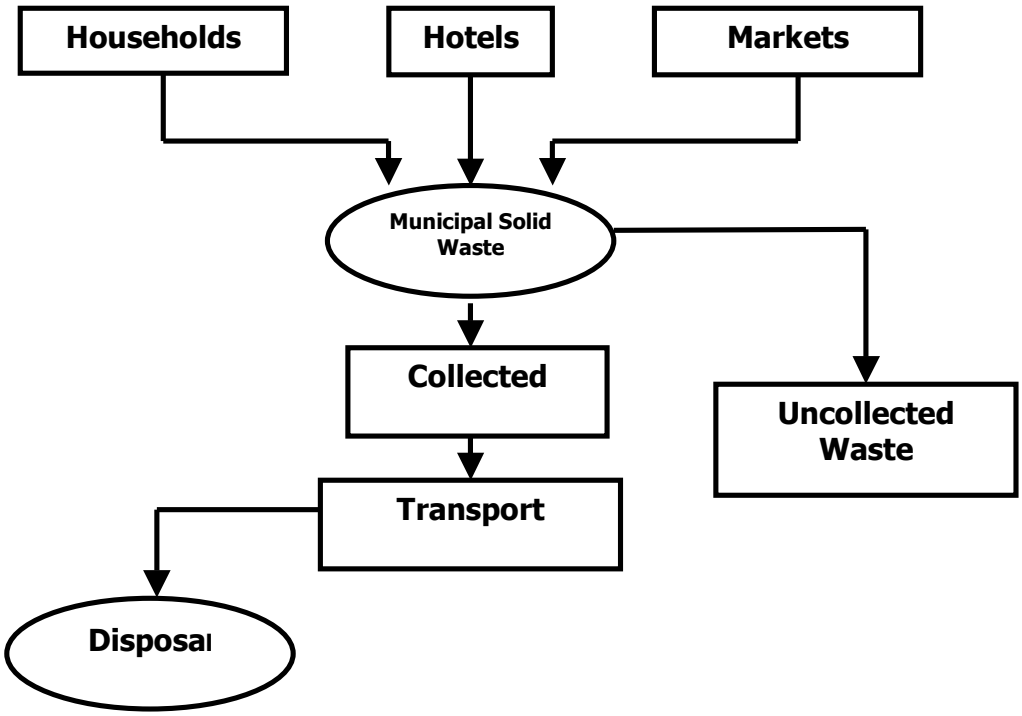
2 Municipal Solid Waste Management

2.1 Objectives and Approach

Solid waste management poses a major environmental challenge. Most of our cities are unable to manage their waste and litter almost everywhere marks most of our urban landscape. This is not a matter of visual pollution but also breeds diseases and causes ill health. Thus one needs to value the cost of unmanaged solid waste.

The objective of this chapter is to develop a methodology for valuing unmanaged solid waste and illustrates it with sample data collected and gathered for this purpose.

Fig.2.1 Flowchart for collected and uncollected solid waste.



2. 2 Solid Waste Management practices in Goa:

Municipal Councils (MC) is responsible for collection, transportation and disposal of solid wastes generated within the municipal limits. Households and establishments including hospitals, private nursing homes, restaurants, etc., deposit their wastes in communal waste storage bins, for subsequent collection (manual) and transportation to a dumping site. A large number of waste pickers make their livelihood by collecting a variety of recyclable wastes from bins and the disposal site. Silt from storm water drains and construction wastes are collected separately by the MC's engineering division for disposal in low-lying areas.

2.3 Survey Analysis of Hotels in Goa

The present survey of hotels in Goa, is carried out to quantify tourism (within the hotel industry) and its role in the Goa economy. The target population of the survey includes hotels (5 Star, 3 star, 4 star and budget hotels) and the survey design is based on stratified sampling procedure through a set of 3 separate surveys. These hotels could serve as major arrival and exit points for an overwhelming majority of the tourists visiting Goa. Further, the geographical coverage of the survey includes various districts of North and South Goa, with an objective of enhancing the statistical precision of the estimates. The districts covered under North Goa are Pernem, Mapusa, Panaji, Valpoi, Bicholim and Ponda. Similarly for South Goa, the districts covered in the survey include Marmugao, Margao, Quepem, Cancona and Sanguem. The identification and mapping of localities selected for the survey were conducted as under:

The entire state of Goa was divided into North and South and covered the above-mentioned districts within both. A total number of 11 districts were selected as the first stage. This comprehensive survey of hotels, wherein the primary respondents are hotel managers or owners in Goa provides several details of tourism behavior. The interviewers were provided training for a period of 3 days prior to the survey. The training was deemed necessary in view of the types of concepts entailed in understanding and explaining the tourism sector as a whole and it also enabled the interviewers to better communicate the problems to the field supervisors and survey managers, and to comprehend the feedback. In addition, the presence of senior researchers contributed strongly to increasing the motivation and dedication of the investigators.

Note that the Hotel and Restaurant Approval and Classification Committee (HRACC), set up by the Department of Tourism, classify the functioning hotels under the star system into six categories from one to 5-Star Deluxe. A new category of Heritage Hotels has also been introduced since 1994. The Department also re-classifies these hotels after every four years to ensure that these hotels maintain the requisite standards. The Committee set up for the purpose has representatives from Department of Tourism, Government of India, State Governments and hotel and travel industry associations.

Some data relating to the average duration of stay by domestic and foreign tourists, total no. of hotels with no. of rooms and no. of beds and average physical characteristics of waste generation by hotels of the study areas are collected from the publications of the Central Pollution Control Board (CPCB), Goa Pollution Control Board and The Department of Tourism (Government of Goa) in India.

The information about tourist inflow, employment inclusive of wage levels, entry tax, size, revenue generated, budget allotted for the tourism site are collected. Information is elicited on type of hotel, structural characteristics, and location comprising distances from major tourist spots, no. of beds, waste generated, treatment plants (if any), pattern of energy use, total water intake is also elicited. **The survey results for hotels are given in the Annexure.**

2.4 The Tourism Sector in Goa

Most of the tourism in Goa is concentrated in the coastal stretches of Bardez, Salcete, Tiswadi and Marmagao. Over 90 percent of domestic tourists and over 99 percent of the international tourists frequent these areas. Two types of tourists with distinct needs, which this state satisfies, visit Goa. The first is the domestic tourists, who comprise 80 percent of all tourists. The second is the international tourists who visit Goa purely for the natural environment and beaches. Within the category of international tourists are there are two sub-categories: backpackers and charter tourists. Although both visit Goa for the beaches, the backpackers are not found in areas of charter tourists; they prefer to mingle and live with the local communities. Whereas, the charter tourists tend to stay in the luxury starred hotels.

In previous decades, a clear off-season for all tourists could be identified, today this is not so for domestic tourists, who come throughout the year albeit in larger numbers in the non-monsoon

months. However, international tourists avoid the monsoon months, as for them the use of the beach is the prime attraction to come to Goa.

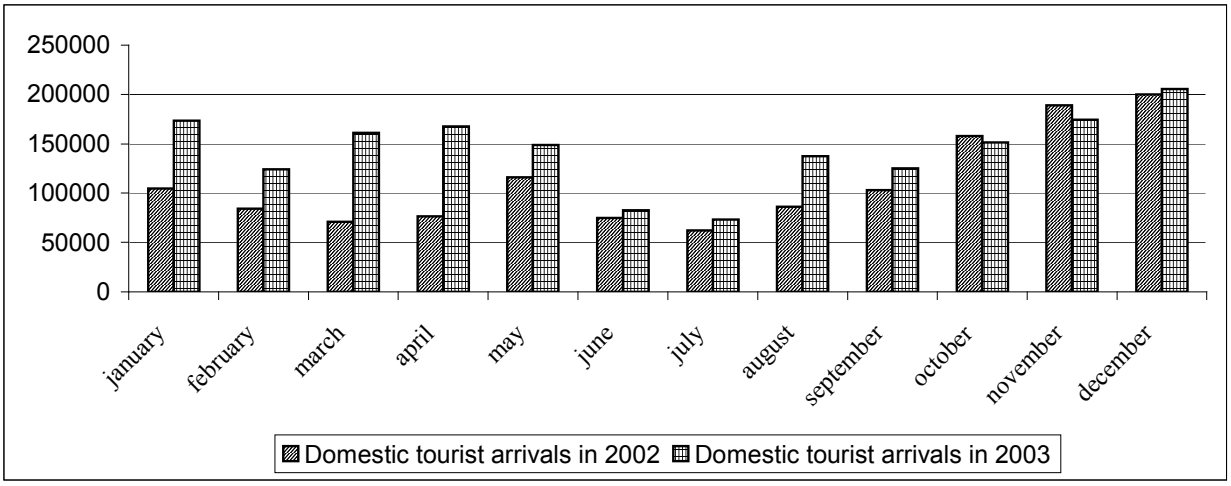
In 2002, it is estimated that domestic tourists traveled to Goa as compared to 1725140 in 2003, reflecting a percentage change of 30.17 per cent. The highest inflow in 2003 was in the months of March and April with percentage change in domestic tourist arrivals was 126.68 and 119.88 per cent respectively as compared to 2002.

Table 2.1: Percentage Change in Domestic Tourist Arrivals in 2002 and 2003

Month	**% Change**
January	65.72
February	47.70
March	126.68
April	119.88
May	28.15
June	10.85
July	17.33
August	59.44
September	21.27
October	-4.01
November	-7.67
December	2.74
Total	**30.17**

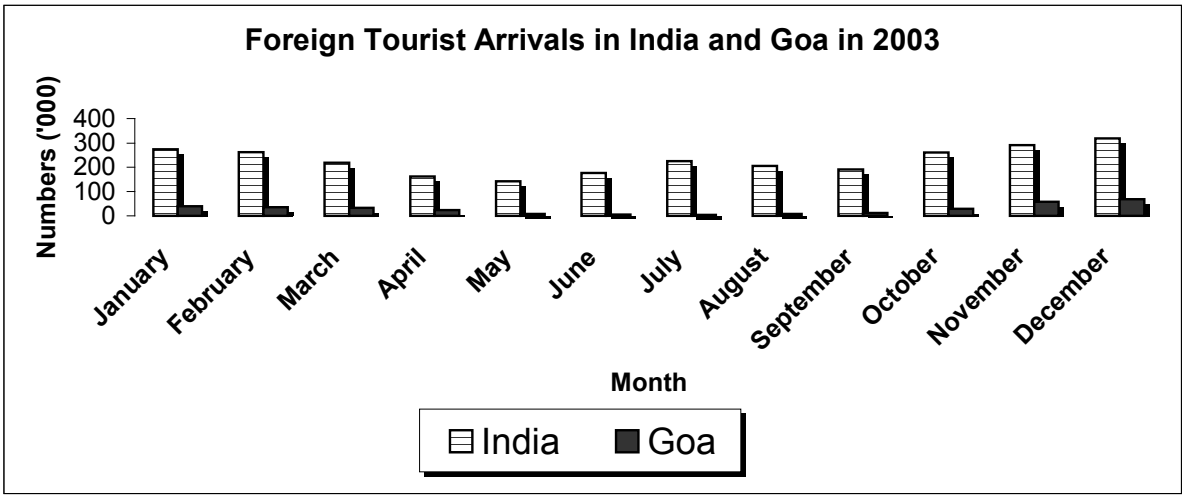
Source: Tourism Statistics Goa 2004.

Figure 2.2: Domestic Tourist Arrivals in Goa in 2002 and 2003



In India, a total of 274215 foreign tourist arrived in India in January 2003, whereas the corresponding figure for Goa is 38236 (13% of India). In December, the foreign tourist arrivals stood at 319271 and 67792 for India and Goa respectively (Figure 3.2).

Fig 2.3: Foreign Tourist Arrivals in India and Goa in 2003



Source: Department of Tourism, Government of Goa.

A similar analysis for domestic and foreign tourist arrivals within Goa for the last 5 years suggest that in the year 2000, a total of 1268513 tourist arrived in Goa, of which 976804 and 291709 were domestic and foreign tourists respectively (Table 3.2). In 2005, the arrivals are 300830 and

108291 respectively for domestic and foreign tourists. (Note that the values for 2005 are for Jan-Feb 2005 only).

Table 2.4: Goa Tourist Statistics Arrivals (Year wise)

Year	Domestic Arrivals	Foreign Arrivals	Total
2000	976804	291709	1268513
2001	1120242	260071	1380313
2002	1325296	271645	1596941
2003	1725140	314375	2039497
2004	2085729	363230	2448959
2005*	300830	108291	409121

*Source: Tourism Statistics Goa 2004. *Values are for Jan-Feb 2005*

The various factors that have contributed to this rise in domestic tourism are:

- Increased disposable income of the middle class,
- Increased urbanization and stress of living in cities and towns,
- Increased ownership of cars, which is making domestic tourism more attractive, especially among the upper-middle and middle classes,
- Improved employment benefits, such as the leave travel concession,
- Development of inexpensive mass transport and improved connections to various places of tourist interest,
- Increased number of cheap accommodations and resorts,
- Greater advertising targeted at domestic tourists both by the central and the state governments, as well as the tourist industry.

2.5. Analysis of survey results

2.5.1 Characteristics of waste generated

The average physical characteristics of wastes generated by hotels indicate that almost 37 per cent of the wastes in hotels comprise paper and cardboard wastes (Table 2.3). Further garden wastes comprised a sizeable 19.4 per cent in hotels.

Table 2.5: Average Physical Characteristics of solid waste generated by Hotels in Goa (in % share)

	Metals	Paper / cardboard	Food	Plastic	Glass	Garden Waste	Others	Total Tones/yr.
2star	0.23 (6%)	3.28 (80%)	0.26(7%)	0.11(5%)	0.19(5%)	0.01(negli.)	0.00	10.17
3star	0.039(3%)	0.04(3%)	0.61(54%)	0.19(17%)	0.20(17%)	0.03(2%)	0.08(7%)	1.19
4star	0.02(6%)	0.01(2%)	0.27(74%)	0.05(14%)	0.02(2%)	0.01(3%)	0.00	0.38
5star	4.90 (2%)	36.51(17%)	24.70(12%)	0.03(negli.)	18.27(9%)	24.38(12%)	101.59(48%)	**210**

Source: IRADe Survey, November 2005

By Different Hotel Groups in Goa (in tonnes/yr)

Table 2.6: Average Physical Characteristics of solid waste generated

Source	Metals	Paper/ Cardboard	Food	Plastic	Glass	Garden	Others	Total
5 star, 4 star, 3 star and budget hotels	**4.8** **R**	**36.8** **R**	**22.3** **C**	**0.09** **R**	**0.15** **R**	**19.4** **C**	**16.46** **-**	**100** **-**

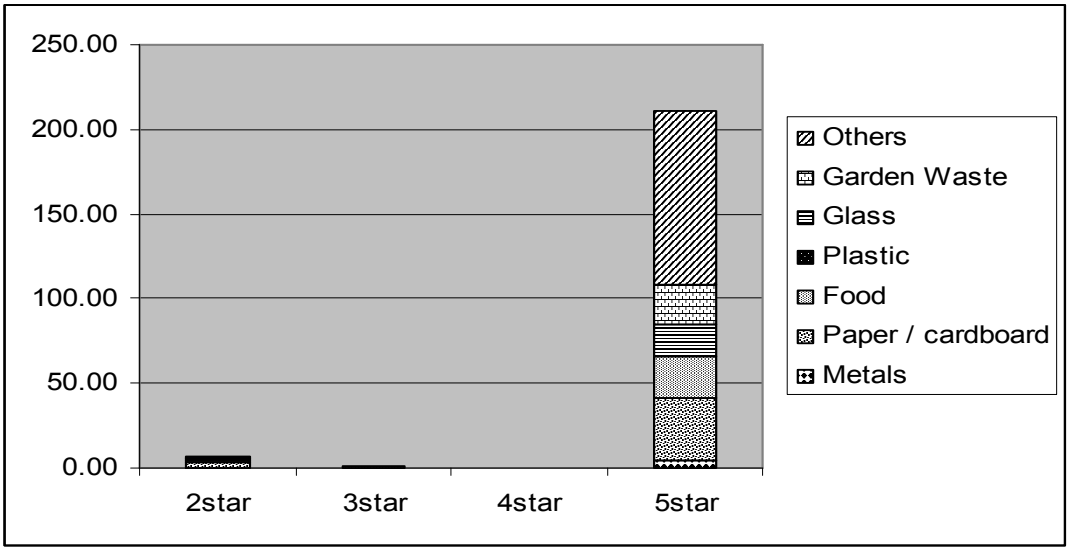
Source: IRADe Survey, November 2005

Fig.2.4: Average Physical Characteristics of solid waste generated

By Different Hotel Groups in Goa (in tones/yr)

R= Partially Recyclable, C= Compositable

The following table and graph show the average quantities of different types of solid waste generated by different hotel groups. From the sample surveyed, it may be seen that five star hotels are generating the highest amount of total solid waste. The composition of waste and the share of each type of waste are also shown in the table and the bar chart.



Source: IRADe Survey, November 2005

Table 2.7: Average per Room solid waste generated by Different Hotel Groups in Goa (in tones/yr)

Types of Hotels	**Avg. No: of Rooms**	**Avg. Per room Solid waste generated**
2star	29	1.98
3star	53	0.29
4star	98	0.013
5star	159	2.75

Source: IRADe Survey, November 2005

From the above data it maybe seen that though the difference in the absolute values of total solid waste generated is very high between the 2star and 5 star hotel groups, the difference in percapita waste generated is not as high.

The data below gives a bird's eye view on the characteristics of waste generated by different hotel groups in Goa. Conclusive arguments may not be drawn from the data on the grounds that the sample surveyed was small and the purpose of the sample was to establish the methodology to be used.

2.6 Municipalities in Goa

According to the Census 2001 Goa has 12 Municipal Councils and 1 Municipal Corporation. The details of the population and area of the municipal councils / corporation is given below in Table 3.1. As can be seen from the table the total urban population of Goa is 869095 and it constitutes 65% of the total population.

Table 2.6: Area and Population of Municipal Councils / Corporation of Goa, 2001.

Name	Population	Share of total population of Goa	Area (Sq. Km)
Panaji	65856	5 %	1736
Pednam	71986	5 %	264
Mapusa	***40487***	***3 %***	***NA***
Ponda	***149630***	***11 %***	***292.8***
Valpoi	7917	1 %	NA
Margao	***78382***	***6 %***	***1966***
Councolim	15860	1 %	NA
Quepem	73926	6 %	318.25
Kurcharim (Kakoda)	21407	2 %	NA
Sanguam	64130	5 %	873.75
Marmugoa (Vasco)	***144836***	***11 %***	***109.12***
Concona	43912	3 %	352.12
Bicholim	***90766***	***7 %***	***238.8***
Total	**869095**	**65 %**	**6150.84**

Source: Goa Government website

* Municipalities that have been surveyed are in italics.

2.7 Methodology: The following methodology has been adopted in order to assess the value of solid waste generated from households, market place and establishments (hotels, restaurants etc.) comes under municipal wastes. Municipal Corporation does the collection of solid waste.

a) Physical Accounts: The quantitative analysis of the solid wastes generated from the households, markets and hotels etc. comes under the physical accounts.

- Generated: Municipality generally collects wastes from three different places i.e.,
    - Households
    - Markets
    - Hotels
- Disposed: The solid waste is generally disposed at waste-land and some part of it is goes for organic composting and recycling.
- Landfill - major part of the solid waste is dumped into wasteland or farmland; generally it is dumped into pit of some depth.
- Organic Composting: - A part of solid waste is used for organic composting.
- Recycled - A part of solid waste is collected and recycled for further use.
- Uncollected - The uncollected waste generated cause serious damage to the environment and society as whole.

b) Monetary Accounts

Cost of Disposal consists of cost of collection, cost of transport and cost of landfills.

Collection: Solid waste has to be collected from bins where households, establishments and markets dump their waste. Cost is involved in collection.

Transport: The collected waste has to be taken to landfill sites. The trucks and trolleys are used for transportation of waste and it is dumped in landfill sites.

Land fills (Value of Land): The value of land that is used for dumping of solid waste has to be counted for and cost of disposal. The depth to which waste is piled up will depend on the site. We have assumed 2 metre of depth. The cost of land (agricultural) is taken as the prevailing price in the market that is Rs.35 million per hectare.

To calculate the value of Land

We take the value of municipal land where the solid waste is disposed and the land is filled upto a depth of 2 meter (assumed). One hectare of land taken for the land filling upto a depth of d meters height has the capacity of d **x** 10000 cubic meters.

Price of Municipal land/hectare, V_L = Rs. 35 million

Every Cubic meter uses up 1/d sq. meter of land.

Cost of land for disposal = (1/d) **x** VL /10000)/ m^3 of waste

= ½ x 35/10000 million rupees

= Rs 1750/m^3

2.8 Surveys for Solid Waste Management in Goa

The survey for natural resource accounting of solid waste management in Goa was carried out at three levels:

- Municipality survey
- Household survey
- Market place survey

For administrative purposes Goa is divided into two districts- North Goa and South Goa with headquarters at Panaji and Margao respectively. Goa has 13 Municipal councils / corporations. The survey has been designed such that both the above districts are suitably represented.

2. 9 Survey design

Five Municipal Councils / Corporations have been selected such that the northern and southern regions of Goa are suitably represented. For the study 40% of municipal councils were covered. The following municipalities have been covered in the survey,

Mapusa Municipal Council

Ponda Municipal Council

Margao Municipal Council

Marmugoa Municipal Council

Bicholim Municipal Council

The key respondents to this survey have been municipal engineers or inspectors. Municipality survey is being performed for the information on financial aspects of solid waste management as well as to get an overall view of solid waste generated, collected, treated and disposed in the State. The municipality survey was aimed to get information on total amount of waste generated

and the total expenditure in management of solid waste in Goa. The survey also gives information on total expenditure on salaries / wages of people employed for solid waste management as well as expenditure incurred in its transport, treatment and disposal. The information is collected from the respective Municipal councils in both North and South Goa

A household sample size of 25 was selected for all towns in Goa. The following table (3.2) shows the number of households surveyed in each town. Households from seven towns have been chosen. Information on composition of waste; collecting authority; frequency of collection; satisfaction with collection system and their willingness to pay, was collected.

Table 2.7. : No: of Households Surveyed in Each Town

North / South	**Towns**	**No: of Households Surveyed**
North Goa	Panjim	4
South Goa	Margao	4
South Goa	Canacona	4
South Goa	Palolim	4
North Goa	Mapusa	4
North Goa	Bicholim	4
South Goa	Zuari Nagar	1
Total		**25**

Source: IRADe Survey

Market places in the following towns were selected for the survey. The following table (3.3) shows the towns in which this survey was conducted. Information on composition of waste; collecting authority; frequency of collection; satisfaction with collection system and their willingness to pay, was collected.

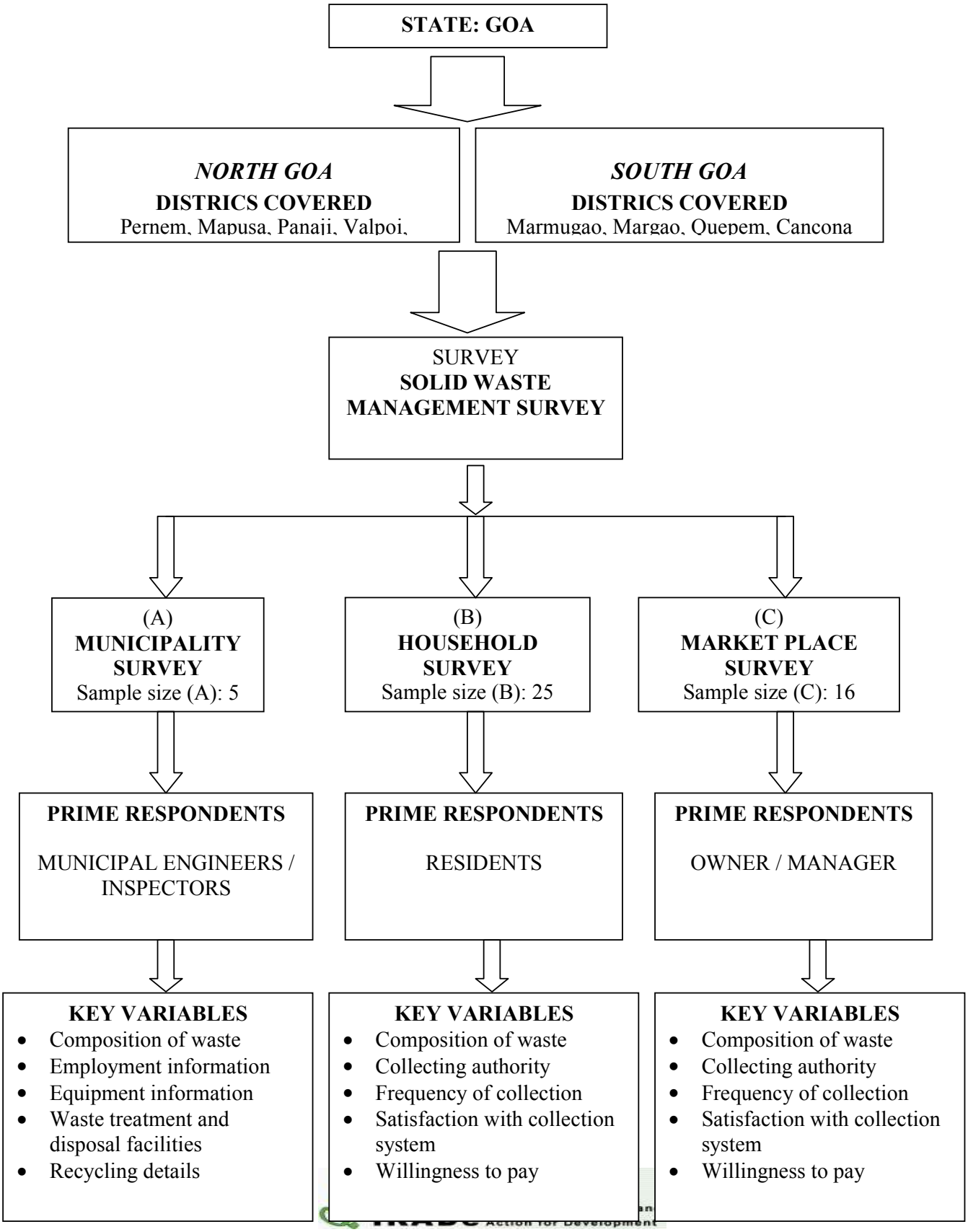
Table 2.8: Market Place Surveyed in Goa

District	Town
North Goa	Panjim
North Goa	Calangut Beach
North Goa	Bicholim
South Goa	Colva Beach
South Goa	Margao
South Goa	Cancona
South Goa	Palolim Beach
South Goa	Zuari Nagar

Source: IRADe Survey

The survey design has been further illustrated in the following flowchart.

