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Natural resource accounting for Indian states — Illustrating the case of forest resources☆

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ABSTRACT

Our main objective is to set out and apply a SEEA-based methodology to reflect the true value of forest resources in India's national and state accounts. We establish that a "top-down" approach using available national databases is both feasible and desirable from a policy perspective. In this paper, we address four components of value creation in forests: timber production, carbon storage, fuelwood usage, and the harvesting of non-timber forest products. The results of our analysis suggest that prevailing measures of national income in India underestimate the contribution of forests to income. The income accounts of the Northeastern states in particular are significantly understated by these traditional (GDP/GSDP) measures. We are also able to identify some states which performed poorly in the context of our sustainability framework, reflecting natural capital losses due to degradation and deforestation. Our results highlight the need to integrate natural resource accounting into the national accounting framework in order to generate appropriate signals for sustainable forest management and for the conservation of forest resources which are widely used by the poor in India, as well as being significant stores of national wealth.

1. Introduction

In common with most developing nations, India faces many trade-offs in its attempt to reduce poverty and improve the living standards of its people. There is a need for an empirical basis on which to base policy decisions on trade-offs between the many competing priorities of a developing nation, including intergenerational claims. Available measures of development, including the current system of national accounts (SNA) with its primary focus on GDP (Gross Domestic Product) growth rates, do not capture many vital aspects of national wealth such as changes in the quality of health, changes in the extent of education, and changes in the quality and extent of India's environmental resources. GDP accounts, and their State-level equivalents GSDP (Gross State Domestic Product) accounts are therefore inadequate for properly evaluating the trade-offs encountered by India's policy makers.

Recognizing that GDP growth is too narrow a measure of economic growth and not a measure of national wealth, we propose to build a "Green Accounting" framework for India and

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its States. This paper is an outcome of the "Green Accounting for Indian States & Union Territories Project" ("GAISP")[1] which aims to set up top-down economic models for annual estimates of adjusted GSDP for 28 States and one Union Territory, thus capturing true "value addition" not just at a National level but at State level too. India has a federal political structure — State legislature and administration has considerable impact on local environmental policies and standards. Whilst states are governed by the same national laws on environment, forests, and wildlife, their environmental attitudes and policies differ, and the range and effectiveness of their environmental and forest management programmes differ quite considerably. Known anecdotally, this feature is not captured systematically. There are no metrics to distinguish sound and unsound environmental performance by India's State governments. Sustainable development at a State level remains un-measurable, and therefore un-manageable.

GAISP aims to construct a metric at the State level, such that the trade-offs in policy choices being made today (with no yardsticks and low transparency) are made in a manner which provides for economic evaluation, un-biased countrywide benchmarking, and eventually, a high degree of transparency and public accountability. None of this will be possible in India's federal structure unless a credible set of yardsticks and statistics are made available at the operative State level.

The scope of GAISP's work includes three sets of valuation and accounting adjustments covering various components of the value of forests, viz.,

a) Timber, Fuelwood, Non-timber forest products, and Carbon
b) Bio-diversity (including bio-prospecting, eco-tourism and non-use value of keynote species)
c) Ecological services (augmenting water resources, and mitigating soil erosion and flood damage)

This paper draws from the authors' work a) above, (Gundimeda et al., 2005) and attempts to provide a comprehensive picture of timber, non-timber and carbon wealth with the latest available data, including from Forest Survey of India's (FSI) recently published 2003 State of Forest Report.

The Central Statistical Organisation (CSO) in India is working on a methodology to systematically incorporate natural resources into national accounts in different states for land, water, air, and sub-soil assets. However, the CSO approach develops accounts for some states and for some sectors, and their studies are still in progress. In contrast to the CSO approach, we use a top-down or macroeconomic approach to model adjustments to GDP/GSDP accounts, for two reasons. Firstly, it has the advantage of providing a consistent and impartial national framework to value hitherto unaccounted aspects of national and state wealth and production. Secondly, it optimises extensive existing research, which is not yet tied together in a manner to be useful for policy analysis. Thus we hope to provide a much-improved toolkit for India's policy makers to evaluate in economic terms their policy trade-offs, and will enable them and the public to engage in a debate on the sustainability of economic growth, using national as well as inter-state comparisons.

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 down-stream from floods. Although these forests provide multiple benefits and cover 21% of the geographical area, the sector contributes only about 1.5% to official GDP in India. The forest products in the national accounts are classified into two major groups: (1) major products comprising industrial wood (timber, roundwood, match and pulpwood) and fuelwood (firewood and charcoal wood) and (2) minor products such as bamboo, fodder, lac, sandalwood, honey, resin, gum, tendu leaves, etc. The majority of India's forest-dependent and rural populations, who are predominantly poor, rely heavily on timber, fuelwood and non-timber forest products (ntfps) for subsistence. But much of this consists of non-market production, which should be fully included in the national accounts according to the 1993 System of National Accounts. But in practice, much of the production and use of non-market forest products is poorly measured and, hence, underestimated in national accounts. Not only do many forest goods and services remain unaccounted as national income (like carbon sequestration), but the destruction of natural capital that occurs when forests are converted to other uses or harvested unsustainably also remains unaccounted for. Hence, there is a need for incorporating the forest resources into the national accounts.

The main objective of the paper is to demonstrate how forest resources can be integrated into the national accounts using the SEEA framework for all the Indian states and illustrate how such a framework can be used in policy analysis. The structure of the paper is as follows. In Section 2 we provide an overview of forest resources in India, and operationalise the physical accounting framework and construct accounts for wooded land, the volume of growing stock and carbon in line with the SEEA framework. In Section 4 we explore ways to monetize the physical accounts. In Section 5 we analyze these results and conclude in Section 6 by integrating these results with the national accounts.

2. Physical accounts for forests

2.1. *Profile of forests in India*

India has a total land area of 329 million hectares of which around 21% is classified as forestland (Forest Survey of India (FSI, 2003)) (see Fig. 1 and Table 1). The total growing stock of the trees inside forests is 4829 million cubic metres and the average growing stock in Indian forests is 72 cum/ha (cubic meters per hectare), which is much lower than the world average. The forest cover in different states is diverse — ranging from 3% to 87% of their geographical area. Given the diversity in the forest cover it is extremely important to track these resources at the state level in a consistent manner.

Champion and Seth (1968) classified India's forests into four major ecosystem groups viz. tropical, sub-tropical, temperate and alpine. These major groups are further divided into 16 type groups: Tropical (wet-evergreen, semi-evergreen, moist deciduous, littoral and swamp, dry deciduous, thorn, dry evergreen), Sub-tropical (broad leaved hill forests, pine, dry evergreen),

[1] Information about GAISP and copies of its reports can be obtained from www.gistindia.org.

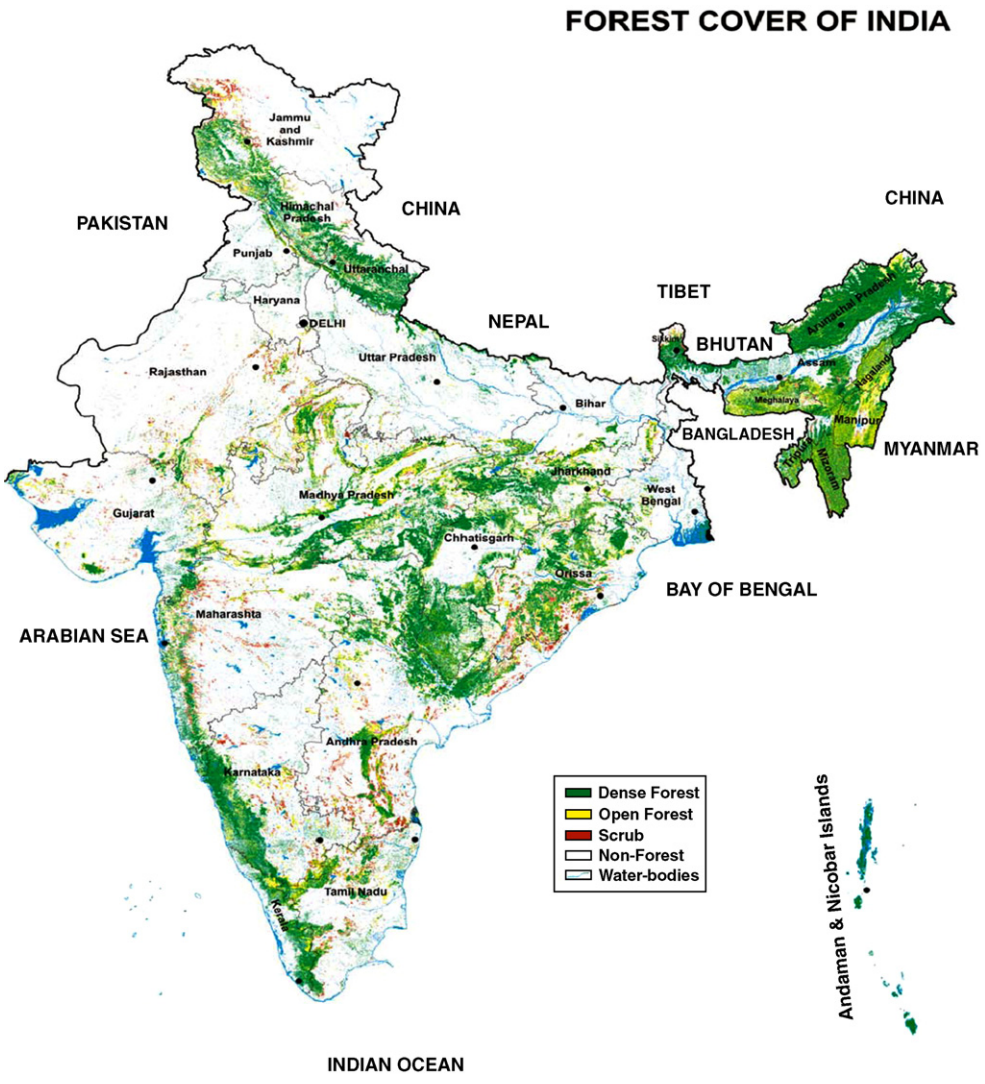

Fig. 1 – Forest cover of India.