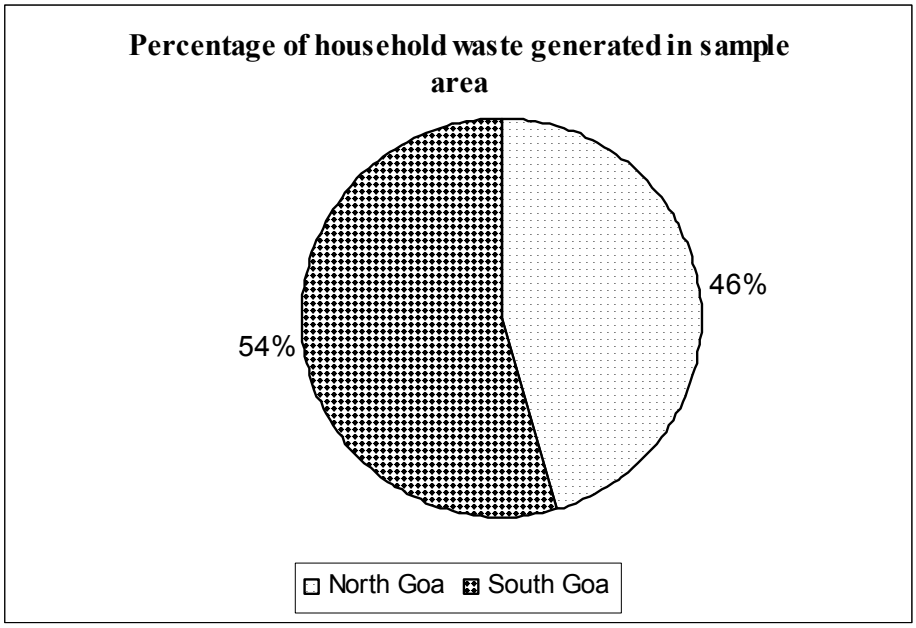
Figure 2.4: Survey Design: Natural Resource Accounting of Solid Waste Management sector in Goa



2.10 Household survey

Preliminary survey of households in North Goa and South Goa shows that 2500 Kg / month i.e 30 tonnes / year of household waste is generated. This waste largely comprises of vegetables and food closely followed by paper waste. Although on an average 2 milk packets are consumed everyday, but in terms of weight they form a negligible portion. Figure 3.3 shows the percentage of household waste generated in North and South Goa sample area. The figure shows that the amount of waste generated in South Goa (54%) and North Goa (46%) are almost equal with South Goa generating slightly more than North Goa.

Figure 2.3: Percentage of household waste generated in North and South Goa (sample area)



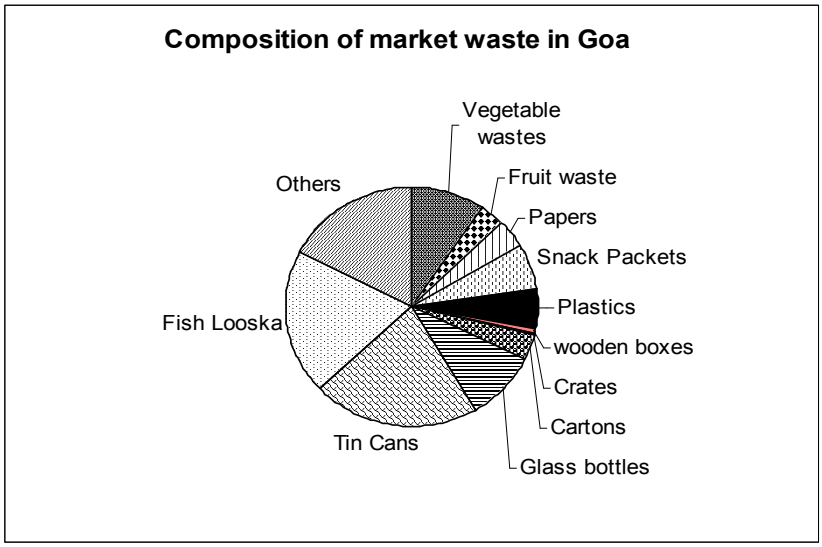
The data available from survey of 25 households from North and South Goa shows that the waste generated per month in North Goa is 95Kg / Household and in South Goa it is 105kg / Household. Thus it can be concluded that about 100kg / Household waste is generated in Goa per month.

In response to queries regarding the willingness to pay most of the households are of the view that the service should be free as can be seen from Table 3.4. While the rest of the respondents were willing to give the same amount that they were paying at the present. Most of the households expressed satisfaction with the present collection system that is done on daily basis.

2. 10 Market Place survey

Preliminary survey of market place in North Goa and South Goa shows that 20968 Kg / day i.e 7665 tons / year of market waste is generated. It largely comprises of fish waste and tin cans closely followed by miscellaneous other wastes (Figure 3.4). Vegetable waste and cartons form other major portion of waste while plastics, crates, wooden boxes, papers, snack packets and fruit waste form minor portions of the total waste generated in market places.

Figure 2.4: Composition of market waste in Goa



In response to queries regarding the willingness to pay the maximum amount that the shop owners were willing to pay is Rs 300 (Table 3.5) while the minimum amount that the respondents were willing to give is Rs 50. Most of the shop owners expressed satisfaction with the present collection system that is done on daily basis.

Table 2.7: Willingness to pay for better services

North / South	Town	Amount Paid per month	Amount willing per month
North Goa	Panjim	60	100
North Goa	Panjim	60	100
South Goa	Margao	300	300
South Goa	Margao	150	150
South Goa	Zuari Nagar	150	150
South Goa	Zuari Nagar	0	50

Source: IRADe survey

2.11 Analysis of Municipality survey results

2.11.1 Quantities and characteristics of solid waste generated:

The total non- hazardous solid waste comprising of municipal waste, industrial waste, construction waste and other waste, generated in five municipalities of Goa was 57861 tonnes in the year 2004. The quantity of waste generated in each category and the per capita waste generated along with the waste generated per sq.km in each municipality is given in detail in Table 3.2. The table shows that the maximum waste generated is in Mapusa municipal council while the least waste generated is in Ponda municipal council area. Since complete data is not available, it cannot be conclusively concluded whether area and population play a major role in the amount of waste generated.

Table 2.8: Per capita waste generated in five municipalities surveyed, 2004-2005

Name of Municipality	Category of waste (Quantity in tones/yr)		Per capita Waste generated (in tones/yr)*	Waste generated per Sq.Km (in tones/yr)
	Municipal waste	Construction waste	-	-
Mapusa Municipal Council	7000	17500	0.17	-
Marmugao Municipal Council	10950	3650	0.08	100.3
Ponda Municipal Council	1729	NA	0.01	5.9
Bicholim Municipal Council	2432	NA	0.03	10.2
Margao Municipal Council	14600	NA	0.19	7.4
Total	36711	21150	0.48	123.8

Source: IRADe survey

* Per capita is only for Municipal Solid waste

* NA – Not available separately

From the above table average per capita waste (tonnes / year) generated and average waste generated per Sq. Km can be calculated, which comes to 0.09 tonnes / year or 0.3 kg / day of waste generated per capita and 31 tonnes / year of waste generated per Sq. km in a year. Thus it can be estimated that about **1.3 lakh tonnes /year** of waste is generated in Goa (Population of Goa: 13, 42,998).

Table 2.9: Urban waste generated in the municipalities of Goa*, 2001

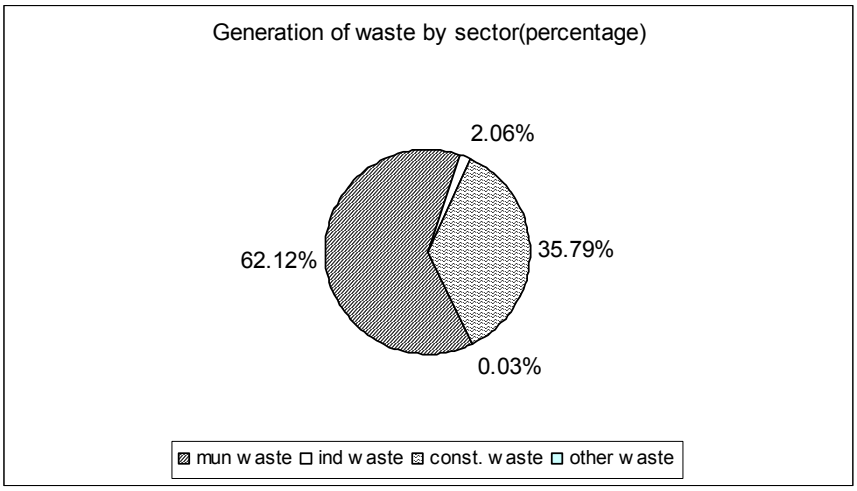
Name	Population	MSW generated (tonnes / year)	% Share of MSW generated
Panaji	65856	5927	18.0
Pednem	71986	6479	19.7
Valpoi	7917	713	2.2
Councolim	15860	1427	4.3
Quepem	73926	6653	20.3
Kurcharim (Kakoda)	21407	1927	5.9
Sanguam	64130	5772	17.6
Concona	43912	3952	12.0
Total	**364994**	**32849**	**100.0**

Source: Goa Government website

*Other than the municipalities surveyed

The total municipal waste generated in sample municipalities is 36711 tonnes / year.

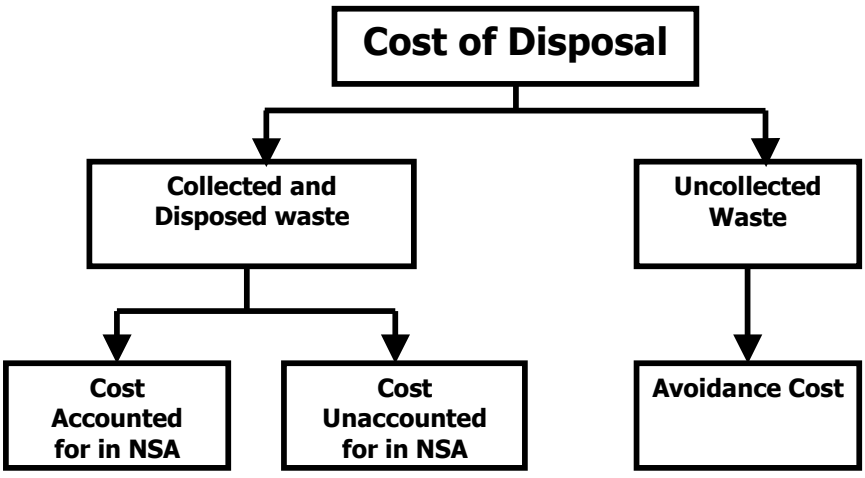
Figure2.5: Percentage of waste generated by sector, 2004-05



Souce: IRADe survey

The details of composition of waste, employment information and waste treatment and disposal facility are given in ANNEX 1.

2.12 Cost of collection of total waste generated in Goa.



2.12.1 Cost of collection (C_c):

The cost of collection of total waste generated in Goa can be calculated from the following derivation:

Let

Waste generated per day (tons) $= W_d$

Waste that can be collected by each worker per day (tons) = W_w

Salary of each worker per day (Rs.) = w

Waste generated per year (ton) = $W_d * 365 = W_a$

Number of bins used for collection = N_{bin}

Cost of each bin (Rs.) = C_{bin}

Life of a bin (years) = f

Discount rate = i

Annualised cost of bins (Rs.) = B

$$B = \frac{N_{bin} * C_{bin} * i}{1-(1+i)^{-f}}$$

Annual cost of collection (C_c) (Rs.) $$= \left(\frac{1}{W_w} * w\right) * W_a + B + misc.$$

Miscellaneous expenditure in Rs. per year includes cost of minor equipment, shovels, trolleys etc.

Estimation: based on five surveyed municipalities.

W_d (tons) = 103

W_w (tons) = 2.17013

w (Rs. million) = 0.000100694

Waste generated per year (tons) = 36711

Number of containers = 1350

Price per containers (Rs.) = 2000

Average life of a container = 4 years

Discount rate = 10 per cent

Annualised cost of containers (million Rs. /year) = 0.851769946

Misc. exp. (million Rs. /year) = 0.4204

Total cost of collection (million Rs. /year) = 2.97555464

The above derivation shows that the estimation of cost of collecting 36711 tonnes of solid waste in Goa is about Rs.3 million / year or Rs 82/tonne/yr.

2.12.2 Total Uncollected Waste

IRADe has done the estimates of industrial waste, construction waste, household waste, market places waste and solid waste from hotels in the survey. The actual amount of waste is more than

what has been estimated as our survey as it does not include the waste generated from hospital, offices etc. The total waste from the survey is more than the total municipal solid waste. Thus, we can infer that the uncollected waste (Uw) is total estimated waste (O) – total municipal waste reportedly collected (Mw).

Total uncollected waste is calculated as given below

Let,

Total Uncollected Waste = Uw[1]

Municipal Waste collection reported= Mw

Total Industrial Solid Waste = Iw

Total Construction Waste = Cw

Total Household Solid Waste = Hhw

Total Market places solid Waste = Mpw

Total Solid Waste from Hotels = Hw

Let O as the sum of different types of solid wastes.

O = Iw + Cw + Hhw + Mpw + Hw

Uw (Uncollected Waste) = O - Mw

Thus,

O = Σ4424+28374+230+7665+730 = 41423 tons/ year

Uw = 41423 - 36711 = 4712 tons/ year

Thus from the data available it is seen that 4712 tons / year of waste is uncollected. The disposal cost of this can be taken as avoidance cost to adjust for the accounts and this uncollected waste can be said as the environmental cost unaccounted for.

Economic Value of Land used for dumping waste

Total area of landfill sites	=	32040 sq.mt
Density of wastes	=	432 kg/cu.m
Landfill sites (annual inputs in tonnes)	=	25450 tonnes
Total cost of collection	=	Rs.3 million/year or Rs.82/tn/yr

[1] The data for uncollected waste from hospitals, offices and several commercial places is not available; the calculation here is based on survey of industrial, construction, household, market places and hotels.

Total Uncollected Waste Uw	=	4712 tn/year
Avoidance Cost of Uncollected wastes	=	4712*82 = Rs.390000/tn/yr.
Collected waste	=	1750*55500 = Rs.97 million
Uncollected waste	=	1750*8100 = Rs.14 million

Where, 1750 = Cost of land for disposal in Rs. / m^3

2.13 Summary

Goa is one of the best and first choice of tourist from India as well as from foreign countries. The visit of tourist generates income for locals of Goa and increases the economy of our country. This has led to increase in solid waste that is generated from hotels, market places and households. The waste generated from the hotels comprises of metals, paper/cardboard, food, plastic, glass, garden and others. The maximum solid waste generated is from the 5 star hotels and it is equal to 210 tonnes /yr. This shows that there is lot of waste generated from the hotels and five star hotels are contributing the most. The total cost of collection of waste generated by the hotels surveyed in IRADe survey in 2005 is Rs.19 million / year.

The survey for solid waste management was carried in three parts i.e., municipality, households and market place. The cost of land was assumed from the prevailing prices of the land in the market. The economic value of municipal land for disposal comes out to be Rs. 1750/m^3. The percentage of household waste generated per month in North Goa is 95Kg / Household and in South Goa it is 105kg / Household. The estimated total solid waste generated is about 1.3-lakh tn/year in Goa. The total cost of collection is Rs.3million/year or Rs. 82/tn/yr. The avoidance cost of uncollected waste is Rs 4 lakhs/tn/yr. The cost of uncollected waste is Rs.14 million. This shows that the uncollected waste which costs Rs.14 million and the avoidance cost is Rs 4 lakhs/tn/yr, serious steps needs to be taken for the better disposal and collection of the solid waste for better environment and economy of the Goa and country as a whole.

3 Air and Water Pollution

3.1 Introduction

Industries are growing at a fast pace in India. Industries also are potential contributors to the degradation of the environment leading to water pollution, air pollution, noise pollution and so on. Unplanned and uncontrolled industrial development leads to incompatible land use patterns thereby increasing the risks on the receiving environment.

The protection of the environment can be achieved by proper planning and management of various spatial entities viz. water resources, land, settlements, forests etc. in the most effective manner. As in many other parts of the country, developmental activities and human pressure, including tourism, have had an adverse impact on the environment of Goa. Like other states being affected by the rapid industrialization

Goa too now is at the stage of great concern for the environmental conservation. Several issues, which need to be looked upon, include Waste management, pollution of wells in villages, uncontrolled construction with little attention given to protect delicate ecosystem and many others. There seems lack of basic infrastructure for proper management and sustain the pressure of the massive flow of tourists every year.

Though Goa aspires to be a modern state in many ways. Unlike some specially protected states it has been a kind of open house to welcome for new industries and other developmental activities.

3.2 Different types of industries causing Air Pollution in Goa

3.2.1 Small-scale industries

During the year 2003-04 upto December 2003, 101 SSI units have been permanently registered with an investment of Rs. 696.10 lakh providing employment to 618 persons. In addition, 582 SSI units have been registered provisionally with an investment of Rs. 4109.20 lakh generating employment to 4588 persons. Trend in registration of small-scale units, employment generation and investment during the post-statehood period of Goa is given in **table 3.1.**

Table 3.1 SSI units registered in Goa: 1987-2002

S.No.	Year	SSI units registered	Employment generated	Fixed Investment (Rs. In Million)
1	1987-88	3271	22657	508
2	1988-89	3602	24438	603
3	1989-90	3924	26136	719
4	1990-91	4120	27328	807
5	1991-92	4344	28459	900
6	1992-93	4558	29672	999
7	1993-94	4787	30918	1126
8	1994-95	4995	32042	1224
9	1995-96	5118	33136	1344
10	1996-97	5278	34472	1576
11	1997-98	5488	36734	1842
12	1998-99	5765	39432	2191
13	1999-2000	5949	40797	2215
14	2000-01	6157	42312	2235
15	2001-02	6469	44222	2856
16	2002-03	6714	46163	3027

Source: Annual report, Goa State Pollution Control Board

3.2.2 Medium and large industries

The State has a High Powered Co-ordination Committee to accord permission for setting up of medium and large industries in the State. The Committee so far has cleared 345 industrial projects in Medium & Large Industrial sector. There are 154 Medium and Large Industries in the State with an investment of Rs. 2368.26 crore generating an employment to 22,560 persons. Pharmaceutical Industry has emerged as a major component in the industrial development of the State.

3.3 Important Industrial characteristics of Goa:

There are a total of 506 factories in Goa, which forms 0.4 % of total factories in India. 20740 people are employed in Goa as can be seen from Table 3.2. Total expenditure on fuels in Goa in the year 2002 – 03 was Rs. 40843 lakhs. Various other estimates of characteristics such as wages to workers, materials consumed, total inputs, value of output, net income, gross capital formation, profit and so on of Goa along with all India values are given in table 3.2.

Table 3.2: Estimates of some important characteristics for the year 2002-2003.

(Value figures in Rs. Lakhs, others in Number)

Characteristics	All India	Goa
1. Number Of Factories	127957	506
2. Fixed Capital	44475938	303001
3. Working Capital	10012110	67347
4. Invested Capital	63747308	427475
5. Outstanding Loans	26339233	164271
6. Number of Workers	6161493	20740
7. Total Persons Engaged	7935948	28727
8. Wages to Workers	2968905	13124
9. Total Emoluments	5515801	25462
10. Prov. Fund and Other Welfare Exp.	1318412	7332
11. Fuels Consumed	6657582	40843
12. Materials Consumed	70077245	489135
13. Total Inputs	91618549	645002
14. Products & By-products	100128587	718715
15. Value of Output	113056111	833137
16. Depreciation	4203558	27985
17. Net Value Added	17234004	160150
18. Rent Paid	379356	3033
19. Interest Paid	3835182	23082
20. Rent Received	83324	950
21. Interest Received	260313	1063
22. Net Income	13019466	134035
23. Net Fixed Capital Formation	541866	40582
24. Gross Fixed Capital Formation	4745424	68567
25. Addition in Stock of		
(a) Materials,Fuels etc.	1087077	1835
(b) Semi-Finished Goods	229669	1730
(c) Finished Goods	335468	-9911
(d) Total	1652214	-6346
26. Gross Capital Formation	6397638	62220
27. Profits	6185254	101241

Source: Annual survey of industries 2002 - 03

3.4 AIR POLLUTION IN GOA

The 18 industrial estates, from Pernem in the north to Madcaim in the heart of Goa, and down to Canacona in the South, have led to a severe pollution in the last few years. The metallurgical units and the steel rolling mills at Kundaim plateau emit voluminous fumes, as scrap iron is openly melted in blast furnaces. The carbon dioxide fumes generated during the production is a threat to the temple towns of Mardol, Mangueshi and Kundaim. The Tapobhumi temple complex is in the windward direction of the Kundil steel rolling mill directly affected by the acid rains generated by the heavy smog produced by the carbon dioxide and the sulphur dioxide fumes of the plant. The steel units around Pernem have polluted the atmosphere in that region. Likewise, the industrial estates in Cuncolim and Madcaim had led to many health hazards to the local villagers.

Table 3.5 shows State-wise distribution of industrial units according to their air pollution control status as reported by the SPCBs. The table indicates that Goa has 18 air polluting units and has 100% of units with air pollution control measures and with satisfying standards**.** It has 7 High polluting units and all of them (100%) have satisfying standards.

Table 3.5: State-wise distribution of industrial units according to their air pollution control status

State	Number of air polluting units	% Units with APC meas-ures	% of units satisfying standards	Num-ber of HPUs	Number of HPUs with facilities to satisfy standards
1	**5**	**6**	**7**	**8**	**9**
Andhra Pradesh	2520	79.84	79.84	220	96.36
Assam	86	38.57	32.56	15	60
Bihar	1386	40.55	40.55	40	82.5
Goa	**18**	**100**	**100**	**7**	**100**
Gujarat	5757	59.74	54.87	200	95
Haryana	1513	74.88	26.76	2580	40.19
Himachal Pradesh	983	74.67	74.67	12	50
Karnataka	6902	59.79	46.33	113	91.15
Kerala	1528	62.04	24.41	24	91.67
Madhya Pradesh	526	58.63	68.63	88	98.86
Maharashtra	7008	72.6	58.86	318	95.59
Manipur	26	100	100	4	*
Meghalaya	81	14.81	0	1	100
Punjab	8299	17.62	17.62	51	76.47
Rajasthan	430	91	*	49	97.95
Tamil Nadu	6998	86.12	*	188	98.4
Uttar Pradesh	281	90.75	80.07	627	83.41

West Bengal	6188	*	*	64	81.25

* Not specified by the SPCB Source: http://envfor.nic.in/cpcb/hpcreport/vol3h.htm

3.5. A brief outline of the Survey Design, Survey Plan and the Questionnaires

Very limited information is available regarding industrial water and air pollution in Goa. There are also very limited studies that deal with economic issues concerning industrial pollution on the environment. This makes it difficult to understand natural resource accounting of industrial pollution. Thus, an intensive survey of various large, medium and small-scale industries is being conducted to gain an insight on the pollution load of such industries on the environment. Both North and South Goa are being covered by the survey to get an overall picture of the state.