Temperate (montane wet, Himalayan moist temperate, Himalayan dry temperate) and Alpine (sub-alpine, moist alpine and dry alpine scrub). Of the 16 forest types, tropical dry deciduous forests form the major percentage, 38%, of the forest cover in India. The other predominant type is tropical moist deciduous forest, which forms 30% of the total forest area of the country. The forests in India are divided into 21 different strata: Fir, Spruce, Deodar, Teak, Sal, Hardwoods etc. by FSI in order to assess the growing stock in the country. Over 45,000 species of plants exist in India and of this several thousands are endemic to this country. Bamboo in India constitutes the largest bamboo resources in the world. Mangroves in India contribute 5% of the total mangrove resources of the world. Of the total forest cover in India, 58% are classified as "dense" (crown density greater than 40%), 42% are open forests (crown density from 10% to 40%). The states with the largest proportion of their landmass under forest cover are the Northeastern states — Arunachal Pradesh (81%), Mizoram (87%), Nagaland (82%), Manipur (76%), Meghalaya (78%), Tripura (77%) and Sikkim (46%). These states account for 21% of the total forest cover in India (Table 1).

2.2. *Physical accounts for forestland, timber and carbon*[2]

In this section the physical accounts for forestland,[3] timber and carbon are constructed for 2001–2003 and their data sources are discussed. The space constraints of a journal article prevent a detailed review of the literature and theory. Readers are referred to Chapters 7 and 8 of the SEEA (UN et al., 2003) for more detailed discussion of forest accounts. Vincent and Hartwick (1997) provide a review of forest accounting in the early 1990s, and Lange (2004) provides a more recent update with an emphasis on the public policy applications of forest accounting. Eurostat (2002a,b) provides a good overview of the work done by several EU members. For a review of some of the theoretical issues,

[2] Information about Ntfps was not sufficient to construct physical asset accounts, but monetary asset accounts can be estimated as described in the next section.

[3] Forested land is defined as land with tree crown cover (or equivalent stocking level) of more than 10% and an area of more than 0.5 ha.

Table 1 – Profile of forests in India as per 2003 assessment

State/UT	Recorded forest area (in sq. km)					Forest cover (in sq. km)					Growing stock	
	Reserved forest	Protected forest	Unclassified forest	Total forest area	% of geographical area	Very dense forest	Moderately dense forest	Open forest	Total	% of geographical area	Volume (000 cum)	Volume per ha (m^3/ha)
A&N	2929	4242	0	7171	87.9	3475	2809	680	6964	84.4	76,087	109.3
AP	50,479	12,365	977	63,821	23.2	23	24,356	20,040	44,419	16.1	278,594	62.7
ARP	10,178	9536	31,826	92,902	61.5	13,907	39,604	14,508	68,019	81.2	764,277	112.4
Assam	27,018	0	8958	35,976	45.9	1684	11,358	14,784	27,826	35.5	305,568	109.8
Bihar and Jharkhand	10,465	24,964	34	35,463	20.4	2620	12,088	13,566	28,274	16.3	104,785	37.1
Goa	237	822	165	1224	33.1	0	1255	901	2156	58.2	16,865	78.2
Gujarat	14,155	395	4563	19,113	9.7	114	6231	8601	14,946	7.6	73,349	49.1
Haryana	249	1158	151	1558	3.5	2	518	997	1517	3.4	2534	16.7
HP	1896	33,043	2094	37,033	66.5	1093	7883	5377	14,353	25.8	254,264	177.2
Jammu & Kashmir	2551	17,643	36	20,230	9.1	2102	8395	10,770	21,267	9.6	462,994	217.7
Karnataka	29,550	3585	9949	43,084	22.5	431	22,030	13,988	36,449	19.0	267,340	73.3
Kerala	11,098	170	0	11,268	29.0	334	9294	5949	15,577	40.1	146,030	93.7
MP and Chattisgarh	84,516	59,623	10,854	154,993	34.9	5540	75,283	18,478	99,301	22.4	244,763	24.6
Maharashtra	49,217	8196	4526	61,939	20.1	8070	20,317	10,681	39,068	12.7	104,688	26.8
Manipur	1467	4171	11,780	17,418	78.0	720	5818	10,348	16,886	75.6	144,505	85.6
Meghalaya	1112	12	8372	9496	42.3	168	6323	10,942	17,433	77.7	79,300	45.5
Mizoram	7909	3568	5240	16,717	79.3	84	7404	10,942	18,430	87.4	638,671	108.1
Nagaland	308	508	7813	8629	52.0	57	5650	7902	13,609	82.1	107,986	79.3
Orissa	26,329	15,525	16,282	58,136	37.3	288	27,882	20,196	48,366	31.1	253,796	52.5
Punjab	44	1137	1903	3084	6.12	0	743	837	1580	3.1	1242	7.9
Rajasthan	11,860	17,652	2976	32,488	9.5	14	4482	11,330	15,826	4.6	15,591	9.9
Sikkim	5452	389	0	5841	82.3	458	1904	900	3262	46.0	39,785	122.0
TamilNadu	19,388	2183	1306	22,877	17.6	2440	9567	10,636	22,643	17.4	88,702	39.2
Tripura	3588	664	2041	6293	60.0	58	4988	3047	8093	77.2	24,815	30.7
Uttar Pradesh & Uttaranchal	34,905	13,098	3485	51,488	17.5	5299	19,119	14,165	38,583	13.1	368,434	95.5
West Bengal	7054	3772	1053	11,879	13.4	2303	3742	6298	12,343	13.9	40,275	32.6
Grand total	452,387	234,179	136,384	822,950	25.1	47,809	336,234	286,845	670,888	20.5	4,829,153	72.0

Source: State of Forest Report (1995).

readers are referred to Atkinson and Gundimeda (2006). Physical asset accounts generally have the following format:

- ○ Opening stocks
  - ▪ Changes due to economic activities
  - ▪ Other changes
- ○ Closing stocks

While the physical accounts for forestland, timber and carbon all follow this general format, the detailed components are slightly different for each and are described below.