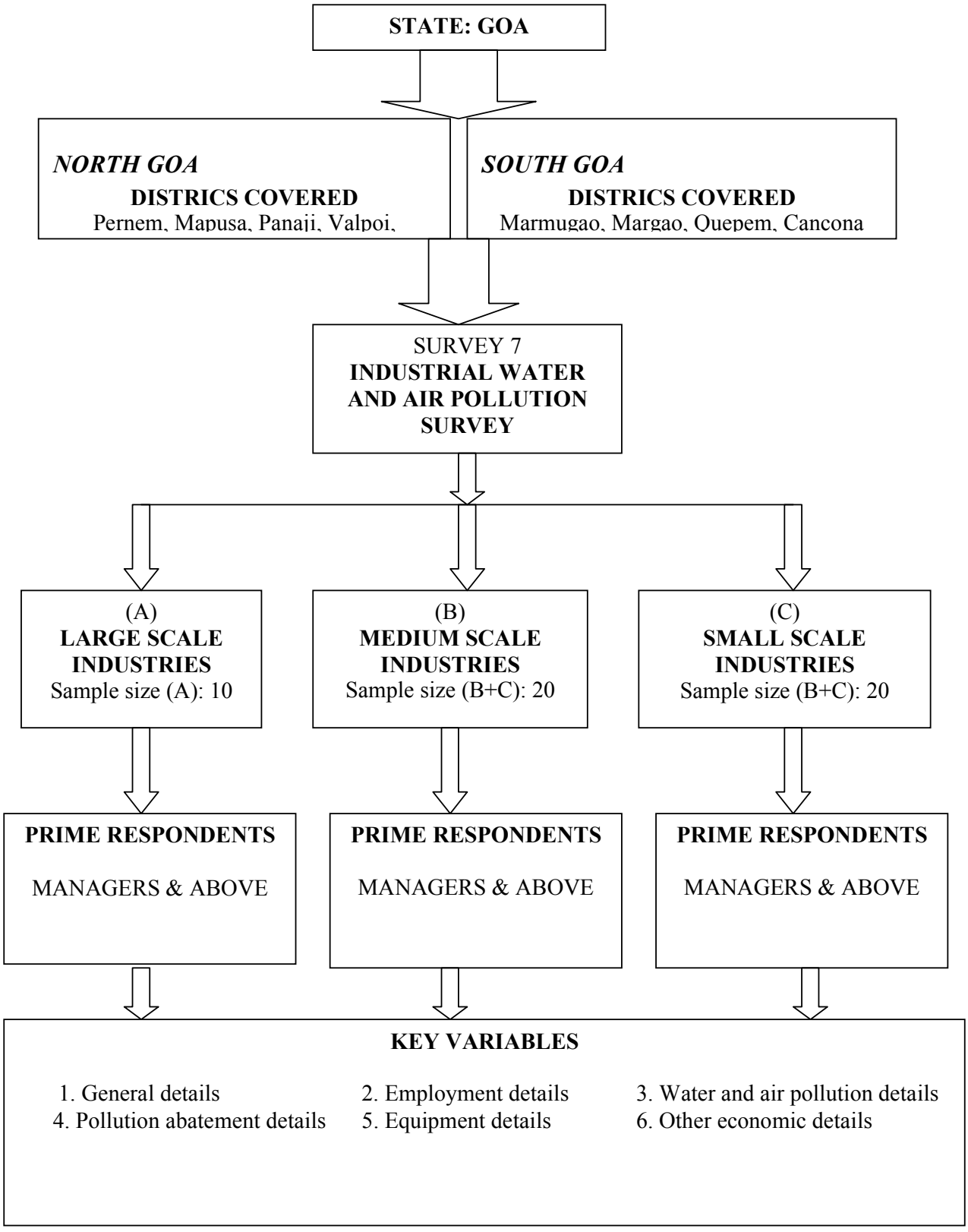
The target population of the survey is large scale, medium scale and small-scale industries. The prime respondents are managers of the industries. 31 industries are being covered by the survey. 11 out of the 17 categories of polluting industries defined by Central Pollution Control Board are being covered by the survey.

Information on general details of the firm, employment information, water pollution details, water pollution abatement details, air pollution details, air pollution abatement details, expenditure on pollution abatement, expenditure on maintenance of equipments and so on are some of the information gathered by the survey.

3.6 Survey Design

Thus the survey aims to bring out comprehensive data on the various environmental and economic aspects of water and air pollution from industries in Goa. Data-set is generated by means of survey at of three types of industries viz., large scale, medium scale and small-scale industries to get a larger picture of pollution load from industries and their economic valuation. The data is collected from North Goa and South Goa to get an overall view of the whole state. In all 31 industries are being covered by the survey. The survey questionnaire for the industrial water and air pollution sector is given in the Annexure. Figure 1 shows the survey design for collection of data from various industries.

Figure 1 Survey Design: Natural Resource Accounting of Industrial Air & Water pollution sector in Goa



3.7 Methodology

In India environmental management is largely carried out at the state level. This is true for natural resources such as forests and land as well as for air, water quality and solid waste pollution. Therefore, the focus of efforts to improve environmental stewardship has to be at the state level.

The methodology implemented here uses state-level data from Goa to calculate pollution intensity, pollution load and cost of pollution abatement of air pollution. **The steps used are briefly described here:**

(i) The first step is to estimate the pollution load for each firm and industrial sector. Since actual information of this nature does not exist, it is estimated by using data on pollution intensities (effluent/emission per unit of output) from the World Bank Industrial Pollution Projection System (IPPS) database. Industrial output data by sector is collected from the official Annual Survey of Industry (ASI) in India. Note pollution intensities are given by sector and thus assume that all firms within a sector are identical.

(ii) Next, calculate the cost of pollution abatement_using estimates of average abatement cost expressed in terms of US$ (1993 prices) per ton of pollutant reduced from the same World Bank IPPS database. We convert this to 2000 - 01 rupees/ton (Table 7). These costs, however, are reported only at the sectoral level and are constant. In other words, for each sector there is only one cost figure

3.8 Application of Methodology to State level data of Goa

As an illustration of the methodology outlined above we focus on 17 "highly polluting" industrial sectors identified by the Central Pollution Control Board (CPCB). These sectors appear to be the focus of regulatory attention and are regularly highlighted in the annual reports of CPCB and on its website. Most state pollution control boards (SPCBs) also take their cue from CPCB in focusing on these sectors. These sectors are also major industrial sectors in terms of share of output and employment. They are: (1) aluminum smelting; (2) basic drugs and pharmaceuticals; (3) caustic soda; (4) cement; (5) copper smelting; (6) distillery; (7) dyes and dye intermediates; (8) fertilizer; (9) integrated iron and steel; (10) leather; (11) oil refineries; (12) pesticide (13) petrochemical; (14) paper and pulp; (15) sugar; (16) thermal power plants, and (17) zinc smelting.

Some of the categories (e.g., "leather", "sugar") are quite general and need to be described further in terms of specific processes that generate pollution. In other words, in order to use

output data from ASI 2000-01 in conjunction with pollution coefficients from IPPS, it is necessary to translate the broad CPCB categories into specific sectors using industrial classification systems. This issue is discussed further below.

As stated earlier, emissions/effluent data is not gathered on a regular basis for most industries in India at the national or state level (only ambient air and water quality are monitored on a regular basis). SPCBs typically classify industries into broad categories based on their potential to pollute. The objective is to subject units in the former category to more frequent monitoring and inspection than those in the latter. There is, however, no regular data collection of emission/effluent discharge for units in either category.

Thus, the *first step is to estimate the pollution load* for these 17 sectors by using the Industrial Pollution Projection System (IPPS) developed at the World Bank. IPPS exploits the fact that industrial pollution is highly affected by the scale of industrial activity and its sectoral composition. It operates through sector estimates of pollution intensity (usually defined as pollution load per unit of output or pollution load per unit of employment). Results from IPPS have been used in various countries where insufficient data on industrial pollution proved to be an impediment to setting up pollution control strategies and prioritization of activities, for example, Brazil, Latvia, Mexico and Vietnam. The IPPS methodology has also been used in published research such as Cole et al. (1998), Vukina et al. (1999) and Reinert and Roland-Holst (2001 a, 2001b).

Thus, sectoral estimates of pollution intensity from IPPS are applied to data on value of output for the polluting sectors identified by CPCB. This enables estimation of the pollution load at the state level for air pollutants such as NO_2, SO_2 and particulate matter. In doing so, one has to first map the broad categories defined by CPCB (e.g., leather, sugar) into specific industrial activities by ISIC codes (e.g., ISIC 3231--tanneries and leather finishing or ISIC 3118- sugar factories and refineries) that are typically used to measure output, value added, employment, etc. Such a mapping is required to make the CPCB categories consistent with IPPS pollution intensities and marginal abatement costs (MACs) that are reported by ISIC. Table 3.6 presents data on value of output for 10 CPCB polluting industries and their corresponding ISIC codes for Goa state.

Table 3.6 Value of output for 10 polluting industrial sectors of Goa

CPCB category	ISIC	Three digit NIC description	Value of output GOA (In rupees thousands)
Aluminium smelter	3720	273	38660
Basic drugs and Pharmaceuticals	3522	242	1857920
Cement	3692	269	26480
Distilleries	3131	155	192210
Fertiliser	3512	241	1612250
Iron and Steel	3710	271	550050
Oil Refineries	3530	232	198850
Pesticides	3512	242	1857920
Pulp and Paper	3411	210	10280
Sugar	3118	154	264380

Value of output data for the 10 industries is taken from the Annual Survey of Industries (ASI) 2000-01. ASI is the principal source of industrial statistics in India. IPPS pollution intensities for 3 air pollutants (NO_2, SO_2 and TSP) for the year 2000 – 01 are given in Table 3.7, whereas estimated pollution loads for these pollutants for Goa is given in Table 3.8 . Annex 2 shows the calculations used for arriving at the pollution load using IPPS and ASI data.

Table 3.7 IPPS pollution intensities for air pollutants kg/thousand rupee (2000 - 01)

CPCB category	ISIC	Three digit NIC description	Pollution intensity for Air		
			SO_2	NO_2	TSP
Aluminium smelter	3720	273	0.384	0.013	0.032
Basic drugs and Pharmaceuticals	3522	242	0.018	0.008	0.003
Cement	3692	269	1.278	0.593	0.618
Distilleries	3131	155	0.039	0.013	0.003
Fertiliser	3512	241	0.011	0.011	0.003
Iron and Steel	3710	271	0.177	0.077	0.041
Oil Refineries	3530	232	0.126	0.072	0.011
Pesticides	3512	242	0.011	0.011	0.003
Pulp and Paper	3411	210	0.254	0.133	0.050
Sugar	3118	154	0.064	0.061	0.042

Table 3.8 Estimated pollution load of Goa in kilograms for the year 2000 - 01

CPCB category	ISIC	Three digit NIC description	Value of output Goa 2000 - 01 (In rupees thousands)	Pollution load of air pollutants of Goa (2000 - 01) in kgs.		
				SO_2	NO_2	TSP
Aluminium smelter	3720	273	38660	14834.3	483.2	1245.9
Basic drugs and Pharmaceuticals	3522	242	1857920	33666.0	14296.5	6364.2
Cement	3692	269	26480.0	33834.3	15709.6	16363.4
Distilleries	3131	155	192210.0	7418.0	2578.3	620.3
Fertiliser	3512	241	1612250.0	17704.7	17048.4	4914.4
Iron and Steel	3710	271	550050.0	97578.8	42385.9	22610.2
Oil Refineries	3530	232	198850.0	25003.4	14383.24	2205.365
Pesticides	3512	242	1857920.0	20402.5	19646.2	5663.3
Pulp and Paper	3411	210	10280.0	2611.4	1362.5	513.2
Sugar	3118	154	264380.0	16873.5	16198.9	11177.3

The pollution load of the Iron & Steel sector is the maximum for all the air pollutants as can be seen from Table 3.8. On comparison the pollution load of SO_2 is found to be highest amongst the three air pollutants with Iron & Steel industry contributing the most SO_2 pollution load.

The next step is to use estimates of average abatement cost, that is, the amount of rupees required to reduce pollution load by a ton for each of the above pollutants for the 10 polluting sectors. These estimates again are from the World Bank IPPS database since this information is not yet available for India by sector and pollutant. The calculations used for arriving at the pollution abatement cost using IPPS data and pollution load is given in Annex 2. Table 3.9 shows the average abatement cost of air pollutants of 10 polluting sectors of Goa for the year 2000 – 01.

Table 3.9 Average pollution abatement cost for air pollutants of Goa in Rupees (2000 - 01)

CPCB category	ISIC	Three digit NIC description	Average pollution abatement cost for air pollutants of Goa (2000 - 01) in Thousand Rupees		
			SO_2	NO_2	TSP
Aluminium smelter	3720	273	88055.5	2215.9	9758.5
Basic drugs and Pharmaceuticals	3522	242	1734547.9	396712.1	65103.7
Cement	3692	269	18709.0	203916.2	8356.3
Distilleries	3131	155	181366.8	300043.8	4296.8
Fertiliser	3512	241	127900.1	341842.2	13319.3
Iron and Steel	3710	271	155932.8	176494.9	149002.9
Oil Refineries	3530	232	184440.6	37117.6	2035.3
Pesticides	3512	242	147389.2	393931.1	15348.9
Pulp and Paper	3411	210	10893.6	7291.3	821.1
Sugar	3118	154	155675.7	210267.8	25239.2
Total			**2804912**	**2069833**	**293283**

Table 3.9 shows that average abatement cost of pollutants is much higher for SO_2 as compared to NO_2 and TSP. The abatement cost is maximum for Basic drugs and Pharmaceutical for abatement of each ton of SO_2, closely followed by Oil refineries sector.

3.9 Transport Sector:

The transport system is categorized into two modes including mechanized and non-mechanized. The mechanized form of transport includes road transport, water, ship, aviation and railways. The non-mechanized transport is **cycle, bullock carts, horse carts etc.** as far as Goa is concerned, all the towns and villages are well connected by efficient and sufficient mode of transport. The total no. of vehicles in Goa is 3.36 lakhs (Table 3.10). Motorcycles and Scooters contribute the most and the figure is 2.38 lakhs. The no. of Government vehicle is 3,392.

Methodology:

Following methodologies were developed in preparation of Energy consumption and Emissions for transport sector in Goa:

Energy Demand

$$Fkt = Sjk \times Ek$$

F= Demand of fuel

k= type of fuel

t= year

j= type of vehicle

S= percentage share of vehicle

E=Energy intensity

Total Emission:

$$Ek = \Sigma Vpi * \Sigma eipk$$

Where,

Vi = No. of vehicles of type i

$eipk$ = Emission of pollutant k per vehicle type i with vintage period p

Ek = Total emission of k pollutant

Vi= where i = 1=Cars and jeeps	&	k	=	1	= CO
2= Two wheelers		2	=	HC	
3= Three wheelers		3	=	NOx	
		4	=	SO_2	
		5	=	Particulates	

6 = Pb

Table 3.10: Vehicles in Goa State as on 31-3-2001

Type of Vehicle	**No. of Vehicles**
Motor Cycles on hire	4,913
Motor Cycles and Scooters	2,38,740
Private Cars and Jeeps	53,569
Taxis	6,788
Goods Vehicles	21,592
Buses/Mini Buses	3,175
Auto rickshaws	3,061
Government Vehicles	3,392
Total	3,35,230

Source: www.southgoa.nic.in

Table 3.11: Emission Factors by vehicle type (gm/km)

Type of Vehicle	Year	CO	HC	NOx	SO_2	Particulates	Pb
Cars & jeeps	Upto 1991	25	5.00	5.00	0.053	-	0.030
	1991-94	19.8	2.73	2.00	0.053	-	0.030
	1994-95	19.8	2.73	2.00	0.053	-	0.008
	1995-99	6.45	1.14	1.14	0.053	-	0.003
	1999-2000	3.16	0.56	0.56	0.053	-	0.003
	2000-05	2.2	0.25	0.25	0.053	-	0.003
Two wheelers	Upto 1991	8.30	5.18	0.1	0.023	-	0.008
	1991-94	6.49	4.5	0.1	0.023	-	0.008
	1994-96	6.49	4.5	0.1	0.023	-	0.002
	1996-2000	5.00	4.32	0.1	0.023	-	0.002
	2000-2005	2.4	2.4	0.1	0.023	-	0.0002
Three wheelers	Upto 1991	12.0	7.0	0.26	0.029	-	0.019
	1991-94	12.0	7.0	0.26	0.029	-	0.019
	1994-95	12.0	7.0	0.26	0.029	-	0.005
	1996-2000	8.1	6.48	0.26	0.029	-	0.005
	2000-2005	4.8	2.4	0.26	0.029	-	0.0004
Commercial	Upto 1991	12.7	2.1	21.0	1.5	3	-
	1991-96	12.7	2.1	21.0	1.5	3	-
	1996-2000	9.96	1.44	16.8	0.75	2.4	-
	2000-2005	5.35	0.66	9.34	0.37	2.4	-

Source: Indian Institute of Petroleum (IIP) and Automotive Research Association of India (ARAI)

Type of Vehicle	Number of vehicles (2001)	CO	HC	NOx	SO_2	Particulates	Pb
Cars & jeeps	53,569	0.3455	0.0610	0.0610	0.0028	-	0.00016
Two wheelers	2,43,653	1.2182	1.0525	0.0243	0.0056	-	0.00048
Three wheelers	3061	0.0247	0.0198	0.0007	0.00008	-	0.000015

3.10 Energy and Emission Accounts: Domestic Sector (Household Air Pollution)

Table 3.12: Estimated emissions from various vehicles (in Tonnes, 1996-99)

Energy and Emission Accounts:

The following methodology has been used for the estimation of energy & emission for the domestic sector of Goa.

Methodology:

$$E_{ip} = Z_i \times \boldsymbol{e}_i \times Y_i \times T$$

Where, E_{ip} = Total emission of pollutant p from fuel type i
Z_i = Per capita annual consumption of fuel i
$\boldsymbol{e}_i$ = Emission factors of pollutant i
Y_i = Percentage of population using fuel i
T = Total population

i = 1= Electricity
2= L.P.G.
3= Fire-wood
4= Kerosene

p= 1= CO
2= SO_2
3= NO_2
4= HC
5= SMP

Table 3.13: Per capita Energy Consumption of different fuels in Goa.

Fuel	***Per capita monthly consumption(2001)***
Firewood (Kg)	7.03
LPG (Kg)	10.7
Kerosene (liter)	2.46

Source: NSSO, 1999-2000. National Sample Survey Organization, Department of Statistic, GOI

Table 3.14: Emission Factors for Fuels (gm/kg) [2]

Fuel	*CO*	*TSP*	*SO_2*
L.P.G.	14.9	0.5	
Fire Wood	66.5	1.0	
Cow-dung	61.4	0.6	
Coke/lignite	20.0		17.0
Charcoal	275.1	2.4	
Kerosene (pressure stove)	62.1	0.7	
Kerosene (wick stove)	17.7	0.5	

Source: TERI, 2000,

Table 3.15: Household using different types of fuel for cooking in Goa

Type of Fuel	*Total*	*%*
Firewood	94,800	34%
Kerosene	33,167	11.9
LPG	145,453	52.1

Source: Census of India 2001

The table below gives the annual consumption of different types of fuel and emission of CO and TSP.The total annual consumption of LPG, Kerosene and Firewood is 12140850 tonnes.

The annual emission of CO is 887428188 tonnes and TSP is 13321349 tonnes.

Table3.16: Emissions from different types of fuel in Domestic sector in Goa

Types of Fuel	Total annual Consumption (tonnes)	Total Emissions (tonnes)	
		CO	TSP
LPG	33546	550977	18489
Kerosene	130508	8933705	100702
Firewood	11976796	877943506	13202158
Total	**12140850**	**887428188**	**13321349**

3.11 WATER POLLUTION IN GOA

Rapid industrialisation, tourism and resource overuse, have had an adverse impact on the environment of Goa. Industrial effluent, mining, agro chemicals, domestic waste, etc. have polluted the water. The two main rivers Mandovi and Zuari, which drain 69 per cent of the state area now harbour on their banks 50 per cent of the population and a large number of industries leading to the pollution of these rivers. The Tiracol River and the sea in the vicinity are often found contaminated with the effluent discharges of the iron processing plants.

Different sources of inputs of polluted water into these streams from various sources viz. industries, municipalities, hotels, open land etc. which drain into it ultimately tends to increase the level of different parameters such temperature, pH, Conductivity, BOD, COD, Total Coliform and many other inorganic and organic constituents. Though the effluent water discharged from Industries, hotels and municipalities may be complying with the set standard of permissible limit at the point of their discharge (which is evident from the fact that all the 32 polluting units in Goa have 100 percent efficient Effluent Treatment Plant), but where accumulated in water bodies it may be sufficient enough to harm the aquatic flora and fauna and even unfit for human use. Goa has 32 water polluting units and all of these units have Effluent Treatment Plant (ETP) and all the units are with 100% satisfying standards**.** If we look upon the data of these two rivers (Mandovi & Zuari) year 2002-2003 as stated by Goa State Pollution Control Board-Table 4.3(a) & 4.3(b), it is evident that some of the parameters have been significantly high during some of monitoring period at different stretch of the stream. Total dissolved solids and concentration of Chloride in both the rivers were found to be above the prescribed limits in the period April, May, November, and December in the year 2002 and during January 2003. Which indicates one of the possibilities and aspect of getting accumulation and thus increasing the level while most of the parameters such as pH, BOD and COD were below the permissible limit during all monitoring periods in both of the rivers.

Table 3.17 shows the length of river in Goa that is polluted with respect to BOD as an indicator. According to water quality status with respect to BOD (Annex Table A4.1), river water in Goa is not severely polluted, although almost 13 km is moderately polluted. Most of the stretch (53 km) is relatively clean. This shows that the extent of water pollution is not very severe in Goa and timely intervention can prevent the remaining clean water from getting polluted.

Table 3.17 Riverine length (in Km) under different level of pollution in Goa

	Biological Oxygen Demand, mg / L			
State	**> 6**	**3 – 6**	**< 3**	**Total**
Goa	0	13	53	66

Source: Central Pollution Control Board

Table 4.3(a): **Data of River Mandovi at Tonca-Marcela-2002-2003**

Parameters	*Maximum Permissible limit for Receiving body		Data of River Mandovi at Tonca-Marcela-2002-2003											
	Inland surface waters	Land for irrigation	April 2002	May 2002	June 2002	July 2002	August 2002	Sept. 2002	Oct. 2002	Nov. 2002	Dec. 2002	Jan. 2003	Feb. 2003	March 2003
pH	6.0 – 9.0	6.0 – 9.0	7.4	7.7	7	6.9	7.9	7.1	7.1	7	7.1	7.4	7.5	7.2
BOD, at 20° C, mg / L	30	100	3.4	4	1.6	1	1	2	2.5	2	3.6	7.5	3	3
COD, mg / L	250	-	28	13	4	4	0	6	6	8	28	7	-	-
Total dissolved solids, mg / L	2100	2100	26060	27160	126	28	6	732	1368	8428	14632	16820	-	-
Total Chromium, as Cr, mg / L	2.0	2.0	-	-	-	-	-	-	-	-	-	-	-	-
Chlorides, mg / L	1000	600	16855	17388	131	25	23	490	827	5318	8939	10998	-	-

***BIS Standards (BIS: 2490 – Part 3 - 1985)**

Table 4.3(b): Data of River Zuari at Panchwadi-2002-2003

Parameters	*Maximum Permissible limit for Receiving body		Data of River Zuari at Panchwadi -2002-2003											
	Inland surface waters	Land for irrigation	April 2002	May 2002	June 2002	July 2002	August 2002	Sept. 2002	Oct. 2002	Nov. 2002	Dec. 2002	Jan. 2003	Feb. 2003	March 2003
pH	6.0 – 9.0	6.0 – 9.0	7.1	-	7	6.8	7.8	7	7.3	6.8	7	7	7	7.1
BOD, at 20º C, mg / L	30	100	1	-	1	1	1.6	3	1	1	3	3	3	2
COD, mg / L	250	-	9	-	4	4	0	6	6	8	28	7	-	-
Total dissolved solids, mg / L	2100	2100	9028	-	30	24	2	30	156	3230	1330	1964	-	-
Total Chromium, as Cr, mg / L	2.0	2.0	-	-	-	-	-	-	-	-	-	-	-	-
Chlorides, mg / L	1000	600	6028	-	55	21	11	75	82	1938	3543	1257	-	-

*BIS Standards (BIS: 2490 – Part 3 - 1985)

Table 4.4 gives the status of pollution control in water polluting units in various states as reported by the SPCBs. It may be seen from the table that Goa has 32 water polluting units. All of these units i.e., 100% have Effluent Treatment Plant (ETP) and all the units (100%) have satisfying standards. Thus we can infer that there is no water pollution in Goa because of these 32 water polluting units/industries. (Source: Evaluation Study on Functioning of State Pollution Control Boards Prepared by Programme Evaluation Organisation, Planning Commission, Government of India, New Delhi. Web:
http://envfor.nic.in/cpcb/hpcreport/vol3h.htm)

Table 4.4: State-wise distribution of industrial units according to their water pollution control status

State	Number of water polluting units	% of units with ETP	% of units satisfying standards
1	**2**	**3**	**4**
Andhra Pradesh	2820	90.85	90.85
Assam	95	30.52	13.68
Bihar	116	70.69	29.31
Goa	**32**	**100**	**100**
Gujarat	8098	52.72	32.16
Haryana	2580	63.49	53.72
Himachal Pradesh	975	77.54	28.82
Karnataka	8015	59.5	57.83
Kerala	2250	51.95	35.6
Madhya Pradesh	526	78.9	*
Maharashtra	7169	86.29	62.29
Manipur	0	0	0
Meghalaya	14	14.29	0
Punjab	3280	49.72	49.72
Rajasthan	692	80.6	*
Tamil Nadu	6338	41.23	*
Uttar Pradesh	454	81.94	48.9
West Bengal	62	96.77	59.68

*not specified by the SPCB
Source: http://envfor.nic.in/cpcb/hpcreport/vol3h.htm

3.12 Water Pollution Abatement Cost

The Determinants of Abatement Costs

Traditionally, abatement cost estimates have been based on plants' reported direct costs of installing and operating pollution control equipment. Coupled with information about the benefits of reducing pollution, such cost estimates can provide a basis for setting realistic

regulatory standards. Until recently, the scarcity of appropriate plant-level data has prevented detailed empirical studies of average and marginal abatement costs by pollutant.

Firms can adjust to the threat of higher pollution-related costs along many dimensions, including new process technology, pollution control equipment, improved efficiency, and allocation of more resources to legal representation or negotiation. At the plant level, all these options will register as changes in the scale and mix of inputs and, consequently, total production costs. In this study, we focus on direct abatement costs.

3.13 The Direct Abatement Cost Function

Industrial facilities can abate pollution by scaling back polluting activities or by diverting resources to cleanup. In either case, pollution reduction will entail costs. Conceptually, abatement cost functions are dual to abatement functions which relate inputs of capital, labor, energy and materials to pollution reduction. Abatement processes frequently reduce more than one air or water pollutant, so joint cost function estimation is appropriate. For example, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Suspended Solids (SS) can all be reduced by treatment in common facilities. These joint equipment requirements are associated with common use of skilled and unskilled labor, energy and materials.

Cost Function Specification

For k pollutants, the environmental engineering literature suggests that an appropriate joint cost function for plant i should include the following variables:

Ci = f (Wi, Ei / Ii, Mj, Xi)

Where

Cj: Total annual cost of abatement for the plant

Wj: Total annual wastewater volume

Ei, /I: Vector of effluent/influent ratios for n pollutants, which can be interpreted either as concentration ratios or volume ratios (since waste water volume is constant across influent and effluent for each plant, it cancels out of the concentration ratio).

Mj: Vector of input prices at location j

Xi: Vector of relevant plant characteristics (sector, age, ownership, productive, efficiency, etc.)

However, due to lack of appropriate data we are not able to calculate the total annual cost of abatement for the plant.

3.14 Summary

Goa has total of 506 factories, which forms 0.4% of total factories in India and employing 20,740 people. The total expenditure on fuels in Goa in the year 2002-03 was Rs.40843 lakhs. The focus is on seventeen "high polluting" industrial sectors as identified by the Central Pollution Control Board (CPCB) for implementation of pollution control programs. The results from IPPS have been used in various countries where insufficient data on industrial pollution proved to be an impediment to setting up pollution control strategies and prioritization of activities. Value of output for ten polluting industrial sectors of Goa is Rs. 65,70,340 (thousands). The pollution load of SO_2 is found to be highest amongst the three air pollutants with iron & steel industry contributing the most SO_2 pollution load i.e., 97579 tonnes/yr. The abatement cost is Rs.1734548 (thousands), maximum for Basic drugs and Pharmaceutical for abatement of each ton of SO_2.

4

Forest Resource Accounting Goa

4.1 INTRODUCTION

The major objective of the chapter is "To *develop a framework for economic and environmental resource accounting of Forest in the states of Goa (physical and monetary terms)* ". In carrying forward this key objective the report has sought to Study the Forest resource accounting for state of Goa in India using the Satellite System of Integrated Environmental and Economic Accounting framework (SEEA). In this study only the forest trees in the natural forests are considered and hence, the forest resources are treated as non-produced assets and no distinction is made between economic and environmental assets.

The state is one of the few states in India having 58.24% of the geographical area as forest including mangroves with high eco-tourism value. Of the total geographic area of 3702 km^2; the area under forest is 2,156 km^2. Out of the total forest area 1255 km^2 is moderately dense forest and 901 km^2 is open forest. The state has five different types of forests.

Forests contribute to the economy in several ways. While forests are a source of timber with market values, they also influence local and regional climate, preserve soil cover on site, and in the case of watersheds, protect soil downstream from floods – functions, which are not in the production boundary of SNA. Further, the net value added in forestry sector does not reflect sustainability of forest resources, because it ignores the consumption of natural capital (depletion) that occurs when forests are harvested or converted to other uses. The only costs of depletion considered in the national accounts are the extraction costs and records the potential loss in forest wealth as other changes in assets that have no effect on Gross Domestic Product (GDP).

4.1.1 SCOPE AND OBJECTIVES

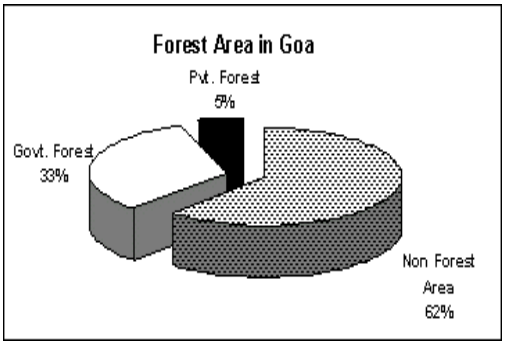
The report deals with economic and environmental accounting of forests, by and large in accordance with the UN System of Economic and Environmental Accounting, (SEEA 2003). It provides a methodological framework to construct asset accounts and flow accounts of goods and services from the forests. Consequently the analytical study has endeavoured to generate primary level data regarding values of household consumption of goods and services provided by forests and land in the study area, especially those which

are non-marketed. Efforts have been made to quantify value of forest amenities flowing to the economy. The primary effort has been to capture the change in resource usage and values and quantity/quality changes (degradation/ up-gradation) since last ten years.

The main objective of the study is to construct asset and flow accounts for the forest assets based on framework provided by Verma (2005) and Haripriya et. al (2005). More specifically, the major output of the study comprises of various resource accounting tables and values of various functions rendered by the forests of Goa.

4.2 GOA FOREST PROFILE

a) Extent of Forests in Goa



Out of the total geographical area of 3702 sq km of the state about 2156 sq km constitutes forest i.e. 0.16% of country's forest area. Of this 1224 sq km has been the classified as government forest (33%) and the rest private forests.

Geographical Area (sq. km.)	**3702.00**
Forest Cover (sq. km.)	**2156.00**
Tree Cover (sq. km.)	**136.00**
Per Capita Forest & Tree Cover	**0.17 ha**

b) *Extent of Government Forests in Goa*

Of the total forest area of 2156 sq. km., 56.77% is government forest and 43.23% is private forest. Goa is one of the few states of India where private forest is also found. The following table provides the details of Government forest area by legal status.

Table 4.1: Government Forest Area by Legal Status

S.No.	Details	Area
1.	Reserve Forest (sq. km.) u/s 20 of Indian Forest Act 1937	236.82 sq km
2.	Proposed Reserved Forest (sq. km.) Under section 4 of Indian Forest Act 1937	722.63

3.	Unclassed forest (sq. km.) declared under section 18 of Wildlife (Protection) Act	137.11
4.	Unclassed forest (sq. km.) identified for section 4 notification	96.21
5.	Balance Unclassed forest areas (sq. km.)	31.69
6.	**Total**	**1224.46**

Source: Department of Forest, Govt. of Goa, 2005

c) District-Wise Forest Cover in Goa (2003)

There are two districts in the state. District and Taluka wise extent of dense and open forest is furnished in Table 4.1.

Table 4.2: District wise extent of Forest cover in Goa

Districts	**Geographic Area**	**Forest Cover (Area in Km^2)**			
		Moderately Dense Forest	**Open Forest**	**Total**	**Percent**
North Goa	1,736	432	456	888	51.15
South Goa	1,966	823	445	1268	64.50
Total	**3702**	**1255**	**901**	**2156**	**58.24**

Source: State of Forest Report 2003, Forest Survey of India, Ministry of Environment and Forest.

d) Taluka-wise Forest Area in Goa (During 1999-2003)

South Goa has only one taluka whereas 10 talukas are in North Goa. The following table provides details of the same.

Table 4.3 Taluka-wise Forest Area in Goa (During 1999-2003)

Taluka	**Geographical Area in Hectares**	**% of Forest Area to Geographical Area**
Salcete - S.Goa	27719	-
Goa (Tiswadi) - N.Goa	16612	
Bardez - N.Goa	26480	-
Mormugao - South Goa	7831	-
Ponda - North Goa	25228	11.62
Bicholim - North Goa	23633	3.03
Pernem - N.Goa	24200	5.45

Quepem - S.Goa	43731	33.63
Sanguem - S.Goa	88660	56.48
Canacona - S.Goa	34736	41.25
Satari - N.Goa	51248	47.29

Source: Department of Forest, Govt. of Goa, 2005

e) Types of forests found in GOA

The forests of Goa are typical of the Western Ghats forest (Southern Maharashtra and Karnataka). There is diversity in the forests due to the variation in altitude, aspect, soil characters, slope etc. As per Champion and Seth (1968) Classification of Forest types of India, the forests of Goa fall in the following types:-

- Estuarine vegetation consisting of mangrove species along narrow muddy banks of rivers
- Strand vegetation along the coastal belts
- Plateau vegetation confined especially to the low altitude
- Open scrub jungle
- Moist mixed deciduous forests
- Secondary moist mixed deciduous Forest
- Sub-tropical Hill forests.
- Semi-evergreen and evergreen forest limited to patches along the high altitude
- Lateritic Semi-evergreen forests
- Evergreen forests

f) Biodiversity of Goa Forest

The flora and fauna of Goa is considerably rich in biodiversity. 33% of the geographic area is under government forests of which about 62% has been brought under Protected Areas (PA) of Wildlife Sanctuaries and National Park – is owned by the Government and is located in the interior eastern regions of the state. The Western Ghats, which form most of eastern Goa, have been internationally recognised as one of the biodiversity hotspots of the world. The flora and fauna of Goa is so incredible that in the February 1999 issue of National Geographic Magazine, Goa was compared with the Amazon and Congo basins for its rich tropical biodiversity.

The rich flora of Goa comprise of bamboo canes, chillar barks, maratha barks, bhirand. Coconut trees are ubiquitous and are present in almost all areas of Goa barring the elevated

regions. Most of the forest products come from coconut trees. The flora and fauna of Goa include deciduous vegetation like teak, sal, and cashew. Fruits include jackfruits, mangos, pineapples and blackberries. Since there is a substantial area under private forests and a large tract under cashew, mango, coconut, etc. plantations, the total forest and tree cover constitutes 56.6% of the geographic area.

Among the fauna foxes, wild boars and migratory birds are found in the jungles of Goa. Numerous types of fish are also caught off the coast of Goa and in its rivers. Crabs, lobsters, shrimps, jellyfish, oysters and catfish form some of the piscine catch. Goa also has a high snake population, which keeps the rodent population in control. The avifauna includes kingfishers, mynas and parrots. The Salim Ali Bird sanctuary, one of the best-known bird sanctuaries in India, is located on the island of Chorao. Other wildlife sanctuaries include the Bondla Wildlife Sanctuary, Molem Wildlife Sanctuary, Cotigao Wildlife Sanctuary, Madei Wildlife Sanctuary, Netravali Wildlife Sanctuary and Mahaveer Wildlife Sanctuary.

g) Mangroves in Goa

(i) Uses of Mangroves

Mangroves provide a vide range of services and benefits to the mankind. Ecological and economical values of mangroves are recognized world over. They are instrumental in providing ecological and livelihood security to coastal regions and people. People in Goa are making use of mangroves by protecting them as a nursery ground for various fish and crab species, which forms a part of their daily food. Good use of mangrove areas is also being made for eco-tourism and tourists from India and abroad is taken to these areas for a pleasant trip and crocodile watching. Felled dried branches of mangroves are also collected at a very limited scale for firewood purpose. However, no beehives have been reported and these areas are not being used for that purpose. Besides, all the river banks are protected by thick mangrove cover. The general services provided by the mangroves are as follows -

1. Prevention from soil erosion and stabilization of coasts and beaches
2. Protection of land from tidal surges and cyclonic storms.
3. Aqua culture.
4. Provides fuel wood, green manure, charcoal, timber, etc
5. Used for boat / canoe making
6. Provides tannin.

7. Used for thatching material, cordage and rope material
8. Used for art and craft, bow making
9. Used as food and beverage
10. Widely used for medicinal purposes.
11. Useful for bee hives and provides wax and honey.
12. Useful for recreational purpose as eco-tourism
13. Provides an excellent home to birds and animals.

(ii) Distribution of species

Goa has one of the best mangrove forests on the west coast houses 14 tree species found on the west coast with few trees species introduced few trees species. As per census by COE (1983), 60 exclusive species of 16 families and 23 non-exclusive species were recorded. UNESCO (1986) confirmed 65 species of true mangroves all over the world while Tomlison (1986) agreed to only 48 mangrove species and Saenger et al (1983) reported 60 species, which are recognized as true mangroves in the list of IUCN. 44 species have been documented in Asia, out of which, 32 are found in India, 13 species on the west coast and 23 species on the east coast. Andaman & Nicobar is quite rich in number of species having about 27 numbers of species.

The species found includes *Rhizophora mucronata, R. apiculata, Avicennia officinalis, A. marina, A. alba, Kandelia candel, Ceriops tagal, Sonneratia alba, S. caseolaris, Bruguiera gymnorrhiza, B. cylindrica, Aegiceras corniculatum, Excoecaria agallocha, Acanthus illicifolius and Xylocarpus spp.* Almost all species are found in all the river estuaries. *Kandelia,* a rare species on the west coast, is found in plenty in Mandovi, Mapusa and Zuari rivers. However, *Avicennia* species is dominant in most of the places with high salinity and *Sonneratia* species is dominant in low salinity areas. Chorao Island in Mandovi river is one of the best mangrove forests and houses most of the species found in Goa.

(iii) Mangroves—tsunami protection and key fish nursery

Mangrove forests—found in silt-rich, saline habitats worldwide, generally along large river deltas, estuaries, and coastal areas—are equally important ecosystems. These forests are critical spawning grounds and nurseries for marine and freshwater species, and also help prevent and reduce coastal erosion and storm damage, as seen in the aftermath of the 2004 tsunami in south-east Asia.

A study released in October 2005 showed that areas buffered by coastal forests, like mangroves, were less damaged by the 2004 tsunami than areas without tree vegetation. The study confirmed earlier experiments, which have shown that 30 trees per 100 square meters may reduce the maximum flow of a tsunami by more than 90 percent. The report mentions that the Mangroves dissipate the energy and size of waves as a result of the drag forces exerted by their multiple roots and stems. Wave energy may be reduced by 75 per cent in the waves passage through 200 meters of mangrove.

The value of ecosystem services afforded by mangrove forests is estimated at over US$100,000 per square kilometer in American Samoa and US$3.5 million per square kilometer in Thailand. In Matang, Malaysia, a 400 square kilometer managed mangrove forest supports fishery worth US$100 million a year. The Matang mangroves also generate further income providing forestry products worth US$10 million a year finds the report.

(iv) Ecotourism through Mangroves

All the twelve major species of mangroves found in Goa along with three important associates have been banned for felling by a notification issued by the Department under Goa, Daman & Diu Preservation of Trees Act, 1984. Forest Department has been declared as Nodal Agency for any activity related to mangroves. All proposals related to mangroves are to be routed through the department for better control. Excellent mangrove area of Chorao has been declared as Dr. Salim Ali Bird Sanctuary, which has not only helped in protection of area but has also become a potential eco-tourism spot. Extensive protection works have also been taken up in the region. Besides a Mangrove Interpretation Centre has been created at Chorao, where people can see different species all around. Details of various mangrove species are depicted by way of drawing & text, which is placed at the Mangrove Interpretation Centre and currently Eco-tourism to mangrove areas, is also being promoted.

h) Growing Stock

As per SFR 2003, the overall growing stock in the forests is 11.771 m. cum. 5.102 m.cum. in the forest area & 6.669 m.cum. in TOF. Forest type wise details of the same are as follows.

Table 4. 4 Forest type wise Growing Stock

Sr. No.	Type of Forest	Growing stock cum. per ha
1	Natural Moist Deciduous Forests, very dense	205.17
2.	Natural Moist Deciduous Forests, dense	137.54
3.	Natural Moist Deciduous Forests, open	81.97

Source: Goa Forest Department, 2005

i*) Villages in Forests*

There are 360 villages in the state of which 138 have forest as a land use. The forest area in these villages is 88,358 ha. Total population of these villages is 0.23 million. The villages having less than 100 ha, between 100-500 ha and more than 500 ha forest area in each village constitutes 28%, 41% and 31% of the total villages respectively. Table 4.5 provides details of villages by forest area and population.

Table 4.5: Forests as land use in villages

Forest Area	No. of villages	Total Forest Area (ha)	Population (No. of People)
Less than 100 ha	39	1,777	69,225
100 - 500 ha	58	16,233	99,142
More than 500 ha	41	70,348	64,246
Total	**138**		

i)* Wildlife *Sanctuaries in Goa

Wildlife sanctuaries are areas, which are set for the proliferation for animals and plants living therein by ensuring that the habitat is not damaged. These areas cover not higher mammals alone, but all living species other than plants from the tiniest ants and beetle to the largest herbivore, the elephant. This includes even germs, fungi and bacteria. Goa, has

one National Park, one bird sanctuary and five wildlife sanctuaries the largest being the Bhagwan Mahavir Wildlife Sanctuary. Table 4.6 provides details of the area under wildlife sanctuaries.

Table 4.6: Areas under Wildlife Sancturies

Name of the Sanctuary	Area in sq. km.	Location (Taluka)
Mollem National Park	107	Sanguem
Bhagwan Mahavir Wildlife Sanctuary	133	Sanguem
Cotigao Wildlife Sanctuary	86	Canacona
Bondla Wildlife Sanctuary	8	Ponda
Dr. Salim Ali Bird Sanctuary	1.8	Tiswadi
Madei Wildlife Sanctuary	208.48	Sattari
Netravali Wildlife Sanctuary	211.05	Sanguem
Total	755.31	

Source: Goa Forest Department, 2005

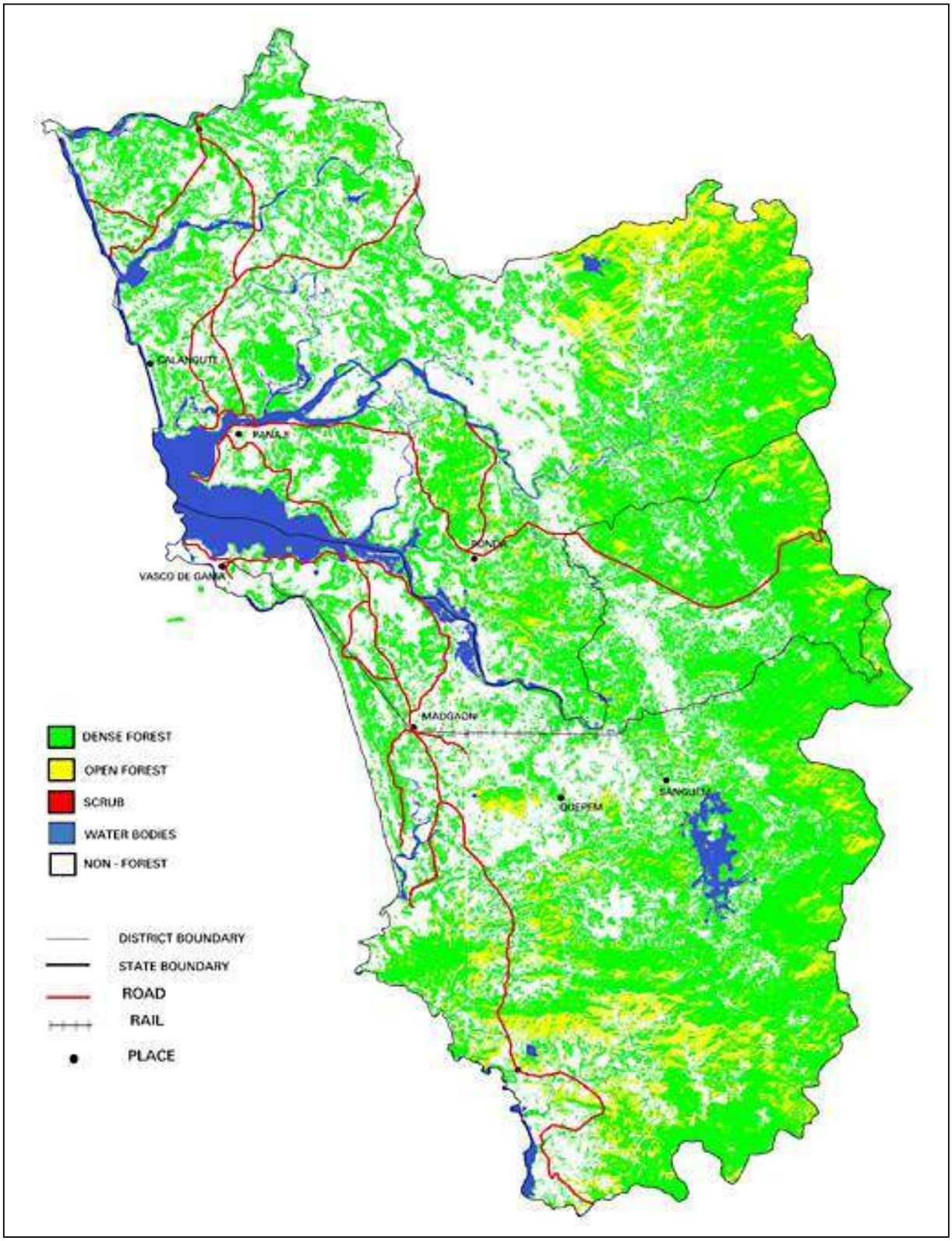
j) Forest Plantation

Considerable work gas been done in recent years to increase the forest cover through plantation activities thereby adding value to the forests of Goa. Maximum area is brought under mangroves (26.49% in 2003-04 and 7.8% in 2004-05) and mixed plantation (30.17% in 2003-04 and 33.48% in 2004-05) category. The work was undertaken engaging 160829 mandays and expenditure of Rs. 202.72 lakhs 2003-04 and 98431 mandays and expenditure of Rs. lakhs 165.67 in 2004-05. Being coastal state, mangroves plantation becomes very essential to provide shelterbelt to the main land to protect it from hurricane and Sunami in recent years.

Table 4.6: Total Area & Additional Area Brought Under Forest Plantation In 2003-04 & 2004-05

Sl. No.	Item	Unit	2003-04	2004-05
(1)	(2)	(3)	(4)	(5)
1.	Area under forest	Sq. Kms.	1424.46	1424.46
	State owned	Sq. Kms.	1224.46	1224.46
	Private	Sq. Kms.	200.00	200.00
2.	Additional area brought plantation during the year			
	(i) New Plantation			
	(a) Casuarina	Ha	-	1.00
	(b) Mangroves	Ha	180.00	35.00
	(c) Mixed	Ha	205.03	149.99
	(d) Canes	Ha	69.00	28.00
	(e) Medicinal plants	Ha	75.00	50.00
	(f) Bamboos	Ha	55.00	40.00
	(g) Jatropa	Ha	--	--
	(h) Garcania	Ha	22.50	--
	(ii) Enrichment			
	(a) Mixed sapling	Ha	73.00	144.00
	(b) Cashew	Ha	--	--
	(c) Rubber	Ha	--	--
	Total	Ha	679.5	447.99
3	Number of labour units engaged	Mandays	160829	98431
4.	Amount spent in plantation work	Rs. In lakh	202.72	165.67

Source: Office of the Conservator of Forests, Panaji – Go, 2005.



Map 1: Forest Spread in Goa State (Source: FSR, 2003)

k) State of Forest Report

As per the 'State of Forest Report 1999' published by Forest Survey of India Dehradun, the total forest cover in Goa was 1251 sq. kms. i.e. 33.79 % the total geographical area , consisting of 995 sq. km. dense Forest , 251 sq. km open forest and 5 sq.km Mangrove. A decrease of 1 sq.km was reported in 1999 assessment as compared to 1997 assessment. The Forest Survey of India has also published the State of Forest Report 2001. As per this report, the forest cover in Goa is 2095 Sq. Km. consisting of 1785 Sq. Km. dense forest and 310 Sq. Km. open forest. The increase is due to the change in the methodology of the assessment and the actual change. As per the new methodology of assessment, Cashew, Mango and other horticultural trees have been included in the forest cover and hence the reported increase.

4.3 FOREST VALUES

The table below gives the details about different values accounted in this project and framework adopted for the same.

Table 4.7 Forest Values and Framework

Values accounted for	Framework adopted
1.Timber products 2. Non-timber products Fodder, Fuelwood. Canes, Bamboo, other NTFPs 3. Watershed services specially Mangroves 4. Biodiversity 5. Eco-tourism 6.Carbon storage	Physical Accounts and Monetary Accounts

4.4 VALUATION TECHNIQUES

4.4.1 CLASSIFICATION OF TECHNIQUES USED

The table below gives the details about different valuation technique that will be adopted for valuation of forest resource in the state of Goa

Table 4.8 Forest Uses and their Valuation Techniques

Variables accounted for	Component	**Valuation Technique**
DIRECT USE VALUES		
Timber products	Marketable produce	Market price analysis
	Non- Marketable produce	Forest Asset account and Market price analysis
Non-timber products	Marketable produce	Market price analysis
	Non- Marketable produce	Direct Substitute Approach
INDIRECT USE VALUES		
Environmental services Biodiversity Eco-tourism Carbon storage	Non-Marketable	Forest Asset and Expenditure accounted using production function & damage cost

4.4.2 DIRECT USE VALUES

a) Market Prices

Many goods and services from Goa forests are traded, either in local markets or internationally, such as timber, NTFPs (e.g., fruits, medicine and wildlife) and recreation. For products that are commercially traded, market prices have been used in the assessment.

b) Related goods approach

A non-marketed good or service may be related to a marketed good or service. By using information about this relationship and the price of the marketed product the analyst may be able to infer the value of the non-marketed product. The direct substitute approach is described below

The Direct Substitute Approach estimates the value of a non-marketed good or service from the value or price of substitute or comparable goods and services under similar conditions. For example, the value of a non-marketed forest product such as fuel wood could be estimated at the cost of an equivalent quantity of a similar marketed good (e.g., fuel wood purchased from other areas), or by the value of the next best alternative/substitute good (e.g., kerosene or charcoal) which would provide the same cooking requirements or heating. (This can be complicated because the different fuels have to be expressed in the same delivered energy terms if they are to be compared. Also, the approach is likely to

Summary of Substitution Approach

1. Identify substitute good for non-marketed good to be valued

2. *If* substitute good has a market price, then the value of non-marketed good is equal to the market price of the substitute good multiplied by the quantity of the non-marketed good harvested

over-value subsistence supplies if the users would not purchase fuel if they could not gather fuel wood (i.e., if they would adopt an alternative such as switching to other gatherable fuels). Similarly, the value of traditional medicine could be based on the cost of purchasing equivalent medication at local stores or chemists. The extent to which the value of the marketed good reflects the value of the non-marketed good depends, to a large extent, on the degree of similarity between the two goods. If the goods are perfect substitutes, then their economic values should be very close. As the level of substitution decreases so does the extent to which the value of the marketed good can be taken as an indication of the non-marketed forest good. Again, account should be taken of market imperfection, which may distort the economic value of the good or service reflected in the market place (i.e., efficiency prices should be used).

4.4.3 INDIRECT USE VALUES

Because of time constraints and other inadvertent reasons, secondary data collection approach is adopted for valuation of indirect benefits from Goa forest. For valuation of carbon storage capacity of forest, forest assets accounted were used to calculate the total forest stock and different parameters were used to calculate the carbon storage capacity of the forest area under study.