2.2.1. *Area accounts for forested land*

Accounts for forestland include the following detailed components

Opening stock

\+ Changes in forest land
  \+ Natural expansion and afforestation
  – Net transfer of forest land to non-forest uses (through deforestation or degradation)
  – Loss of forest land due to shifting cultivation
  \+ Net reclassification and other changes
= Closing stocks

2.2.1.1. *Opening stocks*. Table A1 shows the opening stocks in 2001, by state, for forestland as open or closed forests, based on statistics from the State of Forest Report (FSI, 2001).[4]

2.2.1.2. *Changes in forested land*. The opening stock can change due to

- *Natural expansion:* The stock of forested land may increase as a result of silvicultural measures, or natural expansion (natural regeneration). The area regenerated (naturally and artificially) is obtained from ICFRE (2000).
- *Afforestation:* The stock of forested land may increase because of economic activity resulting in establishment of new forest on land, which was previously not classified as forested land. The afforested area and compensatory afforestation[5] in India is available from various forest statistical reports.
- *Losses due to deforestation and degradation*. Forestland may be lost when transferred to non-forest purposes or as the result of shifting cultivation (a specific form of land transfer), or when the forested land is degraded to a point where tree cover falls below 10% and the land thus becomes classified as other wooded land. Sources of degradation include logging damage and forest encroachment, and heavy grazing by livestock. Although the total area of forest land may not change, some closed forests may become open forests because of excessive harvesting.

The area transferred for non-forest purposes is compiled from a forestland use change matrix between the years 2001–2003 obtained from State of Forest Report 2003. Regarding shifting cultivation there are varying estimates for different states. The estimates for shifting cultivation in Andhra Pradesh, Bihar and Tripura are taken from ICFRE (2000). For other north-eastern states only the cumulative area subject to shifting cultivation for a period of 10 years is available from FSI (1999). For these states we took an average value for the 10 years.

2.2.1.3. *Closing stocks*. The closing stocks are computed as opening stocks less reductions plus additions and reconciled with the 2003 assessment.

2.2.2. *Physical accounts for timber and carbon*

Timber and carbon have more detailed accounts for changes in stock:

Opening stock

\+ Changes due to economic activities
  – Logging and logging damage
  – Forest encroachment and shifting cultivation
  \+ Afforestation
  – Loss due to livestock grazing
\+ Other accumulations
\+ Changes due to natural causes
  \+ Natural growth
  \+ Natural regeneration
\+ Changes due to reclassification
  \+ Net transfer of land
\+ Other Volume changes
  – Stand mortality
  – Forest fires and pest damage
= Closing stocks

Tables A2 and A3 in the Appendix gives the detailed accounts for timber and carbon.

2.2.2.1. *Opening stocks*. The opening stocks represent the growing stock of timber present in 2001. To convert this estimate into units of carbon, estimates of biomass were used based on a study by Haripriya (2000b, 2002) which used the volume inventory data to estimate the carbon content of the biomass in different states and different types of forests. Biomass is converted to carbon assuming a carbon content of 0.5 Mg C per Mg oven dry biomass. The carbon density/ha varies in different states from 3.4 to 171.8 t C/ha with an average carbon density/ha of 42 t C/ha. We have included only the aggregate carbon content of forest biomass and do not include the stock of carbon in soils because we are only interested in the change in carbon as a result of "disturbance" on forested land in the current accounting period.

2.2.2.2. *Changes due to economic activity*. Changes due to economic activity affecting timber accounts include

1) *Logging* (both recorded and unrecorded): The recorded volume of timber harvested/logged can be derived from the production statistics of timber and fuelwood obtained from the CSO for the year 2002–2003. However the volume harvested for timber and fuelwood is highly debated as the estimated consumed volume exceeds the recorded produced volume. A

[4] Open forests include all land with a forest cover of trees with a canopy density between 10% and 40%. Dense or closed forests include all lands with a forest cover of trees with a canopy density over 40%.

[5] If a hectare of forest is cleared it is mandatory to afforest at least two times the area deforested. This is termed as compensatory afforestation.

considerable amount of timber and fuelwood goes unrecorded due to illegal felling of trees. The statistics on the number of trees cut illicitly and the loss in revenue due to illicit logging is available with various state forest departments and the revenue generated from the seizure of illegal material is recorded in the production statistics. However, a considerable amount of timber and fuelwood still goes unrecorded. In order to account for unrecorded production,[6] the CSO uses an estimate of 10% of the total recorded production of industrial round wood as the value of unrecorded production of industrial round wood (which is an approximate estimate).[7] For fuelwood, the CSO estimates the unrecorded removals of fuelwood by superimposing the trend of fuelwood consumption observed from the NSSO consumption surveys for the year 1983–1984 on the estimates for 1980–1981 prepared on the basis of recorded production (see CSO, 1989).[8] Despite accounting for unrecorded production based on the norms set by CSO, on tallying the volume accounts at the end we found that for most of the states some growing stock is still missing. So we accounted for some of this difference in the growing stock as unrecorded removal, which could not be tracked by the forest department. It may be possible that in some states, the estimates of timber and fuelwood consumption are higher than the actual and in other states it is lower. In some of the tables we find that the unreported production is quite high whereas for some states the recorded estimates were high. In this paper, we made an assumption that if it is recorded in the national accounts, it is no longer unrecorded production and only the differences in the growing stock (not tallied) can be treated as unrecorded production.