For Soil conservation and watershed protection services, the annual expenditure of forest department on construction of check dams and ridges etc were analyzed and a comparative assessment was made between Increase and decreases of forest area for last 5 years and change in the annual expenditure on construction of watershed structures for the same years. On the basis of that per hectare expenditure variation were calculated and analyzing the increase or decrease of forest cover, a price allocation was made for role of forest in soil and watershed protection activity.

4.5 METHODOLOGY FOR VALUATION OF FOREST RESOURCES OF GOA

4.5.1 PROCESS: Recognizing that up-to-date information was not readily available, the process of completing this report has been based firmly on twin-track approach of multi-stakeholder consultations and multi-disciplinary analysis. Based on the Total Economic Valuation (TEV) framework developed by Verma (2000), a structured list of data to be collected was developed. It primarily aimed at identification and quantification of the physical and monetary terms of the public goods, which do not have market value, and in addition to other forest outputs. The list was structured in the following table:

Table 4.9: Nature of Required Data

Categories of Data	**Data Sets**
Basic forest data	Forest area, types, degradation, main functions, ownership, and average size of forest properties.
Macroeconomic forest-related indicators	Forestry contribution to gross domestic product (GDP), national employment and trade.
Availability of statistics on forest outputs	Physical and monetary data on market and non-market forest outputs
Identification of forest public goods	Adapting a given list of forest outputs and divided according to the TEV framework, to the forest peculiarities existing in the state.
Direct use values	Estimates of the identified forest direct uses like timber and Non Wood Forest Produce (NWFPs)

4.5.2 Secondary Information needed for NRM accounting project in Goa

Following table depicts data classification and data requirement for developing Forest Resource Accounts of Goa forest.

Table 4.10 Data Requirement

Categories of Data	Data Sets
Forest vegetation inventory mapping details	• Specifying no. and type of species found in the forest of Goa (state and District wise). • Vegetation map of district as well as state. • List of endangered species.
Forest resource trading agency details	• Timber trading • NTFPs trading
Forest based villages details	• No. of villages in Goa (dependent and independent on forest). • Population density

4.5.3 Data Analysis

The data so collected has been analyzed creating the following set of accounts.

- Asset account for standing timber (physical & monetary values).
- Physical estimates & valuation for NWFPs (non wood forest products).
- Volume & value of all forest products.

4.6. Accounting of Forest Resources in Goa

The study is an attempt to estimate various use value of Goa forest using the market price, substitution approach, productivity method, welfare method, avoidance cost and benefits transfer approach.. As, the time related to the study was limited, for certain values it also uses findings of specific valuation studies undertaken in the country and other countries of similar nature of forests to extrapolate for the entire state. The major limitation of the study is possible overlapping of values like eco-tourism with biodiversity, watershed and carbon sink values etc. Further the study treats total growing stock in forest as stock value and all other values as flow values and calculates them on annual basis.

4.7 PHYSICAL ACCOUNTS

4.7.1 Change in Forest cover 2001-2003

The forest cover in the year 2001 was 2095 km^2 and in the year 2003 it was 2156 km^2 therefore the change in the forest cover is 61 km^2. The following two tables represent forest stock accounts of Goa and Volume Accounts of Carbon in Goa.

Table 4.11 Forest Stock Accounts of Goa

Stock	Forest cover (sq. km)
Opening Stocks 2001	**2095**
Change in Dense Forest **Change in open forest**	**-530** **+ 591**
Closing Stocks	**2156**
Changes in Stock 2003	**+ 61**

Source: SFR 2003

4.7.2 TIMBER PRODUCTION

In the state of Goa, Private forest is the maximum producer of commercial timber (96%), while the average percentage contribution from govt. forest in timber production is very less. i.e., 4%.

The table below gives the timber production details from private and Govt. Forest during years 1999-2000 to 2004-05.

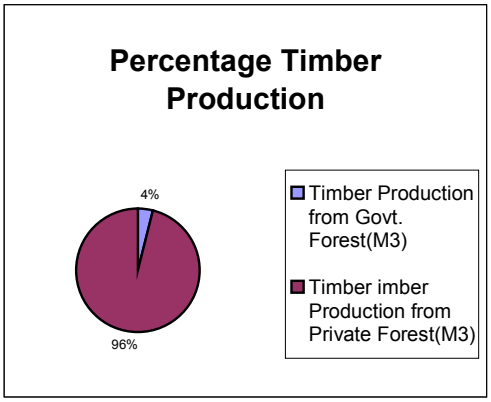


Table 4.12: Timber Production from Government and Private Areas in Goa (M^3)

(During 1999-2000 to 2004-05)

Timber Production from Government and Private Areas in Goa (M3) (During 1999-2000 to 2004-05)		
Year	**Timber (M^3) from Govt. Forest**	**Timber (M^3) from Private forest**
1999-2000	487	7685
2000-01	648	9496
2001-02	382	13156
2002-03	252	15279
2003-04	414	13777
2004-05	626	16727

Source: Department of Forest, Govt. of Goa

4.7.3 FIREWOOD PRODUCTION

Firewood production is maximum (84%) from private forest, while govt. forest contributes around 14% of the total firewood production.

The table below gives the firewood production details from private and Govt. Forest during years 1999-2000 to 2004-05.

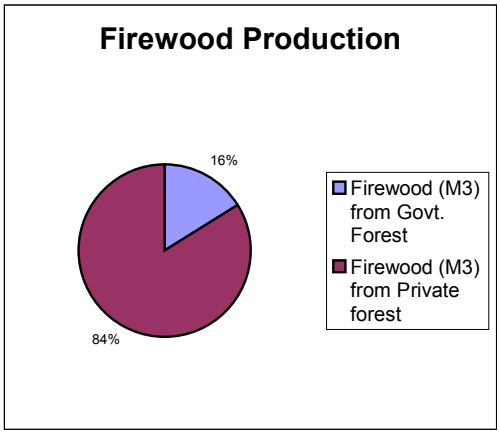


Table 4.13 Firewood Production from Government and Private Areas in Goa (M^3) (During 1999-2000 to 2004-05)

Firewood Production from Government and Private Areas in Goa (M3)(During 1999-2000 to 2004-05)		
Year	**Firewood (M^3) from Govt. Forest**	**Firewood (M^3) from Private forest**
1999-2000	1244	86.358
2000-01	2714	16615
2001-02	134	23816
2002-03	9155	13296
2003-04	1805	22634
2004-05	1066	28065

Source: Department of Forest, Govt. of Goa

4.7.4 FODDER PRODUCTION

Table 4.14 Fodder Production from Government and Private Areas in Goa (During 2000-01 to 2002-03)

Year	Fodder Dry (000 tonnes)	Fodder Green (000 tonnes)
2000-01	251	189
2001-02	223	189
2002-03	233	189

Source: dahd.nic.in

4.7.5. BAMBOO PRODUCTION

In case of Bamboo production, private forest contribution is around 91%, while that for Govt forest is around 9%.

The table below gives the Bamboo production details from private and Govt. Forest during years 1999-2000 to 2004-05.

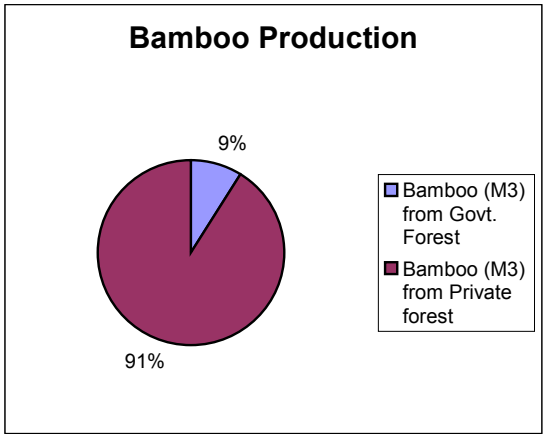


Table: Bamboo Production from Government and Private Areas in Goa (M^3) (During 1999-2000 to 2004-05)

Table 4.15

Bamboo Production from Government and Private Areas in Goa (M3) (During 1999-2000 to 2003-04)		
Year	**Bamboo (M^3) from Govt. Forest**	**Bamboo (M^3) from Private forest**
1999-2000	1800	129300
2000-01	16700	24300
2001-02	10000	132992
2002-03	13296	31100
2003-04	536	116144
2004-05	-	82645

Source: Department of Forest, Govt. of Goa

4.7.6. CANES PRODUCTION

Canes production from Goa is mainly from government forest. The table below gives the canes production details from Govt. Forest during years 1999-2000 to 2003-04.

Table 4.16: Canes Produce from Government Areas in Goa (During 1990-91 to 2004-05)

Year	Cane (Nos.)
1999-2000	19500
2000-01	1890
2001-02	6495
2002-03	140
2003-04	4385
2004-05	1140

Source: Department of Forest, Govt. of Goa

The following two tables 4.17 and 4.18 depict quantity and value of forest produce as estimated by the forest department during 2003-04 and 2004-05 both in government and private forests.

Table 4.17 QUANTITY AND VALUE OF FOREST PRODUCE DURING 2003-04

Sl. No.	Item	Quantity (in Number)			
		North Goa	South Goa	Total	Value realized (in Rs.)
(1)	(2)	(3)	(4)	(5)	(6)
2003-04					
1.	**Canes (Nos.)**	4385	0	4385	78930.00
2.	**Bamboos (Nos.)**				
a.	Govt.	0	0	0	0
b.	Pvt.	98200	17944	116144	1161440.00
3.	**Timber (Cu. Mt)**				

a.	Govt.	395.846	18.061	413.907	1283111.70
b.	Pvt.	6384.34	7393.060	13777.400	47108673.00
4.	**Firewood (Cu. Mt)**				
a.	Govt.	1778.510	26.887	1805.397	415241.31
b.	Pvt.	11073.513	11561.240	22634.753	5205993.10

Source: Office of the Conservator of Forests, Panaji – Goa

Table 4.18 QUANTITY AND VALUE OF FOREST PRODUCE DURING 2004-05

Sl. No.	Item	Quantity (in Number)			
		North Goa	South Goa	Total	Value realized (in Rs.)
(1)	(2)	(3)	(4)	(5)	(6)
2004-05					
1.	Canes (Nos.)	0	1140	1140	18194.40
2.	Bamboos (Nos.)				
a.	Govt.	0	0	0	0
b.	Pvt.	73495	9150	82645	1239675.00
3.	Timber (Cu. Mt)				
a.	Govt.	453.568	172.127	625.695	2828863.70
b.	Pvt.	8700.317	8026.703	16727.020	87480677.00
4.	Firewood (Cu. Mt)				
a.	Govt.	893.215	173.555	1066.770	512049.60
b.	Pvt.	19951.000	8114.670	28065.670	13471521.00

Source: Office of the Conservator of Forests, Panaji – Goa

During last two decades there has been considerable rise in the timber (50.45%), and bamboo production (63.16%), whereas that of cane has declined (nearly 98%). Plantation activity has also increased covering both new plantations and enrichment. Revenue realization has gone up more than three times. The same is depicted in Table 4.19

Table 4.19 Change in Production and Revenue from Goa Forest in Last Two Decades

Sl. No.	Item	Unit	1987	2005-06
1.	Timber production	Cu. Mt.	8,578	17314.720
2.	Fuelwood production	Cu. Mt.	27,727	29601.205
3.	Pole production	No.	6,050	4064.00
4.	Cane Production	No.	1,14,614	325.00
5.	Bamboo's production	No.	26,500	71,933.00
6.	Area brought under plantation			
	a) New plantations			
	i) Casuarina	Ha	50	-
	ii) Mangrove	Ha	0	166.51
	iii) Mixed	Ha	0	192.50
	iv) Canes	Ha	0	76.00
	v) Medicinal plants	Ha.	0	-
	vi) Bamboo	Ha	120	--
	vii) Jatropha	Ha.	-	10.00
	b) Enrichment			
	i) Mixed Species	Ha.	714	217.91
7.	Revenue realized	Rs. In lakhs	52.77	184.29

Source: Office of the Conservator of Forests, Panaji – Goa

In case of services from the forest sector, due to mother volume changes, the carbon stock has declined by 6.09 % during 1999-2003 as shown in Table 4.20.

Table 4.20 Volume Accounts of Carbon in Goa ('000 tonnes of carbon) from 1999 -2003.

Opening stock of carbon	10684.7
Net release due to changes in economic activity	-3.2
Release to atmosphere due to logging	3.7
Afforestation	0.5
Other volume changes	1018.4
Releases atmosphere due to forest fires	0.000
Releases atmosphere due to stand mortality	0.0159
Release of carbon due to animal grazing	0
Release of carbon due to shifting cultivation	0
Release of carbon due to forest encroachments	0
Other accumulation	370.8
Natural growth	371.0
Regeneration	0.2
Carbon loss due to transfer of land to other activities	0.4
Net carbon change	-650.8
Closing stock of carbon	10033.9

Source: Green Accounting Report 2005

4.8 MONETARY ACCOUNTS

Timber and fuel-wood are valued using producer's prices as provided by the CSO. We have the values for the years 2003/04 and 2004/05. We have inflated these values based on the wholesale price index for timber in the table below. The value of the NTFPs like rattan, gum, lac, and bamboo per hectare is also taken from the statistics provided by the CSO. The value recorded represents only some of the non-nationalized items of NTFPs. Further, in India; the residents of forest villages have the privilege to collect all NTFPs for their bonafide personal use or for earning their livelihood. This makes the task of finding the exact value of NTFPs very difficult. In order to take into account this unrecorded production, the value of the NTFPs is taken to be 10 times the value recorded by the State Forest Department. The value of the NTFPs recorded in the national accounts is Rs 20,350 million (in the year 2000/01) and the value of NTFPs per hectare is estimated at Rs 301 per hectare. The present value of NTFPs is about Rs.7525 and is obtained by dividing the value

of NTFPs generated in the first year by the social discount rate of 4%. This value is very low given the fact that only 10 times the royalty value is considered (which as such is very low). (*Haripriya G.S. Green Accounting for Indian Forest States, 2005*)

Given the dependence of population on different open access lands, the value recorded at present is very low. However, due to lack of estimates of exact contribution of NTFPs, we took this estimate as a lower bound. Further, from CSO we could not get the exact contribution of NTFPs. Further, it is assumed that the production of NTFPs is sustainable and prices and costs are also stable. The forests also provide fodder for the livestock. The value of fodder obtained from forests is valued using the cost of alternate acreage. In the absence of well-developed cultivated market, the value is determined as the opportunity cost of allotting alternate acreage to it (Munshi and Parikh 1990). This is equivalent to loss in revenue from agriculture due to cultivating equivalent amount of fodder obtained from forests on agricultural land. The value of the fodder obtained from the forests varies from Rs 18.5/ha to Rs 571.3/ha with an all-India average of Rs 183.5/ha. The present value of fodder derived from forestland is Rs 4588.2/ha (discount rate of 4%).

Table 4.21: Unit Price (per quintal) of timber and fuel-wood as recorded in the national accounts

1	Timber (2003/04) unit price	4252.00
2	Fuelwood (2003/04) unit price	562.00
3	Timber (2004/05) unit price	5626.00
4	Fuelwood (2004/05) unit price	632.00
5	2003/04 weighted price of logging & illegal logging	731.00
6	2004/05 weighted price of logging & illegal logging	1144.00

Source: *Computed*

4.8.1 OVERVIEW OF REVENUE & EXPENDITURE

The Revenue earned the expenditure incurred during the last 10 years is as given below:

Table 4.22 Revenue raised & Expenditure incurred by Forest Department

Sr. No.	Year	Revenue (Rs in lakhs)	Expenditure (Rs in lakhs)		Total Expenditure (Rs in lakhs)
			Non Plan	Plan	
1	2	3	4	5	6
1.	1994-95	138.15	205.78	302.79	508.57
2.	1995-96	138.82	241.38	283.04	524.42
3.	1996-97	157.87	339.66	351.57	691.23
4.	1997-98	113.71	386.10	320.50	706.60
5.	1998-99	70.57	474.72	333.69	808.41
6.	1999-2000	93.25	504.78	525.40	1030.38
7.	2000-2001	110.96	532.46	704.41	1236.87
8.	2001-2002	117.93	538.42	458.53	996.95
9.	2002-2003	72.23	530.32	526.16	1056.48
10.	2003-2004	180.56	572.62	730.15	1302.77
11.	2004-2005	208.29	559.87	1106.01	1665.88

Source*: Goa forest department.*

4.9 Valuing net timber accumulation

The net timber accumulation can be obtained from the present value method or the net price method or the user cost method. A brief description of different methods is given below.

Present value method

The present value Vo of natural resources is the sum of the expected net revenue flows Nt Qt, discounted at nominal or real interest rates r for the life of the asset:

$$Vo = \sum_{t=0} Nt\ Qt / (1+ r)^{t}$$

where Nt is defined as the total unit value of the resource less the costs of extraction, development, exploration and Qt is the quantity exploited during the period t.

Net price method

The value of the resource at the beginning of the period t, Vt is the volume of the resource Rt multiplied with the difference between the average market value per unit of the resource Pt and the per unit (marginal cost of extraction, development and exploration, including a normal return to the capital Ct).

$Vt = (Pt - Ct) Rt$

User Cost Method

The user cost, i.e. the discounted net revenue from the sale of the resource, is:

$$R - X = R / (1+ r)^{n+1}$$

where R is the annual net revenue from the sale of the resource , assumed to be constant over its lifetime (of n years), X 'true income' element calculated so that R-X represents a capital element whose accumulated investment at an interest rate r during the n years would create a permanent stream of income of X.

4.10 Valuing Direct Consumptive Benefits from Goa Forests

The total legal forest area of the State at the tune of 2156 sq. km has tree covers on its 58.24 % area. The total growing stock is 231000 cubic meters from which various direct consumptive benefits like fuel wood, fodder, timber/salvage, timber for right holders & minor forest produce comprising of medicinal herbs, prawn culture. In the first stage broad estimate of these values has been worked out using data of last 4-5 years. For the marketed products like timber, royalty rates fixed up by the department have been used and for the non-marketed products mainly used for self consumption, approximate price of similar goods (e.g. fuel wood, fodder) sold in the other areas is considered. In other words if these people had purchased such products from the market how much they would have paid. The values are calculated as under:

a) Value of Fuel-wood Requirement

Market price of fuel-wood at a conservative rate of Rs.1000 per tonne (as per rate prevalent in other markets) was considered (using HP Report by Verma, 2000); the annual fuel-wood requirement from forest shall have a value of Rs.3 crores.

b) Value of Grasses & Grazing

The livestock population of Goa state is 2.5 lakh. This population when converted into sheep units work out to 7.5 lakhs, (Verma 2005). Each sheep unit requires on an average 2 kg of fodder everyday and thus the fodder required from forests, which is rated as Rs.32.7 crores.

4.11 Valuing Direct Non-Consumptive & Indirect Benefits from Goa Forest

a) Valuing Eco-tourism & Recreational Benefits

Looking to the rate of growth of tourist at 5% per annum in domestic and 20% in international, 24 lakhs of tourists visited Goa in the year 2004-05.The total number of tourists comprise of Indian tourists 67 % and 33 % international tourists. Keeping moderate expenses @ 5000 per tourist & expecting that 50% of expenses are to forest / nature based tourism, the eco- tourism value comes to Rs.600 crores (using HP Report by Verma 2005). But this value do not represent the exact value of forest because there are other factors such as historical monuments and scenic beauty due to which tourists are attracted.

b) Valuing Watershed Benefits

As no individual study could be found for Goa state for watershed benefits, following the benefits transfer approach the value of watershed benefits is being estimated for forest are of 2151 sq. Km. and mangrove area of 5 sq. km. Taking the value from Manoharan, 2000 for value of annual flow of watershed benefits in India @Rs. 2.00 Lakhs per hectare, the value of Goa forest watershed benefits comes to Rs. 43.02 crores. No study of economic valuation of mangroves was found for Goa and also fro India. Thus using the benefits transfer approach once again the mangroves, the value of watershed benefits from mangrove forest is estimated. The value of ecosystem services afforded by mangrove forests is estimated at over US$100,000 per square kilometer in American Samoa and US$3.5 million per square kilometer in Thailand. On account of similarity with Thailand, the same value approximating to Rs. 15.75 Lakhs per hectare was used to estimate the value of 5 sq.km. of mangrove forests of Goa which comes to Rs. 78-75 Crores.

c) Value of Carbon Sink

The growing stock of 11.771 million cubic meters provides an excellent sink for CO_2 emission & thereby thus influence global climate. Thus it becomes essential to quantify and assess carbon stock and flows in forestry activities though the carbon sink function shall considerably vary with changing density of the growing stock but taking the area only under

dense, open & scrub forests i.e 2156 sq.km (2,15,600 hectares) which contain the growing stock & using all India value of Rs1.23 lakhs per hectare for carbon store function of forests (Verma, 2000), the Goa forest tree cover & scrub forest provide Rs 2651 crores worth of carbon sink function. In this case if the forest in agricultural farm land, cantonment and urban areas worth of carbon sink function. In this case if the forest in agricultural farm land, cantonment and urban areas are also considered, the value of carbon sink shall be even more.

(d) Value of Bio-diversity

The State of Goa is the smallest of all the States in the country yet, it shows an astonishing diversity of endemic species, habitats and ecosystems. Goa is under the influence of two global biomes - the marine biome of the Arabian Sea and the terrestrial forest biome of the Western Ghats. Within this geographical canvas are wide ranges of ecosystems and habitats e.g. forests, Ghats, alluvial plains, coasts, rivers, estuaries, mangroves, wetlands, etc. The eco-physiology of the habitats is governed by complex ecological and meteorological conditions. There are normal habitats and extreme habitats (like the rock pools and the salt pans). There are microhabitats, which are equally important - e.g. the termite mounds which play a significant role in the decomposition of plant litter. The status of biodiversity in each of these habitats varies, depending naturally on a variety of genetic and environmental factors. Bio-diversity values are option value & provide an insight into potential future values of genetic information & organic compounds. The value of biodiversity varies considerably according to its richness. In India it is estimated to be Rs. 0.21 lakh/hectare (Verma, 2000). Extrapolating it to the entire area of Goa, (2156 sq.km.) it comes out to be Rs. 452 crores.

4.12 Estimation of Total Economic Value of Goa Forest

Based on the above calculations, the total economic value of Goa forest has been estimated as Rs 4430.45* crores, Per Hectare value for total forest area of 2156 Sq. km is estimated as Rs 2,05,493.97 and Per Ha value for moderately dense forest area of 1255 Sq. Km. is estimated as Rs.317565.73. The details are depicted in Table 4.23

4.23. Forest Satellite Account for Goa (2005)

Economic Value of Direct and Indirect Benefits				
	Physical value	Total Monetary value (Rs. Crores)	Per Hectare value (RS.) for total forest area of 2156 Sq. km.	Per Ha value in Rupees for moderately dense forest area of 1255 Sq. Km.
I. Stock Accounts				
Total growing stock	11.771 m.cum	472 crore	Rs. 21892.39	37609.56
II. Flow Accounts				
I. Direct Benefits				
A. Direct Consumptive benefits				
1.Timber	17353 m^3	74 crore	3432.28	589.64
2. Fuel wood	29131 m^3	3 crore /annum	139.14	239.04
3.Fodder	7.5 lakhs sheep per unit	32.7 crores	1516.69	2605.57
4.Minor forest produce (Bamboo & Canes)	90000 m^3	9 crore	417.43	717.13
Total Direct consumptive benefits				
B. Direct Non Consumptive Benefits				
6.Ecotourism	24 lakhs tourist	600 crores	27829.31	47808.76
Total Direct Benefits (A+B)				
II. Indirect Benefits				
7.Watershed (i) Mod. Dense forest (ii) Open forest (iii) Mangroves	 1255 Sq. km. 445 Sq. km. 500 Hectares	 2510 Crores 445 crores 78.75 Crores	 1,37,377 (Mod+Open) Rs. 15,75,000	 2,06,274.90 (Mod. Dense + Mangroves)
8. Carbon Sink	23000 m^3	225 crores	Rs. 10435.99	17928.28
9.Biodiversity/	Wide variety of	452 crores	Rs 20964.74	36015.93

Endangered Species	floral and faunal population –land and marine based			
Total Economic Value (I+II)		Rs 4430.45* crores Rs. 3985.45** Crores	Rs 2,05,493.97	Rs.317565.73 ***

* Total Forest (2156 Sq. km.), ** and ***Excluding watershed Function from Open Forest

Source: Adapted from Verma Madhu Report (2000)

4.13 Comparison of TEV with State Domestic Product and Expenditure

Comparing the TEV with State Domestic Product and Expenditure during various years, whopping difference could be observed in contribution of forestry sector to state GDP. This contribution may be actually realized in other sector s like agriculture, industry, tourism etc, but is not accounted under the forestry sector. Thus considering this the contribution goes up from 5.56% to 33.68% whereas the allocation of budget is highly disproportionate i.e. 0.76 % only as depicted in Table 4.24. Thus there is urgent need to revise the budget allocation to the forestry sector recognizing its tremendous contribution in Goa's economy.

TABLE 4.24 INCOME ESTIMATES DURING 2001-02, AT FACTOR COST AT CURRENT PRICES (IN CRORES)

Sl. No.	**Sector**	**Estimate**
1	GSDP at Factor Cost (2001-02)	7771.12
2	Agriculture + Forestry & Allied + Fisheries	624.15 Crores
3.	Forestry & Logging	432.22 crores
4.	Forestry as % age of GSDP	5.56
5.	Forestry as % age of Agriculture & Allied	69.2
6.	Total Budget Expenditure of Goa (2004-2005)	Rs.2188.46 crores
7.	Total Expenditure incurred in Forestry sector (2004-2005)	16.66 crores
8.	Total revenue realization (2004-2005	208.29 lakhs

9.	Estimated Total Economic Value of Goa forest (2004-2005)	Rs 4430.45* crores
10.	GSDP of Goa (2004-2005)	13154.27 crores
11.	Total Economic Value of Goa as % of GSDP of Goa (2004-2005)	33.68%
12.	Total Expenditure incurred in Forestry sector as % of Total Budget Expenditure of Goa (2004-2005)	0.76 %
13.	Per capita income of Goa	Rs 52,277* (2002-03)

* Highest in the country

Source: Computed

4.14 Economic Value of Forest

If we look closely into the Total Economic value of the forests of Goa, it gives ambiguous values, as eco-tourism in Goa is not only due to forests but it has got several factors like, sea, beaches, and historical monuments.

Secondly, the watershed benefits and carbon sink are potential of forest and are not direct benefits and in case of fodder only 30% (approx.) of it comes from the forest.

(*Assumptions to be verified by the appropriate survey and primary data collection*)

So, the economic valuation of forest is:

Table 4.25

SL.No.	**Values of Forests of Goa**	**Monetary Value (Rs. in crores)**
1	TEV	(+) 4430
2	Watershed Benefits	(-) 3033
3	Eco-tourism	(-) 600
4	Carbon sink	(-) 225
5	Fodder (70%)	(-) 22
6	**Economic Value of forest of Goa**	**550 Crores**

Source: Computed.

Thus the economic value of Goa as % of GSDP of Goa (2004-2005) is 4.18% excluding the eco-tourism value, watershed benefits, carbon sink and fodder.

4.15 Summary

Accounting for forest wealth is an important ingredient in creating a framework for analyzing policy trade-offs. The accounts that we have presented for Goa forest have described forestry related stocks and flows in terms of land area (under forest), physical volume (of timber and carbon) and finally monetary values. In this way, we have tried to estimate the true value of economic activity in the state of Goa.

The Total Economic Value of Goa forest comes out to be **Rs. 4430.45 crores**. But apart from the eco-tourism value, carbon sink, watershed benefits the value comes to **Rs.550 crores**. The carbon sink, watershed, ecotourism are the potential of forest and other natural resources of Goa. This shows that the role of forest is huge in economy of Goa.

The forest area of Goa state has increased to a significant level. The role of forest in economic benefits such as carbon storage, timber production, non-timber forest products and the many other values of biodiversity including eco-tourism. There are though limitations placed by a paucity of data and the problems of methodology but nevertheless the importance of the sector in state GDP cannot be undermined and calls for improved allocation of budget in future such that wide variety of forest values from Goa forest can be sustained for future uses.

5 Conceptual Framework & Green SNP

5.1 Conceptual Framework

Green Accounting, in whatever format and framework will have conceptual difficulties and data interpretation and collection problems. Even the Systems of National Accounts (SNA) have many problems that we have learned to live with – such as unaccounted women's work that gets monetised when house-help is hired, or appliances are purchased or "unmonetised" when "a man marries his maid" all off quoted paradox about SNA.

Care, concern and love for environment have gone up that manifest into market place. The demand for nature can be judged by the income gathered by animal toys, books, documentaries, movies, dedicated TV channels, eco-tourisms and many nature products. Similarly, clean air and water have their markets in terms of real-estate prices for cleaner neighborhoods, water-purifying systems, bottled water etc. Yet it is difficult to put a value as they are clubbed among various already existing heads in the national accounts. Similarly, negative externalities are not only hidden, they manifest themselves into income, leading to erroneous conclusion that "more the environment deteriorates better is the economy" as the doctors income go up with pollution, oil spills lead to vast expenses by the oil company that year, deforested forest lead to income from the timber and fuel wood.
On the other hand, prudent environmental management that requires firms to purchase pollution abatement on a routine basis shows expenditures in their balance sheet regularly. Thus, environmental accounting is needed to avoid such misconceptions. It can do so, only if it is routinely done to check the sustainability of these activities.

However, computation of environmentally adjusted national accounts involves many challenges. One needs to be careful to avoid double counting. One also needs to be clear about what should be included and what not.

The framework by Dasgupta and Maler (1995) provides a slightly modified framework suggested by Parikh and Parikh (1997) clarifies the basic conceptual framework.

Our purpose, in preparing an IEEA is to get an idea of what is our true net national product after accounting for depreciation of natural assets. Some refer to this as the green NDP, sustainable NDP or environmentally adjusted NDP (EANDP). Consider that social welfare depends on consumption of produced goods, consumption of collected environmental

products such as fuel-wood from forests etc., enjoyment of various environmental amenities provided by environmental assets (such as clean air, clean water, scenic beauty etc.) and leisure. Also consider that the quality of environmental services is affected adversely by production of goods and positively by defensive abatement measures, which require resources. Consider further that the quality of assets such as forests can be improved by human effort and worsened by over-exploitation. This is a slightly extended version of Dasgupta and Mäler (1995), in that we have added explicitly the value of leisure in the welfare function.

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In such a world, one can show that optimization over an infinite horizon gives the following definition of Net National Product:

Net National Product	=	Value of consumption + Value of productions of nature collected (such as fuelwood) + Value of environmental amenities provided by environmental resource stocks (such as clean air etc.) + Value of leisure enjoyed + Value of additions to productive capital + Value of additions to environmental resource stocks (clean air etc.) + Value of additions to natural capital stocks (such as forests) + Value of additions to stock of defensive capital.

In this equation, all valuations are to be done at prices prevailing at the optimal trajectory.

The important thing to note here is that so-called defensive expenditures (such as medical expenditure needed to fight the effect of pollution) are not deducted here and that the value of environmental amenities are added here Peskin (1989). Both these approaches differ from that of the United Nations Statistics Division (UNSD). However, the UNSD approach does not assume that the economy is on the optimal path (if it were so then perhaps the need for an IEEA would not have arisen). Nonetheless, one needs to carefully understand what it is that one is trying to measure.

One should also note that deduction of defensive expenditure at the level of a satellite account may be justified. Consider, for example, a power plant emitting particulate matter into the air. This may make some people sick who may spend money on medicines and may miss work. Their loss in income may be already be included in the conventional national accounts as less output of sectors in which they work. However, if we are to judge the power plant, this loss in income should be shown as a negative outcome of this plant. A

satellite account is like the account of one division of a firm. To judge its performance, its borrowings from other divisions of the firms must be taken into account. One has to be careful, however, when integrating the accounts of different divisions of the firm to obtain its aggregate profit and loss position, and ensure that no double counting takes place.

Thus, up to the level of satellite accounts there is no fundamental conceptual difference among the various proposed approaches to IEEA. The differences arise at the level of final adjustment of the NDP to obtain green NDP.

However, even at the level of satellite accounts, the approaches to valuation may differ. Here the choice of approach is often determined by availability of data.

Due to the problem posed that concerns more with correction of GDP, SEEA approach is followed mainly for the forestry sector. The remaining sectors capture the missing elements in national accounts.

5.2 Approaches to Valuation

Even when one is clear as to what should be included and what not, limitation of data forces one to select a particular approach to valuation. Alternative approaches often measure different things and one needs to be clear as to what one is measuring.

First, it is useful to understand what it is that one ought to measure so that one can assess whether a particular valuation approach gives a lower bound or an upper bound on the value. This we examine now with the help of Figure.

In Figure we consider emission of a pollutant such as suspended particulate matter (SPM) in air. The level of emissions is plotted on the x-axis (one could also look at it from right to left as increasing air quality considering E as the origin).

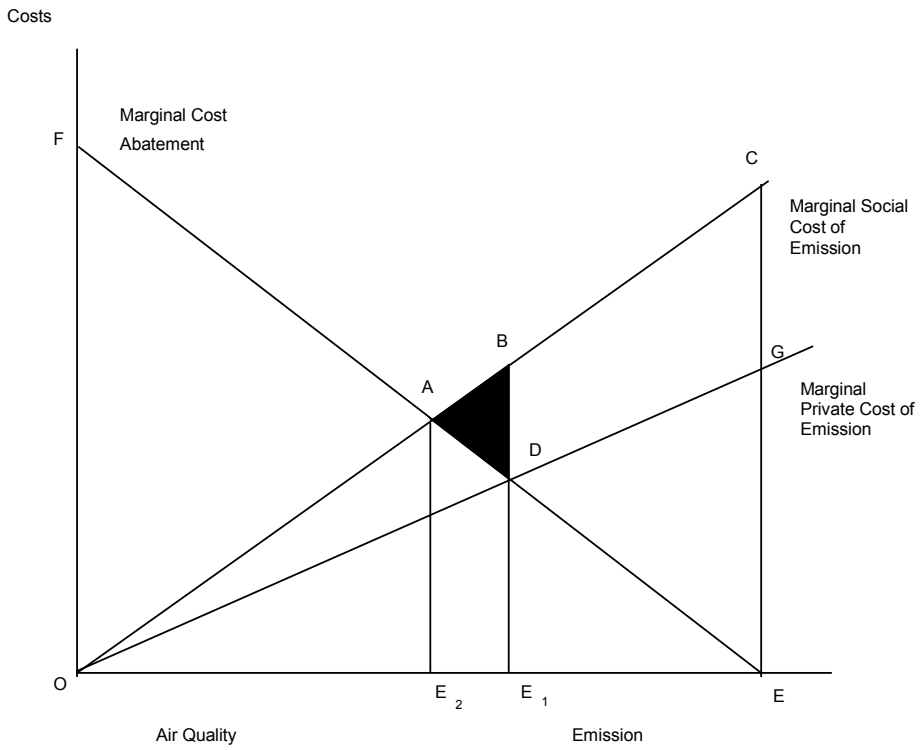


Figure: Demand and Supply of Air Quality and Optimal Emission Level.

The line FE shows marginal cost of abatement (MCA) that would have to be incurred if the emissions were to be reduced. At point O, abatement is complete and there is no emission. The total cost of this abatement would be the area under the line FE, namely the area FOE. If emissions are to be restricted to level OE_1, i.e., if abatement is to be done to the extent of EE_1, the cost of abatement would be area DE_1E. The line FE reflects the engineering or technological costs of abatement.

The line OC in the figure shows the marginal social cost of emission. These are the costs borne by the society due to the emission. For example, suspended particulate matter (SPM) laden air may aggravate respiratory diseases. The incidence of morbidity (sickness) may go up and mortality may also increase as additional deaths are caused by it. There may also be other costs: visibility may be reduced, leading to more accidents or closure of airports, buildings may become dirtier, thus increasing the costs of maintenance and repainting, property value may go down and so on. The line OC reflects these costs. In a sense, this is what those who suffer from this pollution may be willing to pay to reduce the level of pollution. Thus, if the pollution is to be restricted to the level OE_1, the society should be willing to pay an amount equal to the area CEE_1B.

The third line OG shows the private cost of emission to the emitter herself. For example, if there is an emission tax the rate of which increases linearly with the level of emission then OG will represent the marginal tax rate. It is also possible that the emitter herself suffers from the emission. This can happen, for example, if SPM emission by a plant clogs up its own machines and reduces the efficiency of its production processes. In this case, the polluter saves the abatement cost FOE by not doing any abatement but bears the cost OGE, because of the emission OE. It is obvious that the polluter would minimize her costs by abating up to level E_1 so that the total costs borne would be equal to the area ODE.

By imposing a rising tax on emission we internalize the social cost of emission for the emitter, i.e., these costs now become a part of, internal to, her profit and loss account. If the level of taxes corresponds to line OC, then the social costs are completely internalized. If tax rates correspond to OG, the social costs are only partially internalized. The level of emission would depend on the extent to which costs are internalized. Thus, it would be observed that

OE_2 = Optimal level of emissions, when social costs are completely internalized.
OE_1 = Emission if some costs are internalized.
OE = Emission when no costs are internalized.

From the point of view of valuation we should note the following:

If you observe OE, and take the area OFE as cost of abatement and hence as the value of loss of air quality it may be an overestimate or an underestimate depending on whether the area OCE is smaller or larger than the area OFE.

- If you take OCE as the cost that may also be an overestimate (or underestimate).
- What you really want to estimate is area ABD that is the loss to the society.

However, for this you need to know the optimal emission E_2.

Ideally we should measure the social cost accompanying. Since this is often difficult to measure, if not impossible, one often substitutes the abatement cost approach. As long as the pollution level is at the optimal point when the marginal abatement cost equals marginal social cost ($\mathbf{P_O}$) then it does not matter whether one uses abatement cost or social cost.

However, if the actual level of pollution is lower (higher) than the optimal, than the marginal abatement cost will be higher (lower) than the marginal social cost.

Unfortunately, we often do not know what the optimal level is and thus we do not know if the estimate is higher or lower than what it should be.

5.2.1 Urban Municipal Solid Waste Management

We have estimated the cost of uncollected urban municipal solid waste by abatement cost method. Ideally, we should have estimated the social cost of uncollected solid waste. This would have involved the following steps:

1 Assess the additional incidence of diseases and deaths due to uncollected waste.
2 Assess the economic cost of these additional diseases and deaths in terms of medical expenditure, loss of income due to lost days of the patients and relatives etc taking care of him, adjusting the cost for what is already included in the SNA.
3 Assess the loss in property values due to uncollected waste.
4 Assess subjective loss of welfare due to the poor quality of environment, for example through willingness to pay surveys.

These require data and epidemiological studies to establish causality between pollution and diseases and deaths, and studies to establish costs of illness and premature deaths. These would take a long time. Abatement cost thus provides a practical alternative.

The methodology for the use of abatement cost to prepare adjusted accounts has been described and demonstrated in chapter two. The estimates, however, can be improved in a number of ways:

- The estimates of waste generated can be improved by a larger sample size.
- Also waste generated from restaurants, offices and shops other than in markets need to be estimated and added to waste generated. Since we estimate uncollected waste by subtracting collected waste from generated waste, this will increase the estimate of uncollected waste.
- We should also estimate the amount of waste collected for recycling by rag pickers from disposal sites. This will reduce the volume of waste for landfill and consequently the amount of land required for it. This will lower the cost of waste disposal.

- Finally, landfill sites assessment is required to estimate the waste receiving capacity of the landfill sites. Also a more accurate assessment of the price of land can improve the estimate of cost of waste disposal.

5.2.2 Industrial Air and Water Pollution

The costs of air and water pollution are also estimated using abatement cost. The limitation of the use of abatement cost. As discussed for urban waste apply here also and the same justification for its use.

While chapter three describes and demonstrates the use of abatement costs. The estimates can be improved by the following:

- We have used World Bank estimates of emissions. Measurements of actual emissions by industries in Goa would improve the estimates. In any case Goa Pollution Control Board should measure these on a regular basis.
- Also, we have used World Bank estimates for abatement costs. While our survey has collected some data on abatement costs, these should be collected for a number of repeated samples over the year and emissions measured at the same time to arrive at a satisfactory assessment of abatement cost functions. The same applies to treatment costs of water effluents.

5.2.3 Forest of Goa

The accounts that we have presented for Goa forest have described forestry related stocks and flows in terms of land area (under forest), physical volume (of timber and carbon) and finally monetary values. In this way, we have tried to estimate the true value of economic activity in the state of Goa.

We recognize that the results should be viewed with caution due to limitations placed by availability of data. As a result, using suitable conversion factors derives the volume lost. The data used here is from the publication of FSI's 2003 report and using all India value from previous research. Nevertheless, the study has demonstrated that forest resource accounting is feasible in India at a disaggregate level using a 'top-down' approach. There is undervaluation of NTFPs, timber, and fuel wood. In fact, forests have several other services such as biodiversity values, opportunities for eco-tourism, impact on water resources, flood prevention, and drought control services and we have calculated some of them on the basis of all India value from the previous studies.

Green SNP for Goa State

5.3 Environmentally Adjusted SDP and Limitations of the Study

We can now put together the sectoral studies and adjust the SDP. The green SNP for Goa can be calculated by considering the State Gross Domestic Product, depreciation value, loss of income due to environmental degradation from various sectors viz., solid waste, air pollution, water pollution and deforestation (or afforestation) activities. Avoidance cost is also taken into account for the SNP. Keeping all these difficulties into consideration, the Net SNP for Goa has been calculated. The table given below provides the figures for these calculations.

Environmentally Adjusted SDP of Goa 2003-04			
1.	SGDP		9657 Cr.
2.	Depreciation		1748Cr.
3.	S Net DP (1-2)		7909 Cr.
4.	Loss of income due to Environmental Degradation		
	4.a	Uncollected Urban Municipal Solid Wastes	1.4 Cr.
	4.b	Unaccounted cost of Landfill sites	11 Cr.
	4.c	Avoidance Cost	0.4 Cr.
	4.d	Industrial Air Pollution	517 Cr.
	4.e	Industrial Water Pollution	-
		Total	529.8 Cr.
5.	Depreciation Accumulation of Environmental Capital		
	5.a	Deforestation (Afforestation) TEV of Forests	(-) 550 Cr.
6.	Environmentally Adjusted SGDP (1-4)		9127.2 Cr.
7.	Environmentally Adjusted Depreciation (2+5)		1198Cr.
8.	Environmentally Adjusted SNDP (6-7)		
		(9127.2-1198) Cr.	**7929.2 Cr.**

The State Gross Domestic Product (SGDP) of Goa is Rs.9657 Crores for the year 2003-04. The depreciation value for the same year is Rs.1784 Crores deducting the depreciation value from SGDP gives Net State Domestic Product of Goa state is Rs.7909 Crores.

Loss of income due to environmental degradation is due to several factors but here we have accounted only for some of them:

a) Uncollected urban municipal solid wastes causing loss to environment and that are Rs.1.4 Crores.
b) The environmental degradation due landfill sites that is unaccounted in the national accounts is Rs.11 Crores.
c) Avoidance cost for the solid waste management is 0.4 Crores and
d) Environmental degradation causing loss of income due to industrial air pollution is Rs.517 Crores.
e) Afforestation activities are going in Goa state and that has led to increase in environmental capital and therefore the contribution due forest is Rs.550 Crores.

Environmentally adjusted SGDP: - State Gross Domestic product – Loss of income due to environmental degradation (1-4).

Environmentally adjusted depreciation is sum of 2 and 5. But here the forest cover is increasing, so the environmentally adjusted depreciation is 2+ (-5).

The Environmentally adjusted SNDP (6-7) comes out to be Rs.7929.2 Crores.

5.4 Limitations of the Study

The study has demonstrated how environmentally SGDP and SNDP can be estimated. Given the limited resources, the emphasis has been on illustrating the methodology. The various surveys sample have also shown what kind of data needs to be collected and that the needed data are collectible. The various limitations of the study and how they can be overcome are described below:

5.4.1 Urban Municipal Solid Waste

The estimates of waste generated can be improved by a larger sample size. Also waste generated from restaurants, offices and shops other than in markets need to be estimated and added to waste generated. Since we estimate uncollected waste by subtracting collected waste from generated waste, this will increase the estimate of uncollected waste.

We should also estimate the amount of waste collected for recycling by rag pickers from disposal sites. This will reduce the volume of waste for landfill and consequently the amount of land required for it. This will lower the cost of waste disposal.

Finally, landfill sites assessment is required to estimate the waste receiving capacity of the landfill sites. Also a more accurate assessment of the price of land can improve the estimate of cost of waste disposal.

5.4.2 Industrial Air and water Pollution

We have used World Bank estimates of emissions. Measurements of actual emissions by industries in Goa would improve the estimates. In any case Goa Pollution Control Board should measure these on a regular basis.

Also, we have used World Bank estimates for abatement costs. While our survey has collected some data on abatement costs, these should be collected for a number of repeated samples over the year and emissions measured at the same time to arrive at a satisfactory assessment of abatement cost functions. The same applies to treatment costs of water effluents.

5.4.3 Forest of Goa

The accounts that we have presented for Goa forest have described forestry related stocks and flows in terms of land area (under forest), physical volume (of timber and carbon) and finally monetary values. In this way, we have tried to estimate the true value of economic activity in the state of Goa.

If we look closely into the Total Economic value of the forests of Goa, it gives ambiguous values, as eco-tourism in Goa is not only due to forests but it has got several factors like, sea, beaches, and historical monuments.

Secondly, the watershed benefits and carbon sink are potential of forest and are not direct benefits and in case of fodder only 30% (approx.) of it comes from the forest.

We recognize that the results should be viewed with caution due to limitations placed by availability of data. As a result, using suitable conversion factors derives the volume lost. The data used here is from the publication of FSI's 2003 report and using all India value from previous research. Nevertheless, the study has demonstrated that forest resource accounting is feasible in India at a disaggregate level using a 'top-down' approach. There is undervaluation of NTFPs, timber, and fuel wood. In fact, forests have several other services such as biodiversity values, opportunities for eco-tourism, impact on water resources, flood prevention, and drought control services and we have calculated some of them on the basis of all India value from the previous studies.

Review: Pilot Project on Natural Resource Accounting in Goa (Phase 1)

ANNEX 1

A1 Introduction

A1.1 The report, "**Pilot project on natural resource accounting in Goa (Phase 1)**", begins with an overview on Goa; the demographic profile, main economic activities and environmental pressures in the state. Chapter 3 examines advances in the field of Natural Resource Accounting (NRA) with the objective of evolving a resource accounting framework for the state. The subsequent chapters (4-8) in the context of the framework discussed in the previous chapter provide physical and economic accounts to assess the depletion and degradation of natural resources in the state for the period 1991 to 1996. The sectors that have been covered in the first phase of the project are Land-use change; Forest resources; Mineral resources; Energy and emission accounts for the transport and domestic sector.

The report states that the scope of the first phase is restricted by availability of secondary data and one of its main objectives is to identify areas where additional primary data for the second phase will be necessary.

This chapter provides an overview of the Phase-I, the methodology used and the findings for each sector. The chapter also highlights the limitations and strengths of the study, and measures on how they may be dealt with.

A1.2 Sector-Wise Summary and Comments

i) Land-use Change

'Chapter 4: Land-use Change' of 'Pilot project on natural resources accounting in Goa (Phase1); had the primary objective to account for land-use changes in Goa due to economic activities such as agriculture, mining and tourism for the period 1991-1996, using secondary data.

The methodology adopted for physical accounting is the opening stock-closing stock approach. The framework is as under:

Table A1.1: Framework for physical accounts of land-use

Land-use categories (hectares)	
Opening stock	Area under forest, land not available for cultivation, cultivable wasteland, net area sown, etc. at the beginning of accounting period
Other accumulation	Change in land-use (transfer of land from one use to another)
Other volume changes	Change in land use and land area due to natural, political or other non-economic issues
Closing stock	Area of and under forest, land not available for cultivation, cultivable wasteland, net area sown, etc. at the end of accounting period

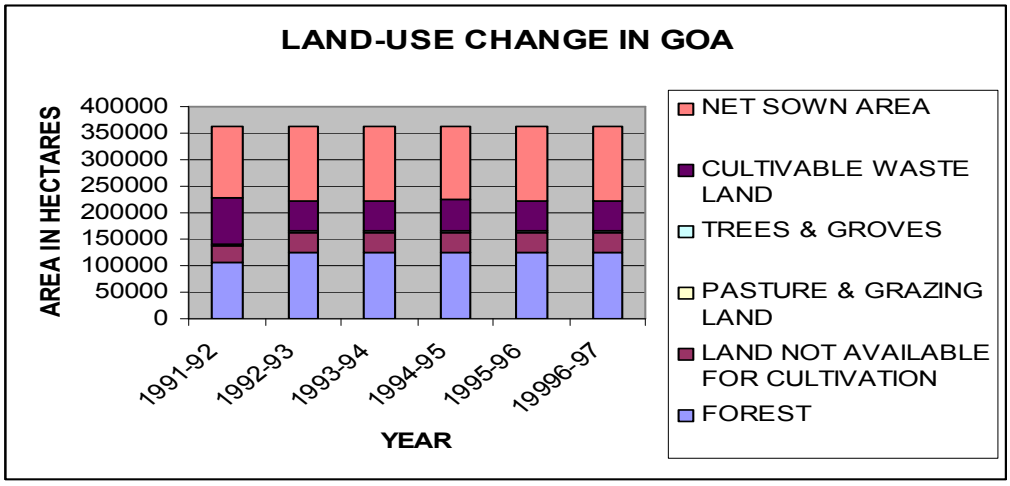
The following land-use categories were considered for accounting:

Forests

Land not available for cultivation (including area under barren uncultivable land and land put to non-agricultural uses such as construction, roads and area under water).Permanent pastures and other grazing land. Land under miscellaneous tree crops and groves, cultivable wasteland (including area under fallow, both current and other than current fallow), net sown area.

The analysis showed that major land-use change occurred only during the year 1992-93 with no significant change in other years. 'Physical accounts' show that the area under forests, land not available for cultivation and net sown area had increased however the area under cultivable wasteland reduced. Area under permanent pastures and grazing land and land under miscellaneous tree crops had remained changed. This is illustrated in the chart below.

FigA1.1: Land Use Change in Goa, 1991-97



The analysis on agricultural land conversions at the taluka level to study the impact of tourism indicated that tourism was accelerating land use change from agriculture to non-agricultural uses. This is illustrated in the table below.

Table A1.2: Taluka-wise agricultural land conversion (area in hectares)

Taluka	1991		1992		1993		1994		1995		1996		Total Land Conversion
	R	NR	R	NR	R	NR	R	NR	R	NR	R	NR	
Sanguem	0.1	0	0.1	0.1	36.3	60.3	12	0	8.9	50	88.9	68.2	324.8
Tiswadi	7.9	0	85.4	0	3.8	0	14.2	0	51.9	0.4	59.2	0	222.7
Bardez	22.2	0	10.1	52.7	19.9	34	9.6	1	28.8	0.9	32.2	0.3	211.7
Salcete	27.9	0	30.4	6	23.3	0	8.7	0.9	16.8	0	23.8	0	137.9
Ponda	11.1	0	0.2	0	7	0.2	5.4	0	32.4	20.6	6.7	5.7	89.8
Bicholim	0.8	0	0	0	0.1	8.7	4.2	0	0.3	9.4	4.4	10.7	38.6
Pernem	0	3.5	21.6	0.1	0.1	0	0	0	0	0	12.8	0.2	38.3
Sattari	0	15.1	0	0	0	0	0	0	0.2	0.4	0.2	0	15.9
Canacona	0	0	0	0	2.8	0	0.1	0	8.5	0	2.4	0	13.9
Marmugao	0	0	0.1	0	0.9	0	1.8	0	0.6	0	8.9	0.6	12.9
Quepem	0	0	0	0	0.1	0	0.1	0	1.4	0	0.1	0.6	2.3

To assess agricultural land productivity, production of major crops was analyzed, in relation to area cropped, yield and so on. Agricultural productivity of major food and cash crops remained stable or decline marginally during the study period.