- *Logging damage*. Damage due to logging is assumed to be 10% of the volume of timber logged from both recorded and unrecorded production.[9] We assumed that some of the damaged timber leaves the forested land because deadwood is collected for use as fuel. The remaining timber is left on-site but is assumed that it is an economic loss.
- *Forest encroachments and shifting cultivation:* In India forests are encroached every year illegally. As a result though that land is legally classified as forests, in reality the forestland is occupied by humans or put to use for some human activity. This results in loss of tree cover in that area. Similarly, in some of the Indian states forests are cleared for agriculture and after a few years the land is left for trees to grow. Such practice is very often seen in some of the northeastern states. The volume of timber lost due to shifting cultivation and forest encroachment is obtained by multiplying the area subject to this disturbance with the growing stock per hectare in open forests.[10]
- *Afforestation:* The statistics on afforestation reported at the national level do not indicate various species planted, the survival rate of these plantings, how much area actually ends up forested and the growing stock per ha in these afforested areas. Such effort is being made by the FSI for some agro-forestry areas but is not yet complete. So the study estimates the volume additions due to afforestation by multiplying the area afforested with the mean annual increment per sq. km and assume that the same conditions prevail at the existing sites.[11]
- *Damage from heavy grazing*. We have considered only the area subject to heavy grazing, about 6% of forest area, as discussed in Section 2.2.1. The volume lost due to grazing is derived by multiplying naturally regenerated volume and the afforested volume with the percentage of area subject to heavy grazing. However, no carbon loss is assumed from grazing because the carbon increases due to regeneration (if any) on the grazed land is assumed to be offset by loss in carbon due to surface fires and grazing.

While developing timber accounts is quite straightforward, accounting for carbon needs careful analysis because any disturbances of forests involve fluxes of carbon between the atmosphere, soils and forest products. When forests are subjected to disturbances, some of the carbon remains in the forest biomass itself, some remains *in situ* (in the forests on the floor or transferred to soils) and a part of it is transferred to the atmosphere as CO_2, CO and CH_4. The proportion of carbon transferred to the atmosphere, soil etc are based on disturbance matrices (given in Haripriya, 2003).

As the timber can be logged either by clear felling or partial cutting, one has to consider the respective carbon balances by different methods. Haripriya (2003) has assumed that when the logging is done by clear-cutting only 80% of the stem biomass is transferred to the wood products, whereas 2% remains on the stem, 8% is transferred to soils and 10% is released to the atmosphere. When the forest is subject to partial cutting 85% of the stem biomass is transferred to wood products, 10% remains on the stump and 5% is transferred to the soils. The amount of carbon remaining on the stem or transferred to soils gives the amount of logging damage.[12] The volume of carbon lost to encroachment and shifting cultivation is obtained by multiplying the area subject to these disturbances with the growing stock per hectare in open forests. Here we have assumed that 80% of the carbon is transferred to the wood products and the rest is released.

Another point to be noted here is that from the standpoint of national accounting, we have defined the change in carbon as the amount of carbon released arising from disturbances

[6] Unrecorded production refers to extraction of timber without proper records, illegally and detected theft.

[7] Due to ban on clear felling this assumption may need to be revised. It is recorded that in some states like Rajasthan the logging figure is as high as 2.5 times of the recorded production.

[8] From the total estimate of fuelwood consumption, the amount of biomass obtained from agriculture is deducted by CSO in order to avoid double counting.

[9] The figure is based on the information provided by the state forest department of Maharashtra (visited on May 28th 1997).

[10] We made the assumption that forest encroachments and shifting cultivation usually happen on the periphery of open forests. So the growing stock in open forests needs to be used for calculations.

[11] The assumption was made, as the information on volume of stock growing in afforested area is not available.

[12] One can argue that the carbon remains on the stump even without the cutting. As per the discussions with the officials of the forest departments, some of the portion remains on the tree while harvesting and damaged, as the tree cannot be uprooted totally. This is categorized as logging damage because the tree cannot grow again nor can be used for any purpose. It is equivalent to a dead tree. The carbon will be released from it in the course of time.

(e.g. logging) on forested land in the current accounting period (Atkinson and Gundimeda, 2006). In other words, it does not matter that the carbon in forest products is not released in 2001–2002. The key thing is that the logging activity occurred in this period. This includes the transfer of carbon to the atmosphere as well as to the soil.

2.2.2.3. Other accumulations

2.2.2.3.1 Natural processes. Other accumulations due to natural processes consist of the natural growth (mean annual increment) and natural regeneration. The mean annual increment of different species is taken from the statistics published by the FSI (1995b). This volume estimate is converted to units of carbon using the same method as discussed earlier. The area regenerated (naturally and artificially) is obtained from ICFRE (2000), but only in some states. The volume added is computed by multiplying the area regenerated with the mean annual increment per hectare of different species.[13]

2.2.2.3.2 Changes in forest stock due to reclassification. Changes in forest stock due to reclassification include the transfer of forestland for non-forest purposes (for example, for agriculture, residential or industrial purposes) or transfer from agriculture to forests. The volume reduction due to transfer of land for non-forest purposes is derived by multiplying the area transferred with the growing stock per hectare. Here we assume that there is some standing timber left on the forestland before the land is converted to nonforest purposes. This timber may be used in various wood products from which the carbon will be released depending on the use to which it is put to.

2.2.2.4. Other volume changes. Other volume changes comprise reductions due to forest fires, stand mortality, insect infestation, and degradation due to heavy grazing.

- Forest fires. The area subject to forest fire is given by ICFRE (2000). The volume of forest stock affected by forest fire is derived by multiplying the naturally regenerated volume and the afforested volume with the percentage area affected by the forest fire.[14] Haripriya (2003) estimated that when the forest is affected by fires, only 20% of the stem biomass remains, 50% is burnt and the carbon transferred to the soils (immediate and releases that eventually occur in future as a result of fires today) and 30% is released into the atmosphere.
- *Insect and pest infestation*. The latest statistics available about insect induced mortality at the time of this analysis are estimates from Indian Forest Statistics (various years between 1947 and 1972) for various states. These statistics reveal that the average volume rendered unusable annually due to attack of insects/pests is around 0.031% for broad-leaved species and 0.005% for coniferous species. From this the average volume lost due to insects and pests has been derived for the years 1947–1970[15] and the same proportion has been used for the study period. The volume estimates are converted to carbon estimates as discussed before.

The closing stocks are computed as opening stocks less reductions plus additions.

3. Monetary accounts

Asset values are constructed for timber, carbon, and ntfps but not for forest land. The SEEA discusses several methods that can be used for valuing forest assets (see UN et al., 2003). Asset values for timber and fuelwood have been derived using the net price method in which volume entries in the physical accounts are multiplied with the net price or unit resource rent.[16] The net price is calculated as the difference between average market value per unit of the resource (P_t) and the per unit marginal cost of harvest, development and exploration (C_t). As we could not get marginal costs of extraction we used average costs. Using the net price method, asset value at the beginning of period t (V_t), is calculated as the physical volume of the opening stock (R_t) multiplied by the net price, ($P_t - C_t$), or $V_t = (P_t - C_t)R_t$. Once the value of the opening stocks and closing stocks are determined, the value of depletion can be calculated by subtracting the value of the opening stock from the value of the closing stock.

The main task is to calculate the net price, obtaining the market value of timber and the costs of harvesting. Figures for the value of timber and costs by state were obtained from CSO (see Haripriya, 1998 for more details on different costs). These were converted to unit values, using physical production data from CSO, in order to apply them to the more accurate estimate of physical production provided by this study (see Table 2).

For valuing carbon sink services, we used an estimate of $20/t C based on a marginal social damage approach described in Atkinson and Gundimeda (2006). The tree can be valued either for timber or carbon but not both because carbon is sequestered within the timber. If the timber is burnt all the carbon is released back into the atmosphere. As timber and carbon values are non-additive, we have used the official "Reserved Forest" classification for ascribing carbon value, the rest being valued at the weighted net price of timber and fuelwood.[17]

In addition to timber, forests yield non-timber forest products (ntfps) like bamboo, sandalwood, lac, honey, fodder, resin, gum, tendu leaves etc. These are also referred to as minor forest products. A survey carried out by the National Sample Survey Organisation (NSSO) indicated large-scale dependence on the population on common property resources, of which forests are a major part, including fuelwood, fodder, thatching materials,

[13] As a result of frequent fires and heavy grazing only 18.3% of the total forest area has regeneration potential of important species (FSI, 1995a).

[14] Only the forest area that is prone to frequent fires is considered as affected by fire annually in this study.

[15] During the period 1947–1972 the forests were classified as deciduous and broad-leaved forests. The area, volume of growing stock and volume of timber lost because of pests and diseases was available for that period. From this we computed the proportion of timber (volume of timber affected/total growing stock) affected annually and used the same proportion for the latest year.

[16] Also known as stumpage value in forestry.

[17] A sensitivity analysis using alternative approaches was conducted but cannot be presented here because of space constraints. It will be available in future reports.

Table 2 – Net price of timber, fuelwood, ntfps and fodder used for asset valuation (in Rs)