Mining was also found to be accelerating the process of land use change.

Table A1.3: Changes in land use pattern due to mining activities (1988-97)

	1988	1997	Change in Area
Mine pits	1055	1609	(+) 554 (52%)
Dumps	959	1301	(+) 342 (36%)
Beneficiation plants	74	116	(+) 42 (57%)
Tailings ponds	89	204	(+) 115 (129%)
Stockyards	127	118	(-) 9 (7%)
Mine area total	2304	3348	1045 (2%)

Comments

Although the study analyses the trends in agricultural production and yields of principal crops (indicators of yield and productivity) during the accounting period, it is not followed by an analysis on the impact of these changes on future earnings. There has been also no attempt to derive optimal land use patterns. These subsequent steps are not covered in the analysis.

The report mentions that land used for tourism related activities is not separately classified in land –use statistics and was not available from any other source either. Hence changes to land use on the account of tourism has been analyzed on the basis of variations in land conversion from agricultural land to residential or non-residential use among different talukas of Goa in relation to tourist arrivals there. However, (Economic Survey of Goa, 2003-04, Pg 6), there area a number of studies that indicate the multiplier effect of tourism in the economy; its contribution can be linked to most of the sectors of SDP. For instance 'Trade, Hotels and Restaurants' a component of service sector contributes about 15% of value addition to the SDP and it is a fact that most of the hotels and restaurants mainly cater to the tourism industry. Tourism has also activated other sectors like transport, banking, insurance, real estate etc., all of which contribute significant value addition in the SDP. The study should have included the above variables in its analysis.

Physical accounting is only the first step towards studying the impacts of use changes or land quality on long-term income. It is difficult to say whether a change in the pattern of land utilization is desirable or not unless an optimal pattern for the region is established.

This has not been dealt with in this study. In the absence of such knowledge, a change in the land-use pattern per se cannot be integrated with natural resource accounting.

The framework adopted in the Phase1 report rests on the premise that land quality will change (improve or deteriorate) due to continuous use or change of use. The study however does not analyze the changes in land quality in monetary terms (Monetary Accounting).

In order to value land quality changes, damage cost function or production function approach could have been used or alternatively the cost of restoration could have been determined. Hence, benchmarking soil for major land-use types in different agro-ecological regions of India based on primary field investigations is essential to arrive at a generally acceptable norm for each of the land quality parameters. These in turn, should be regularly monitored to capture changes over time. Further, remotely sensed data could be used to map land-use changes, especially if the accounting period is sufficiently long. Satellite images from Indian remote sensing satellites are readily available for the past 15 years. GIS tools could be used to analyze the spatial differences in land-use in different periods.

ii) Forest Resources

'Chapter 5: Forestry Resources' of 'Pilot project on natural resources accounting in Goa (Phase1); had the primary objective to prepare physical and monetary accounts (both assets and income) to determine the extent of depletion of forest reserves due to production/consumption of timber and fuelwood in Goa. The chapter begins with a current system of forest resource accounting and prepares the physical and monetary accounts for the forest asset in Goa. The value of depletion is estimated and adjusted against the reported value added by the forestry sector.

Table A1.4: Value added by the forestry sector adjusted for depletion (current prices)

	Conventional Accounts			Depletion	
	Value added by forestry and logging	SDP (lakhs)	% of forestry and loggin in SDP	Value (Rs lakh)	% of value added by forestry and logging
1993-94	2167	188651	1.15	-400	-18.50%
1994-95	1590	209554	0.80%	-571	-35.90%
1995-96	1747	242877	0.70%	-519	-29.70%
1996-97	2072	257389	0.80%	-696	-33.60%

The estimation of Gross Value Added (GVA) by the sector is based on the following underlying assumptions:

In the case of industrial wood, the value of unrecorded production is taken to be 10% of recorded production. Typically, CSO estimates industrial and other uses of fuelwood at 6% of household consumption.

In the case of MFPs (minor forest products), the economic value is taken as 10 times the royalty value.

Costs of material inputs such as transportation, water, electricity, fuel, normal repairs and maintenance of fixed assets are assumed at 10% of the value of output.

The study adopts the net price method of economic valuation of forests adapted from Bateman and Turner (1993) and cited in Chopra and Kadekodi (1997). This method applies the prevailing average net price per unit of the resource (current revue less current production cost) to the physical quantity of reserves and changes therein. The method requires only current data on prices and costs and assumes competitive market equilibrium.

Comments

The value of non-timber forest produce and ecological services provided by forests is not attempted here. There are major gaps in the data that need to be filled to facilitate a better

understanding of the services provided by forest and their contribution to national income and wealth.

As CSO itself notes, there are several discrepancies in the current system of accounting for income from the forestry sector. It does not distinguish among the extensive variety of tree species and timber quality. There is no proper recording of the output of timber, fuel-wood, pulpwood etc. from the privately owned forests. Data for most minor forest products is totally inadequate. The coverage of the conventional accounts is inadequate as it partially covers forest products and totally ignores intangible services provided by forests. The system mainly accounts for commercial wood and fuel-wood at the market prices and some minor forest products based on notional values. The sustainability of extraction of forest products is not taken into account and hence there is no provision for forest depreciation, which results in a long-term loss in the productive capacity of forests.

The study accounts for public and private forests and does not distinguish between forest resources that have a market and those, which don't have a market. This distinction is of importance as it suggests which valuation tool maybe used to identify the value of a forest good. All forests are treated as non-produced economic assets. There has been no attempt to value forest services, which provide indirect use value, bequest value, existence value and so on.

Physical and monetary balances should be ideally disaggregated by type of forest (native or planted) and density to provide a detailed description of change in forest reserves. Further, minor forest products such as bamboo and cane and other services provided by forests are not accounted.

iii) Mineral Resources

Chapter 6: 'Mineral Resources' of 'Pilot project on natural resources accounting in Goa (Phase 1)' aims at estimating the cost of iron ore depletion in the state to derive the contribution of the sector to SDP, net of this cost. The cost of depletion represents the depreciation in stock of an exhaustible natural resource. This in turn has been estimated as the amount that needs to be set aside or reinvested in other forms of capital assets capable of providing at least the same economic benefits to compensate for the current consumption of exhaustible natural assets.

TERI used the following framework for developing physical and economic accounts to study the depletion of iron ore in Goa.

Proven reserves of iron ore	
Opening stock	Stock of mineral resources at the beginning of the accounting period
Other accumulation (+ / -)	Accretion to reserves
Other volume changes	Catastrophic losses etc.
Closing stock	Total change in stock

The following categories were considered for physical accounting of iron – ore depletion:
Proven resources as estimated by the Indian Bureau of Mines.
Total iron ore mined and sold.
Volume reductions on account of non – economic factors such as natural disasters.
Remaining exploitable reserves of iron ore at the end of each period.

For monetary accounting of iron ore depletion and adjusting the State Domestic Product, User Cost and Net Price methods were used in the study.

The report mentions that the value of depletion is sensitive to two factors (apart from the resource rent, i.e. prices and costs), the lifetime of the resource and the discount factor. During the time of study, at current prices, depletion as a percent of value added by the mining and quarrying industry in Goa ranged from 26% (at 6% rate of discount in 1994 / 95, when the prices were lowest) to 168% (at 0% rate of discount in 1992 / 93). Apart from depletion of ores, the other external costs of mining are resource costs (due to depletion of mineral and ground water depletion), environmental costs (due to loss of forests and biodiversity), health and other costs (due to air and water pollution) and other social costs such as loss of agricultural livelihoods.

Table A1.5: Resource, environmental and social costs of mining in Goa, (Rs lakh), 1996/97 prices.

Resource cost	Health costs	Economic costs of agriculture loss			
Ground water depletion	Environmental costs at 6% rate of discount	Water Pollution	Air pollution	Loss of Crop productivity	Loss of agricultural land (discounted at 6%)
11.3-13.0	4202.4	1	49.2 - 69	1.5	550.1

The analysis indicated that due to lack of accretion, mining of the ore had led to a sharp decline in the iron ore stock available for the future use. There was a **28% decline** in the stock over the study period.

Comments

The study attempts to value environmental and social costs of mining in Goa, however this is not comprehensive. These are potential costs that result from mining activity and cannot be ignored in the accounting framework. The resource, environmental and social costs of mining should be explored further for a comprehensive assessment of these and other costs. Further other costs such as socio – cultural transitions in community due to relocation of people can be studied.

Physical and monetary accounting by way of estimating volume changes by ore grade has not been done on the grounds that production cost information grade wise was not available. These data gaps need to be filled to get a more realistic estimation.

The pattern of investment by the mining industry also needs to be studied to assess the extent to which the industry is reinvesting the capital cost of depletion in various forms of capital.

iv) Energy and Emission Accounts: Transport Sector

Chapter 7: Energy and Emission Accounts: Transport Sector' of 'Pilot project on natural resources accounting in Goa (Phase1) prepared by TERI; had the primary objective to develop energy consumption and emission accounts for the road transport sector in Goa. Emission inventories are prepared for the first and the last year, 1991 and 1996, to study changes over the period. The pollutants studied were carbon monoxide (CO), hydrocarbons

(HC), oxides of nitrogen (NO_x), total suspended particulates (TSP) and sulphur dioxide (SO_2)

The following methodology was used to prepare energy consumption and emission accounts for the transport sector in Goa. Establishing a source inventory for the whole state Estimating fuel consumption for each source using vehicle utilization and fuel efficiency norms.Verifying estimated fuel consumption with actual fuel sales in the state.
Estimating emissions of pollutants such as CO, HC, NO_X, TSP and SO_2 using emission factors. Emissions were estimated at the sate level.
The actual emissions of pollutant X, from a particular vehicle type T, were estimated as:
T_X = Number of vehicles * Vehicle utilization (km/year) * Emission factor (g/km)
Where the emission factor is given in g/km

Alternatively,

$$T_X = \frac{\text{Number of vehicles * vehicle utilization (km/year)}}{\text{Fuel Efficiency (km/litre)}} * \text{emission factor (g/litre)}$$

Where the emission factor is given in gm/litre
The study concludes that there has been a significant rise in the number of vehicles in Goa, which has resulted in a drastic increase in emissions from the sector. The number of vehicles increased by almost 70% over the study period.

Table A1.6: Number of Vehicles on Road in Goa, 1991 and 1996.

Category	**1991**	**1996**
Motorcycles on hire	3820	4497
Motorcycles and scooters	96516	162484
Private cars and jeeps	15939	31009
Goods vehicles	10576	17273
Taxis	2628	4709
Buses	1196	2064
Kadamba Buses	299	302
Tractors	366	411
Auto-rickshaws	1497	2354
Government Vehicles	2247	2796

The emissions of most pollutants increased by around 60% in the five year period. Emissions were estimated using fuel consumption and emission factors for different vehicle categories.

Table A1.7: Total emissions from road transport sector (tonnes).

	CO	HC	NOx	TSP	SO_2
1991	17373.42	6218.92	11585.48	1359.37	1387.81
1996	28435.84	10020.67	18705.38	2175.02	2211.03
% Increase	63.67	61.13	61.46	60	59.32

In both the periods two-wheelers were the largest contributors to the total CO emissions, contributing over 30%, followed closely by goods vehicles. Two –wheelers contributed as much as 55% to the total emissions of hydrocarbons. Goods vehicles on the other hand, were the single largest emitters of NOx, TSP and SO_2 contributing as much as 60%, 50% and 35% of the total respectively.

The study examined the trends in emissions of CO and TSP from the combustion of domestic fuels. It was suggested that the emissions of these two pollutants declined by 20% in the rural areas over the study period. This has been primarily because of the shift to cleaner fuels.

Comments

The following are important issues that need to be addressed:

Again, the report calculates only the annual quantity of emissions of different pollutants but not the cost of pollution. Socio-economic, especially health costs, and environmental costs need to be assessed.

The difference in vehicle utilization across states and regions has not been taken into account. Vehicle utilization is also likely to vary by sector – for instance, vehicle utilization of taxis engaged in the tourist sector would be different from those in the non-tourist sectors.

Disaggregated data on vehicle population (for instance, number of trucks and lorries articulated vehicles under the category goods vehicle) has not been used. This is necessary to enable a more realistic estimation of fuel consumption and emissions.

Even though the ambient concentration of pollutants is within the standards at the two monitoring locations, there may be critical areas where this is not the case. Such areas have not been identified.

Water transport is an important mode of transport and goods movement in coastal areas is a potential source of air and water pollution. Their fuel consumption and emission factors have not been studied.

v) Energy and Emission Accounts: Domestic Sector

'Chapter 8: Energy and Emission Accounts: Domestic Sector' of 'Pilot project on natural resources accounting in Goa (Phase1) attempts to estimate emissions arising from the consumption of fuels in the household sector in Goa. Emission inventories were prepared to study the changes over the period 1991 – 1996. The study focused particularly on carbon monoxide and suspended particulate matter.

The following steps were adopted in preparing emission accounts.

Estimating the quantity of different fuels used in rural and urban areas based on estimates of per capita fuel consumption and proportion of households using different fuels and population data for urban and rural areas based on data from 1991 and 2001 census.

Quantity of fuel, X, used = Per capita monthly consumption of fuel X% of population using fuel X*12*Total Population.*

Validating fuel consumption estimates thus derived by reported fuel sales in the state.

Estimating the emission of different pollutants in rural and urban areas of Goa based on emission factors for different fuels i.e.

*Emissions of pollutant Y from fuel X = Quantity of fuel X used * Emission coefficient of Y from fuel X.*

The study revealed that while the consumption of fuel wood decreased in rural areas (a decline of 11%), and in urban households (70% decline), the per-capita monthly consumption of electricity increased in both rural and urban households by 40 and 100% respectively.

Table A1.8: Estimated total consumption of various fuels by households in Goa, 1991-1996.

		Firewood and chips ('000 tonnes)	Electricity (million st units)	Kerosene(000 tonnes)	LPG(000 tonnes)
1991	RURAL	79.1	82	4.9	1.6
	URBAN	8.5	42.5	5.8	3.3
	TOTAL	79.1	124.5	10.6	4.8
1996	RURAL	53.5	117.6	6.7	4.4
	URBAN	2.1	107.7	4.5	9.2
	TOTAL	55.5	225.2	11.3	13.6
% Change	RURAL	-24.2	43.4	38.9	184.1
	URBAN	-75.9	153.2	-21.1	179.8
	TOTAL	-29.8	80.9	6.3	180.9

The study concludes with the analysis that there has been a marked shift from fuel wood to cleaner fuels such as electricity and LPG in urban and rural households of Goa. This shift has been responsible for the marked reduction in emissions. In addition the use of non-conventional fuels such as biogas has also grown in the state.

Comments:

The report calculates only the annual quantity of emissions of different pollutants but not the cost of pollution. Socio-economic, especially health costs, and environmental costs need to be assessed.

To substantiate this study on emissions, IRADe has prepared the study which provides the abatement cost of pollution from industries.

A2.1 Composition of waste generated in five municipalities

Figure A1 shows the composition of waste generated in Goa. It includes paper, plastics, textiles, glass, metals, organic waste, food waste and other wastes. Plastics form the largest share of 40% (1388 tonnes/month) while organic (846 tonnes/month, 24%) and food waste (454 tonnes /month i.e. 13%) together form 47% of total waste generated. Paper waste form a small part i.e. 9% (301 tonnes) of total waste generated per month.

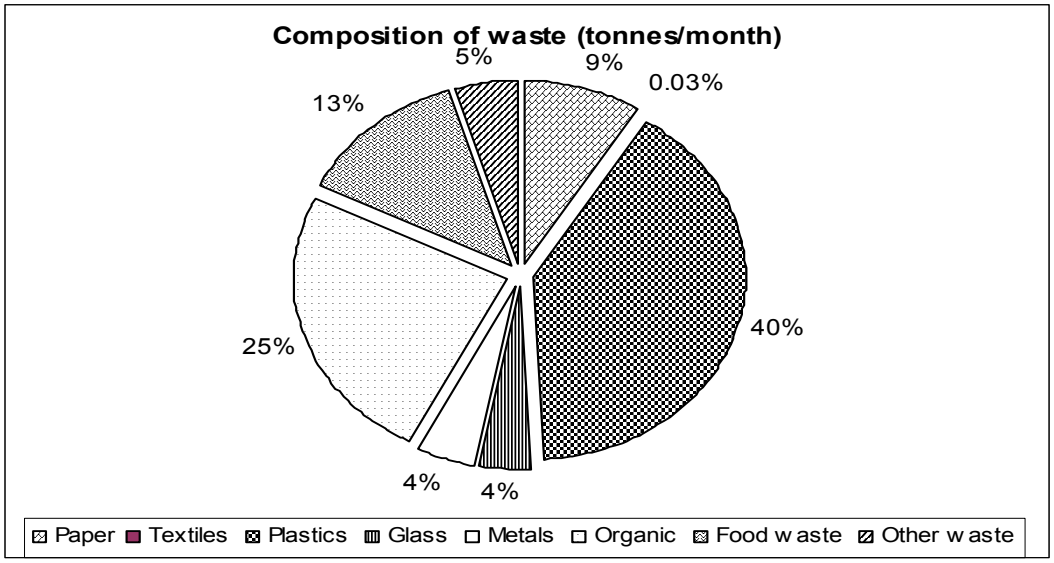
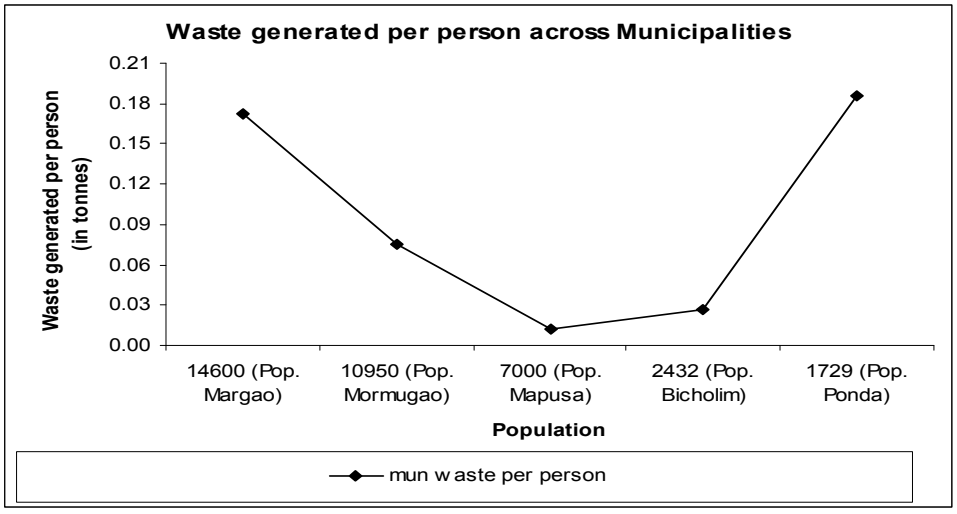


Figure A2.1: Composition of waste generated in five municipalities (percentage)

According to the data available from 5 municipalities it can be observed that about 100 tonnes of waste is collected daily. On comparison across municipalities for municipal waste generated per person versus population it is found that the municipal waste has direct relationship with the population for most of the municipalities (Figure A2.2). The data of other wastes are almost insignificant to come to any conclusion.



Source: IRADe study

Figure A2.2: Comparison of waste generated per person across municipalities

A1.2 Employment information:

Solid waste management in Goa consists of three functions viz., collection, transportation and disposal. There are various categories of workers involved at the three functions as can be seen from figure A2.3. Details of staff, vehicles and equipments are given in Annex 2.

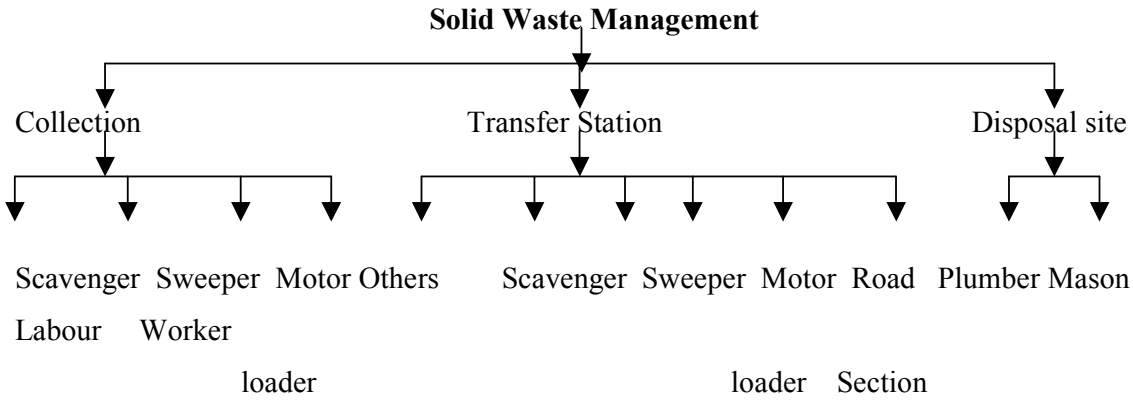


Figure A2.3: Workers at the three levels

A2.3 Details of waste treatment and disposal facility

Waste treatment and disposal facilities are available at only few municipalities. The details of other municipalities are not available. These facilities handle waste from 10 tonnes / day to 40 tonnes /day depending on their capacity (Table A2.1).

Table A2.1: Details of waste treatment and disposal facilities

	Treatment plants number	Landfill sites number	Landfill sites annual inputs (In Tonnes)	Other waste treatment/disposal facilities capacity (In Tonnes)	Waste Handled per day (Tonnes)	Amount of waste processed per day (Tons)	Land requirement for whole process (hectares)
Mapusa Municipal Council	0	1	7200	7200	20	20	20000sq.mtr.
Mormugao Municipal Council	1	1	14600		40	40	12000sq.mtr.
Ponda Municipal Council							
Bicholim Municipal Council	0	1	3650		10		40 sq.mtr.
Margao Municipal Council							

Source: IRADe study

ANNEX 3

A 3.1 Staff Details

Table A2.1: Details of staff at collection, transfer and disposal site

Municipality	Total staff for collection	Total staff at transfer site	Total staff at disposal site
Mapusa Municipal Council	80	170	Disposal site handled by private vendor (Housing board)
Mormugao Municipla Council	66		Disposal site handled by private vendor (M/s Camtrol)
Ponda Municipal Council	40		
Bicholim Municipal Council	30		2
Margao Municipal Council	81		10

Source: IRADe study

A3.2 Vehicle details

Table A3.2: Details of vehicles used for collection, transportation and disposal

Municipality	Compactors	Refuse Tippers	Trucks	Jeeps /Rickshaws etc.	Others (Close trucks)
Mapusa Municipal Council	2		7	0	
Mormugao Municipal Council	5		2	0	0
Ponda Municipal	2		0	1	2

Council					
Bicholim Municipal Council	1		3	1	
Margao Municipal Council	3	6	3	2	

Source: IRADe survey

Table 3.3: Willingness to pay for better services

North / South	**Towns**	**Amount paid per month**	**Amount willing to pay per month**
North Goa	Panjim	Amount	Amount
North Goa	Panjim	30	30
North Goa	Panjim	0	This Service should be free
North Goa	Panjim	30	30
South Goa	Margao	30	30
South Goa	Margao	0	30
South Goa	Margao	0	This Service should be free
South Goa	Margao	0	30
South Goa	Canacona	0	This Service should be free
South Goa	Canacona	0	30
South Goa	Canacona	0	This Service should be free
South Goa	Canacona	0	30
South Goa	Palolim	0	This Service should be free
South Goa	Palolim	0	This Service should be free
South Goa	Palolim	0	This Service should be free
South Goa	Palolim	0	This Service should be free
North Goa	Mapusa	0	This Service should be free
North Goa	Mapusa	0	This Service should be free
North Goa	Mapusa	0	This Service should be free
North Goa	Mapusa	0	This Service should be free
North Goa	Bicholim	0	This Service should be free

North Goa	Bicholim	0	This Service should be free
North Goa	Bicholim	0	This Service should be free
North Goa	Bicholim	0	This Service should be free
South Goa	Zuari Nagar	0	30

Source: IRADe survey

ANNEX 4

Air & Water Pollution

A4.1 Calculations Involved

Applying appropriate conversion factors to IPPS and ASI data to arrive at pollution load and abatement costs

In the IPPS:

1. Pollution intensities (emission factors) are in pounds per US$ million at 1987 prices.
2. Abatement cost coefficients (cost per ton abated) are in US$ per ton abated at 1993 prices.

The Annual Survey of Industry (ASI) output data is in thousand rupees at current (2000-01) prices. The Indian financial year (FY) runs from April 1 to 31 March. FY reports all data. We assume calendar year t = FY t - t+1, e.g., calendar 1987 = FY 1987-88.

The following steps are used in calculating pollution loads:

1. Convert IPPS pollution intensities to Indian rupees (INR). In 2000 - 01, INR 45.684= US$ 1. (Source: Economic Survey 2004-2005 Table 6.5 http://www.indiabudget.nic.in/es2004-05/). So, multiplying pollution intensity by 0.45/45,684 gives us kilograms (of SO_2, NO_2, etc.) per thousand INR in 2000 - 01.