States	Net price of timber (Rs/cum)	Net price of fuelwood (Rs/MT)	Weighted net price used in the study (Rs/cum)	Value per hectare of ntfps (in Rs)	Net present value per hectare of ntfps (in Rs)	Value per hectare of fodder (in Rs)	Net present value per hectare of fodder (in Rs)
A&N	1436.8	875.0	887.6	23.5	588.02	71.4	1785.7
AP	21,283.7	1157.0	1690.0	238.2	5954.70	253.7	6341.9
AR.P	2645.2	971.0	1057.6	14.9	371.45	44.6	1114.1
AS	3002.9	733.0	778.4	25.4	634.16	117.2	2929.1
BI	12,665.9	1290.5	1712.3	245.7	6141.34	18.5	462.4
GOA	4006.1	710.0	2131.9	77.3	1933.17	129.9	3248.5
GUJ	9255.6	664.0	1274.1	35.8	895.92	167.6	4189.5
HAR	1968.8	586.0	770.9	242.9	6071.84	201.1	5027.9
HP	7646.3	1408.0	4088.9	774.3	19,357.59	288.6	7215.8
J&K	8977.8	1002.0	3111.1	118.2	2954.75	363.0	9074.6
KAR	17,112.4	1409.0	3342.3	46.1	1151.63	171.6	4289.8
KER	11,873.5	1428.0	2515.6	22.6	563.95	287.7	7193.5
MAH	6964.6	2131.0	2258.9	1428.6	35,714.06	244.7	6117.3
MANI	5071.1	986.0	3981.0	42.4	1060.50	126.8	3170.5
MEGH	536.2	333.0	343.5	61.4	1535.23	123.2	3080.3
MIZ	513.2	777.0	770.0	153.3	3831.31	309.2	7730.2
MP	8983.9	981.0	2444.4	358.6	8965.47	184.8	4620.0
NAG	1309.0	1186.0	1191.2	0.7	16.86	315.6	7890.6
ORI	8641.9	1074.0	1169.7	401.1	10,026.52	185.2	4629.2
PUN	1638.5	1127.0	1159.8	510.3	12,756.99	114.6	2864.0
RAJ	3996.8	1091.0	1117.3	63.9	1597.73	88.8	2220.7
SIK	122.2	724.0	713.9	161.9	4047.92	29.6	741.0
TN	35,416.2	730.0	7583.9	112.7	2817.48	283.2	7079.3
TRI	2821.4	681.0	730.7	1534.2	38,354.56	311.8	7795.5
UP	152.1	1194.6	1164.3	352.9	8822.05	111.5	2786.3
WB	7752.0	1235.0	1659.6	65.0	1624.89	571.3	14,281.6
All-India average	7145.9	1018.6		305.2	7631.20	118.30	2957.6

Source: Computed.
Notes: Weighting factors obtained from CSO; for computing the weights the fuelwood has been converted to equivalent of round wood units.

fruits, bamboo, canes, reeds, honey and other products. Ntfps are valued by multiplying the forest area accounts with the discounted value per hectare of the products computed from the statistics provided by the CSO (see Haripriya, 2001). As the only input required in collecting ntfps are the labor and it is mostly those who have no opportunity to work elsewhere are involved in collection, the cost of inputs are considered to be zero and the entire output value is considered resource rent. Like timber and fuelwood, the value of ntfps is severely under-reported; the CSO estimates the value of unrecorded ntfp production as 10 times the value recorded by the State Forest Departments, which[18] are based on a nominal 'royalty' charged to forest users for collecting ntfps, but which is largely unenforceable.

Though we do not make any attempt to adjust the value of nontimber forest products, we do attempt to adjust the value for fodder using a different approach because fodder is highly as the forest department gives fodder at very nominal rates to concessionaires.[19] We value fodder using the cost of alternate acreage as described in Haripriya (2000a), that is, the opportunity cost of allotting alternate acreage to it. This is equivalent to loss in revenue from agriculture due to cultivating equivalent amount of fodder obtained from forests on agricultural land. The total fodder produced in the forests of India is 99 million tons (Haripriya, 2000a). The amount of land required to grow fodder grazed in forests is computed as the ratio of total fodder grazed in forests and the average yield of fodder on agricultural 50 tons/ha on irrigated land and 25 tons/ha on unirrigated land. The ratio of irrigated to unirrigated area in different states is used to obtain the average yield of fodder on agricultural lands. The opportunity cost of land in different states is derived as the ratio of the agricultural GDP to the gross sown area ratio in each state.

In contrast to timber which if harvested once is lost forever unless replanted and the tree grows to maturity again (hence, can be valued only once), the value from ntfps and fodder can be generated every year, i.e., when a hectare of forest is deforested the revenue earned from ntfps and fodder every year is lost. Hence we used the present value of ntfps and fodder, which is obtained by dividing the net price by the social discount rate of 4% percent, a very conservative value. The monetary asset accounts for ntfps and grazing can be derived by multiplying the area accounts with the present value per hectare, given in Table 2. Once the value of the opening stocks and closing stocks are determined, the value of depletion can be calculated by subtracting the value of the opening stock from the value of closing stock.

[18] No adequate explanation has been provided for using this norm. CSO has initiated some studies to revise this estimate.
[19] For many states the value of fodder is recorded as negligible or non-recorded.

4. Integration with the national accounts

In the final step we integrated our estimates with the national accounts. The SEEA describes many different indicators of sustainability that can be derived from environmental accounts, and in earlier work (e.g., Atkinson and Gundimeda, 2006), we reported the impact of forest accounting on Adjusted Net Savings following the work of the World Bank (1997, 2005). In this paper we have chosen to focus on adjustments to Gross/Net Domestic Product (GDP/NDP) and Gross/Net State Domestic Product (GSDP/NSDP). Our forest accounts provide more accurate figures for forestry affecting three components of the national accounts:

1) figures for the production of timber that adjust unreported production. This will increase (or decrease) both GDP and NDP by the amount of the 'missing' timber.
2) Capital accounts that expand
   a. Capital formation to include accumulation in natural forests and depletion. In the conventional accounts, only accumulation of produced capital is included. Natural forests, which are called non-produced assets, are excluded. We add the value of accumulation of natural forests to investment, which increases GDP/GSDP and NDP/NSDP.
   b. Consumption of capital to include the cost of depletion of natural forests, which decreases NDP/NSDP.

It should be noted that while the first adjustment is completely consistent with the SNA and represents simply a better estimate of conventional national income, the second set of adjustments is outside the SNA and represents SEEA revisions to the SNA. This second set of adjustments is particularly important when natural forests are converted to non-forest purposes, the income from logging is recorded in GDP and NDP, but the decline in asset value is recorded only under other volume changes which does not have any impact on GDP or NDP. As we discussed earlier, when forests are logged (above the mean annual increments) or converted to non-forest purposes, potential values of the forests are lost and need to be accounted for rather than just accounting for the income from harvesting.