2. To find out pollution load of year 2000-01 we use ASI output data of Goa of 2000-01 and IPPS pollution intensity for air pollutants for the year 2000 - 01.

$$U * V = Z$$

Where:

(U) ASI output data of 2000-01

(V) IPPS pollution intensity

(Z) Pollution load

3. Convert IPPS abatement cost coefficients to INR at 1987-88 prices.

(i) First, multiply IPPS figure by 31.399 (in 1994-95, INR 31.399 = US$ 1, Economic Survey Table 6.5, op. cit.) to arrive at rupees per ton abated in 1994-95 prices.

(ii) Then inflate using compound inflation rate to arrive at 2000 - 01prices. The compound inflation rate is calculated by the following formula:

$Pn = P0 (1+r)^{n}$

The compound inflation rate for the year 2000 – 01 was 3.8%. This was used to inflate the IPPS abatement coefficients to the price of 2000 – 01. The abatement coefficient thus arrived was multiplied by pollution load of Goa to arrive at the average abatement cost of SO_2, NO_2 and TSP of various industrial sectors of Goa. Thus,

$$\mathbf{P_L * Ac = P_{AC}}$$

Where

P_L = Pollution load of Goa

Ac = Abatement cost coefficient of 2000 – 01

P_{AC} = Pollution cost abatement of Goa in the year 2000 – 01

Table A4.1: BIS Standards (BIS: 2490 – Part 3 - 1985)

Parameters	**Receiving water body**		
	Inland surface waters	**Public sewers**	**Land for irrigation**
pH	6.0 – 9.0	6.0 – 9.0	6.0 – 9.0
Suspended Solids, mg / L	100	600	200
BOD, at 20º C, mg / L	30	350	100
COD, mg / L	250	-	-
Total dissolved solids, mg / L	2100	2100	2100
Sulphide as S, mg / L	2.0	2.0	2.0
Total Chromium, as Cr, mg / L	2.0	2.0	2.0
Oil and Grease, mg / L	-	-	-
Hexavalent Chromium, C+6, mg / L	-	-	-
Chlorides, mg / L	1000	1000	600
Sodium, percent	-	-	-

Table A4.2 gives the criteria and class of water quality as designated by CPCB. Class A water is the highest class water that can be used for drinking purposes whereas Class E water is not fit for drinking, washing or bathing but is suitable only for industrial and irrigation purposes. The water quality below Class E is not fit for any purpose and hence regarded as polluted.

Table A4.2: Water quality criteria

Designated-Best-Use	**Class of water**	**Criteria**
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms OrganismMPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
Outdoor bathing (Organised)	B	1. Total Coliforms Organism MPN/100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Propagation of Wild life and Fisheries	D	1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH betwwn 6.0 to 8.5 2. Electrical Conductivity at 25oC micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Source: Central Pollution Control Board

Table A4.3 shows the National ambient air quality standards.

Table A4.3: National ambient air quality standards (NAAQS) for India (in µg/m^3)

Pollutant and time-weighted average	Concentration in ambient air			
	Industrial area	Residential, rural, and other areas	Sensitive area	Methods of measurement
Sulphur dioxide Annual average 24 hours	80.00 120.00	60.00 80.00	15.00 30.00	*Improved West and Gaeke method * Ultraviolet fluorescence
Oxides of Nitrogen Annual average 24 hours	80.00 120.00	60.00 80.00	15.00 30.00	*Jacob and hochheiser modified (Na-Arsenite) method *Gas-phase chemilluminescene
Suspended particulate matter Annual average 24 hours	360.00 500.00	140.00 200.00	70.00 100.00	High-volume sampling (average flow rate not less than 1.1 m3 per minute)
Respirable particulate matter (size less than 10 µgm) Annual average 24 hours	120.00 150.00	60.00 100.00	50.00 75.00	Respirable particulate matter sampler
Lead Annual average 24 hours	1.00 1.50	0.75 1.00	0.500 0 .750	Atomic absorption spectrometry after sampling using EPM 2000 or an equivalent filter paper
Carbon monoxide 8 hours 1 hour	5.00 10.00	2.00 4.00	1.00 2.00	Non-dispersive infrared spectroscopy
Ammonia Annual average 24 hours	-----	400.00a 100.00a	----	

Source: Central Pollution Control Board

Table A4.4: Permissible limits described for different parameters of effluent water for different types of industries as per the Environment (protection) Rules 1986

Sr. No.	INDUSTRY	PARAMETER	STANDARDS
1	2	3	4
		Concentration in the effluents not to exceed milligramme per Litre (Except for Ph)	
1.	***Aluminium Smelter*** Green anode shop Anode bake oven Pot room	Particulate matter Particulate matter Total fluoride *For soderberg technology For pr-baked technology *Separate standards for VSS, HSS, PBSW & PBCW as given in column 4 stands abolished.	150 mg/l 50 mg/Nm^3 2.8 kg/ton by 31st December 2006 0.8 kg/t by 31st December 2006
2.	***Basic Drugs and Pharmaceuticals***	Effluents, Concentration in the effluents not to exceed milligramme per Litre (Except for Ph)	
		pH Oil & Grease Total Suspended Solids BOD (3-days at 27°C) Bio-assay test Mercury Arsenic Chromium (Hexavalent) Lead Cyanide Phenolic (as C_6H_5OH) Sulphides (as S) Phosphates (as P)	5.5-9.0 10 100 30 90% survival of fish after 96 hrs. in 100% effluent 0.01 0.10 0.10 0.10 0.1 1.0 2.0 5.0
3.	***Cement***	No discharge of waste water effluent	
4.	***Distilleries***	Not Available	
5.	***Fertiliser***	Concentration in the effluents not to exceed milligramme per Litre (Except for Ph)	
	Effluent-Straight Nitrogenous Fertilisers excluding the Calcium Ammonium Nitrate and Ammonium Nitrate Fertiliser	Plants commissioned January 1, 1982 onwards	Plants Commissioned prior to January 1, 1982
	pH Ammonical Nitrogen Total Kjeldahl Nitrogen Free Ammonical Nitrogen Nitrate Nitrogen Cyanide as CN Vanadium as V Arsenic as As Suspended Solids Oil & Grease	6.5-8.0 50 100 4 10 0.2 0.2 0.2 100 10	6.5-8.0 75 150 10 0.2 0.2 0.2 100 10

	*Hexavalant Chromium as Cr	0.1	0.1
	*Total Chromium as Cr	2.0	2.0
	*To be complied with at the outlet of Chromate removal unit.		
	Straight Nitrogenous Fertilisers including Calcium Ammonium Nitrate & Ammonium Nitrate Fertilisers	Plants commissioned January 1, 1982 onwards	Plants Commissioned prior to January 1, 1982
	pH	6.5-8.0	6.5-8.0
	Ammonium Nitrogen	50	75
	Total Kjeldahl Nitrogen	100	150
	Free Ammonical Nitrogen	4	4
	Nitrate Nitrogen	20	20
	Cyanide as CN	0.2	0.2
	Vanadium as V	0.2	0.2
	Arsenic as As	0.2	0.2
	Suspended Solids	100	100
	Oil & Grease	10	10
	*Hexavalant Chromium as Cr	0.1	0.1
	*Total Chromium	2.0	2.0
	*To be complied with at the outlet of Chromate removal unit.		
	Complex Fertilisers, excluding Calcium Ammonium Nitrate, Ammonium Nitrate & Ammonium Nitrophosphate Fertilisers	Plants commissioned January 1, 1982 onwards	Plants Commissioned prior to January 1, 1982
	pH	6.5-8.0	6.5-8.0
	Ammonium Nitrogen	50	75
	Free Ammonical Nitrogen	4	4
	Total Kjeldahl Nitrogen	100	150
	Nitrate Nitrogen	10	10
	Cyanide as CN	0.2	0.2
	Vanadium as V	0.2	0.2
	Arsenic as As	0.2	0.2
	Phosphate as P	5	5
	Oil & Grease	10	10
	Suspended Solids	100	100
	*Flouride as F	10	10
	**Hexavalent Chromium as Cr	0.1	0.1
	**Total Chromium as Cr	2.0	2.0
	Complex Fertilisers, including Calcium Ammonium Nitrate, Ammonium Nitrate Ammonium Nitrophosphate Fertilisers	Plants Commissioned January 1	Plants Commissioned prior to January 1, 1982
	pH	6.5-8.0	
	Ammonical Nitrogen	50	
	Free Ammonical Nitrogen	100	
	Nitrate Nitrogen	20	
	Cyanide as CN	0.2	
	Vanadium as V	0.2	
	Arsenic as As	0.2	
	Phosphate as P	5	

	Oil & Grease Suspended Solids *Fuoride as F **Hexavalent Chromium as Cr **Total Chromium as Cr *To be complied with at the outlet of Flouride removal unit. If the recipient system so demands, Fluoride as F shall be limited to 1.5 mg/l **To be complied with at the outlet of Chromate removal unit. Straight Phosphatic Fertilisers pH Phosphate as P Oil & Grease Suspended Solids *Flouride as F **Hexavalent Chromium as Cr **Total Chromium as Cr	10 100 10 0.1 2.0 7.0-9.0 5 10 100 10 0.1 2.0	 0.1 2.0
	Straight Phosphatic Fertilisers pH Phosphate as P Oil and Grease Suspended Solids *Flouride as F **Hexavalent Chromium as Cr **Total Chromium as Cr *To be complied with at the outlet of Flouride removal unit. If the recipient system so demands, Flouride as F shall be limited to 1.5 mg/l. **To be complied with at the outlet of Chromate removal unit.	 7.0-9.0 5 10 100 10 0.1 2.0	
	<u>Emissions</u> -Phosphatic Fertilisers (Fluoride & particulate matter emission) -Urea (Particulate matter emission)	 Phosphatic acid manufacturing Granulation, mixing & grinding of rock phosphate Prilling Tower Commissioned prior to 1-1-1982 Commissioned after 1-1-1982	 25 milligramme per normal cubic metre as total Fluoride 150 mg/normal cubic metre of particulate matter 150mg/normal cubic metre or 2 Kg per tonne of product. Cubic metre or 2 Kg per tonne of product 50 mg per normal cubic metre or 0.5 kg per tonne of product
6.	***Iron & Steel***	Particulate Matter Emission - Sintering Plant - Steel making - During normal	 150 mg/normal cubic metre 150 mg/normal cubic metre 400 mg/normal cubic

		operation - Rolling mill - Carbon mono-oxide from coke oven	metre 150 mg/normal cubic metre 3 kg/tonne of coke produced
7.	**Oil Refineries**	Concentration not to exceed, mg/l (except for pH)	
		Oil & Grease Phenol Sulphide BOD (3-days at 27°C) Suspended solids pH	10 to 7 1 to 0.7 0.5 to 0.35 15 to 10.5 20 to 14 6 to 8.5
8.	**Pesticides**	***Effluents*** Temperature pH Oil & Grease Total Suspended Solids BOD (3-days at 27°C) Bio-assay test ***Specific Pesticides*** Benzene hexachloride Carbaryl DDT Endosulfan Diamethoate Fenitrothion Malathion Phorate Methyl parathion Phenthoate Pyrethrums Copper sulphate Copper xylochloride Ziram Sulphur Paraquat Propanol Nitrogen ***Heavy metals*** Copper Manganese Zinc Mercury Tin Any other metal like Nickel, *etc.* **Organics:** Phenol & phenolic	Shall not exceed 5° C above the receiving water temperature 6.5-8.5 10 100 30 90% survival of fish after 96% hours in 100% effluent 10 10 10 10 450 10 10 10 10 10 10 50 9600 1000 30 2300 7300 780 1.0 1.0 1.0 0.01 0.1 shall not exceed 5 times the drinking water standards of BIS 1.0 0.2 0.2

		Compounds as C_6H_5OH **Inorganics:** Arsenic (as As) Cyanide (as CN) Nitrate (as NO_3) Phosphate (as P) *Emissions HCl Cl_2 H_2S P_2O_5 (as H_3PO_4) NH_3 Particulate matter with pesticides compounds CH_3CL HBr * limits should be complied with at the end of the treatemnet plant before any dilution.	50.0 5.0 not to exceed mg/Nm^3 20 5 5 10 30 20 20 5
9.	***Pulp & Paper***	Concentration not to exceed, mg/l (except for pH and sodium absorption ratio)	
	**Discharge into inland surface water* *Disposal on land* These standards are for paper mills having capacity below 24,000 MT per annum.	pH Suspended Solids BOD (3-days at 27°C) Suspended Solids Sodium absorption ratio Absorbable organic halogens (AOX) in effluent discharge	5.5 – 9.0 100 30 100 26 3.00 kg/ton of paper produced with effect from the date of publication of this notification. 2.00 kg/ton of paper produced with effect from the 1st day of March, 2006
10.	**Sugar**	Concentration not to exceed, mg/l (except for pH)	
		BOD (3-days at 27°C) Suspended solids	100 for disposal on land 30 for disposal in surface waters 100 for disposal on land 30 for disposal in surface waters

ANNEX 5

A5.1 List of Tree species as found in the District of Goa

Sl. No.	Type of Species	Area in Ha.
1.	Teak	9507
2.	Eucalyptus	5204
3.	Bamboo	223
4.	Cashew	11196
5.	Rubber	851
6.	Acrocarpus	226
7.	Casuarina	768
8.	Others	11446
9.	Roadside Plantation	1041
10.	Canal Bank plantation	1256

ANNEXURE VI

A5.2 Medicinal Plants: List of Medicinal Plants as found in the District of Goa

S.No	Common Name	Botanical Name	Parts used	Use
1.	Ganji	*Abrus precatorius*	leaves, roots and seeds	For the cure of sore throat, dry cough,ardour,urine,rheumatism, prevention of conception, for skin disease, ulcers and eye diseases, and serves as a blood purifier, a purgative and a tonic
2	Shami	*Acacia arabica*	Tender leaves, bark and gum	Treatment of gonorrhea, leucorrhoea, discharge, prolapse of uterus, diarrhoea, dysentery, diabetes, bleeding from bites of leeches and as an expectorant
3	Shikakai	*Acacia concinna*	leaves and pods	Treatment of jaundice, malarial fever, a mild laxative, biliousness, promotes growth of hair, kills dandruff and skin

				diseases
4.	Aduso	*Adhtoda vasica*	leaves, root, bark, flowers and fruits	An antispasmodic, treatment of chest diseases, phthisis, chronic bronchitis, asthma, diarrhoea, dysentery, malaria fever, fresh wounds, rheumatic joints, inflammatory swellings, scabies, neuralgic pains, nose bleeding, diphtheria, gonorrhoea, an antiseptic and arthelmentic
,985	Belpatri	*Aegle marmelos*	leaves, root, bark and fruits	A mild laxative in fever and asthma, treatment of constipation, jaundice, diarrhoea, dysentery, dyspepsia, antiscorbutic and a tonic. A sharbet of ripe fruit gives cooling effect.
6	Anasaroli	*Alangium Salvifolium*	root and bark	Treatment of dogbites, a purgative, antidote and emetic
7	Shiras	*Albizzia lebbeck*	leaves, bark, flowers and seeds	Treatment of night blindness, an astringent, piles, diarrhoea, dysentry, gonorrhoea, cure spongy gum boils, swellings, scrofulous enlargement of glands, and eye diseases.
8	Satan	*Alstonia scholaris*	Leaves and barks.	Treatment of ulcers, fevers, dyspepsia, debility, skin diseases, liver complaints, chronic diarrhoea and dysentery
9	Kaju	*Anacardium occidentale*	Bark, apple, shell oil and seed.	In leprosy, ringworm, corns, obstinate ulcers, scurvy, diarrhoea, uterine complaints, dropsy, neuralgic pains, rheumatisms, elephantiasis, the

				seed oil is an excellent emollient and used in gastroenteritis
10	. Sitaphal	*Annona squamosa*	leaves, bark, fruit and seeds	For the treatment of prolapse of anus of children, boils, ulcers, a fly infested sore, malignant tumours, hysteria, diarrhoea, acute dysentery, melancholia, spinal diseases, a tonic and an abortifacient
11	Brahma-dandi	*Argemone mexicana*	roots and seeds	Treatment of dropsy, jaundice, skin diseases, gonorrhoea, blisters, rheumatic pains, ulcers, vesicular calculus, boils, abscesses, cough, pulmonary diseases, asthma, whooping cough, diseases of intestine
12	Sathavari	*Asparagus recemosus*	roots	Treatment of dysentery, diarrhoea, tumours, inflammation, biliousness, blood diseases, kidney, liver, eye and throat complaints, tuberculous, leprosy, epilepsy, night blindness, scalding urine, rheumatism and gonorrhoea
13.	Kadulimbu	*Azadirachta indica*	Leaves, bark, gum, flowers, fruits and seeds.	Treatment of jaundice, skin diseases, malarial fever, boils, chronic ulcers, small-pox, syphilitic sores, an effective vaginal douche in after treatment of child-birth, liver complaints, a purgative, a tonic for treatment of general debility, nervous headache, urinary diseases, piles and intestinal

				worms.
14.	Palas	*Butea monosperma*	Leaves, bark, flowers and seeds.	In diarrhoea,heartburn, sweating of phthistis, diabetes, flatulent colic, piles, ulcers, cough, catarrh and ringworm diseases
15	Undi	*Calophyllum inophyllum*	bark, root and leaves	Treatment of of sore eyes, ulcers, leprosy, gonorrhoea and skin disease
16	Bhavo	*Cassia fistula*	leaves, roots and pods	Treatment of paralysis, rheumatism, skin diseases, black water fever, a strange purgative and tonic
17	Taikulo	*Cassia tora*	leaves, roots and seeds	Treatment of gonorrhoea, fever and headache, childrendiarrhoea and a laxative.
18.	Sanvor	*Bombax ceiba*	leaves, bark, pods, roots and gum	Treatment of gonorrhoea, fever and headache, children diarrhoea and a laxative.
19	Brahmi	*Centella asiatica*	entire plant	A tonic, blood purifier, for treatment of nervous diseases, amenorrhoea, piles, elephantiasis, skin diseases, dysentery of children and bowel complaint, rheumatism, mental weakness and poor memory, gonorrhoea, jaundice and fevers
20	Dalchini	*Cinnamomum Zeylanicum*	bark, root and leaves	Treatment of amenorrhoea, typhoids, rheumatism, headache, toothache, paralysis of tongue, nausea, vomiting, gastric irritations, neuralgic pains, and tedious labor caused by defective uterine contraction

A5.3 NURSERIES OF THE FOREST DEPARTMENT

District	Taluka	Location of Nursery
North Goa	Satari	Veluz, Bironda, Keri, Kankumbi, Kankumbi Ponsulem, Bondla, Morlem, Satrem, Zormen Karanzol, Kapordem, Nanoda.
	Pernem	Keri, Tuem, Chandela
	Ponda	Forest Colony Ponda, Nirancal, Pale, Usgao, Tiska Usgao, Kankirem, Dhavali, Ghotmod, Undir Bandora, Madkai
	Bicholim	Dodamar, Amthane
	Bardez	Verla, Pilerne, Olaulim, Pirna, Colvale
	Tiswadi	Chorao, Campal
South Goa	Canacona	Poinguin, Ozrem, Codimol, Cotigao, Fondsonem Pissonem
	Sanguem	Valkini, Mattoni, Dharbandora, Collem, Dargem, Salgini, Sancordem, Netravali, Ba!li, Mangal
	Salcete	Aquem Forest Colony
	Quepem	Condimol, Quepem, Forest Colony, Kopramadi, Malkarnem, Sirvoi, Quisconda, Quitol, Naqueri, Adnem, Padi

A5.4 Species wise description of mangroves found in Goa

1. *Rhizophora mucronata:*

It is a moderate sized tree, much branched, very rough bark, leaves elliptic, broad, opposite, pale beneath with black dots, flowers yellowish white, four petals, radicle slender, elongated, 15 to 40 cms. long, flowering & fruiting takes place in between December to Mid June. Locally known as Kandal, it is available in plenty in the high salinity areas in all the estuaries.

2. *Rhizophora-apiculata:*

It is a moderate sized much branched tree with rough bark, leaves elliptic, lanceolate, dark green above, base tapering, pink petioled, clustered towards end of branches, infloroscence 3-4 times forked, 4-8 flowered, flowers white, radicle thick, short and cylindrical, upto 30 cms. in length. Flowering and fruiting takes place in between December to May. It is seen mainly in between R. mucronata trees, which is dominant species. The species is found occasionally here and there and its total occurrence is quite less in Goa.

3. *Bruguiera gymnorrhiza:*

It is a straight stemmed, buttressed tall tree, upto 30m. in height, dark coloured, fissured bark, leaves elliptic, pointed, pale beneath, crowded at branchlet end, flowers solitary, petals bifid with hairs at the base, calyx red to bright red, radicle 15-20 cms. long, faintly ribbed, alike ladyfinger. Flowering and fruiting takes place in between November to April. It is found in low salinity areas and can be seen in the interior areas of the State. The tree has a conical shape and is seen mainly in Zuari & Chapora rivers.

4. *Bruguiera cylindrica:*

It is a medium to tall buttressed tree with smooth grey bark, leaves oblanceolate, thin, elliptic, flowers white to greenish, radicle 10-15 cms. short. Flowering and fruiting takes place in between the months of November to April. The species is observed in most of the river estuaries of the State and smaller size trees only are seen. It does not form a colony and is seen scattered here and there.

5. *Ceriops tagal:*

It is a small, 1to 2 m. tall straight stemmed tree or shrub forming buttress. Stem has lot of lenticels, leaves simple, opposite narrowed downwards, collected at branchlet end, flowers white and small and in cyma inflorescences. The species is localized to Terekhol river only and also planted in Chapora river. Flowering and fruiting takes place in between January to April.

6. *Kandelia candel (K. rheedi):*

It is a small, 5-6 tall trees with smooth reddish bark, leaves dark green, polished above, shortly petioled, elliptic, flowers white, radicle 30-40 cm. long and slender. Distributed in all estuaries of Goa. Flowering and fruiting takes place two times in a year, prominently from December to April and also from September to December.

7. *Avicennia officinalis:*

A tree with smooth yellowish grey bark, low branching, leaves very fine, silvery white, tomentose beneath. Flowers yellow collected in small clusters, capsule velvety, compressed, obvate and pointed. It is found in all estuaries and make colonies. Profuse seedings & regeneration is observed. Flowering & fruiting takes place in between March to August.

8. *Avicennia marina:*

It is known as "White mangrove" due to its white bark, leaves opposite, shortly petioled, glossy green on upper side & dull grey or silvery white tomentose hair on lower side, flowers yellow or white, fruit a compressed capsule. Found in all estuaries and make colonies. Flowering & fruiting takes place in between March to August. Profuse seedings & regeneration is observed.

9. *Avicennia alba:*

It is a Small tree, about 2m. high brownish black bark, leaves lanceolate, whitish, tomentose beneath, wrap on both sides unlike other species of Avicennia. It is found in all estuaries and make colonies. Flowering & fruiting takes place in between March to August. Profuse seedlings & regeneration is observed.

10. *Sonneratia alba:*

It is much branched moderate size tree, bark orange brown / grey, branches silvery grey, swollen, leaves leathery, opposite, elliptic, thickened, flowers solitary or in threes, white, pale green, fruit about 3 cms. dome shaped. It is available in plenty in higher salinity areas. Profuse regeneration forming pure patches is observed. Flowering and fruiting takes place twice in a year, from January to April and September to December.

11. *Sonneratia caseolaris:*

It is a moderate sized tree, brown rough bark, leaves 5-10 cms. long, broadly obvate, flowers tinged with rose colour, fruit fleshy, cushion shaped. It is found in low salinity areas, on the higher reaches of the rivers. Flowering and fruiting takes place twice in a year, from January to April and September to December. Fine patches showing excellent growth are seen at many places, particularly along Zuari River, in Khazan land in Borim and Shiroda.

12. *Aegiceras corniculatum:*

It is a small shrubby tree, bark brown with reddish tinge, leaves alternate, elliptic, flowers white, in umbels, fruit cylindrical, curved, and very small. Available in plenty in low salinity areas. Flowering and fruiting takes place in between February to April.

13. *Excoecaria agallocha:*

It is a much branched tree, upto 5 m high. Bark greyish, leaves pale green, alternate, elliptic, produce latex which is poisonous & dangerous to eyes. Flowers dioecious, arranged in sessile axillary catkins. Male and female plants found separately with distinct characters. Found in all the estuaries and is a common species in Goa.

14. *Acanthus illici folius:*

It is a shrub, upto 2 m high, aerial root formation is seen. Leaves glabrous, decussate with pair of spines. Flowers light blue to violet. Fruit 2-3 cms. long. It is found in abundance in all the estuaries. Flowering and fruiting takes place in between February to April.

15. *Lumnitzera racemosa:*

A small tree upto 10 m. high. Bark grey and fissured. Pneumatophores are thin, knee shaped. Leaves small, fleshy, oval, clustered towards end of branches Flowers white. Fruit hard, ovoid. Flowering and fruiting in between March to September. Localised to Siolim area, along the bunds.

A5.5 POPULATION: As per 2001 census

Taluka	Area in sq. km.	Population	Population		Literates		
			Rural	Urban	Male	Female	Total
Tiswadi	213.57	1,60,091	55,019	1,05,072	65,781	55,789	1,21570
Bardez	263.98	2,27,695	54,210	1,33,445	94,140	80,673	1,74,813
Pernem	251.69	71,999	62,386	9,613	29,737	22,536	52,273
Bicholim	238.80	90,734	53,647	37,087	38,094	29,688	67,782
Satari	489.46	58,613	50,696	7,917	22,443	16,867	39,130
Ponda	292.78	1,49,441	1,00,826	48,615	62,152	48,495	1,10,647
Sanguem	836.82	64,080	53,074	11,006	24,453	18,506	42,959
Canacona	352.04	43,997	32,096	11,901	16,351	13,108	29,459
Quepem	318.25	74,034	40,054	33,980	26,956	21,877	48,883
Salcete	292.94	2,62,035	1,10,456	1,51,579	1,00,263	93,827	1,91,090
Marmugao	109.13	1,44,949	24,587	1,20,362	60,120	45,904	1,06,024

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