The result of these adjustments is the environment adjusted state domestic product (ESDP)

$$\text{ESDP} = \text{NSDP} + (A_{np} - D_{np})$$

Where D_{np} is the depletion of nonproduced natural assets and is obtained from the asset accounts.

The asset accounts are constructed as follows:

Closing stocks − Opening stocks
= changes due to economic activities
± other accumulations
± other volume changes
± omissions and errors

Depletion = other accumulations
± changes due to economic activities

The second term captures the net effects of accumulation natural forests (non-produced assets, A_{np}) minus depletion (D_{np}).

5. Discussions of results and implications for policy

Table 3 summarizes the physical and monetary accounts for the entire country, and Tables A1–A4 give the disaggregated statewise accounts between 2001 and 2003.

Table 3 – Volume and value accounts for 2001–2003

	Volume account		Value account					
	Timber	Carbon	Timber	Carbon	Ntfp	Timber[a]	Carbon[a]	Ntfp[a]
	000 cum	000 tons	Million rupees	Million rupees	Million rupees	% of GDP	% of GDP	% of GDP
Opening Stocks	5,068,313	3,558,126	10,318,016	3,202,313	825,069	55.65	17.27	4.45
Changes due to econ. activity	−409,263	−236,280	−819,963	−212,652	–	−2.21	−0.57	
Logging/harvest/logging damage	355,469	229,034	752,652	206,131	–	2.03	0.56	
Afforestation	10,786	5152	31,615	4637	–	0.09	0.01	
Shifting cultivation	14,002	6883	20,449	6194	–	0.06	0.02	
Forest encroachments	41,672	5515	59,642	4963	–	0.16	0.01	
Grazing	8905	0	18,836	0	–	0.05	0.00	
Other volume changes	843	785.0	1649	6238	–	0.004	0.02	
Forest fires	158	45	292	40	–	0.001	0.0001	
Stand mortality	685	3	1357	3	–	0.004	0.00	
Other accum	242,260	1,778,920	432,230	161,028	–	1.17	0.43	
Natural growth	182,239	130,865	355,909	117,779	–	0.96	0.32	
Regeneration	91,990	48,983	153,824	44,084	–	0.41	0.12	
Transfer of land	−31,969	−928	155,701	−835	–	0.42	−0.002	
Omissions and errors	4772	0	8489	0		0.02	0.00	
Net changes	−167,845	−58,145.4	−380,803	−115,968	4152	−1.03	−0.31	0.01
Closing Stocks	4,905,240	3,499,981	9,937,213	3,086,346	829,221	53.60	16.65	4.47

Source: Computed.
Notes: [a]The percentage values are for one year only.

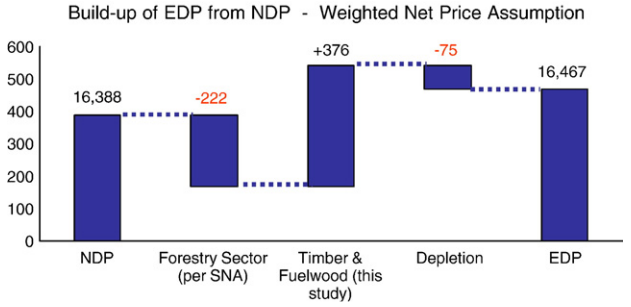

Fig. 2 – Build-up of EDP from NDP — Weighted Net Price Assumption.

5.1. *Physical accounts*

From the area accounts (Table A1) it appears that the country's forest cover has gone up by 272,200 ha but in reality *open* forests have increased and *dense* forests have decreased resulting in a net loss of timber of 168 million cum (Table A2). With the exceptions of Chattisgarh, Tripura, Manipur, Meghalaya and Nagaland, the decline in area under dense forests is a countrywide phenomenon in India across all states. In terms of the volume accounts, the largest decline in the physical stock of available timber over the period is due to logging (409 million cum) and associated damage while natural growth is the largest source of increase. The closing stock of timber, taking account of these losses and gains in volume is 4905 million cum: i.e. an overall decrease of some 168 million cum.

The net loss of timber is accompanied by a net carbon released (now and in the future) of roughly 58 million tons of Carbon (Table A3). Column 15 describes all gains or losses in carbon arising from disturbance in the current accounting period.

5.2. *Monetary accounts*

In economic terms, this decrease in stock of timber over the two year period represents a wealth depletion of over INR 380 billion, based on state-wise weighted net prices of timber and fuelwood, which amounts to over 1% of GDP — a highly material unrecorded capital loss at the national level. It is also a strong indicator of the weakness of compliance with India's current regime of forest-related regulation, supplemented by Supreme Court orders which prohibit most forms of logging and milling activities in addition to the ban on clear felling. This result suggests that the ability of national legislation to contain unsustainable depletion or degradation of forest cover is somewhat limited. It points to the need for greater recognition of the cost of such depletion at the policy decision level, administration level, and indeed among the wider public for whom this is not yet perceived as a matter of public wealth depletion which could affect their future well-being.

The net timber accumulation equals −1.03% of GDP, arising mainly from logging equivalent to 2.03% of GDP, other losses of timber (due to forest fires and so on) amounting to 0.001% of GDP and offset to a large extent by the timber value of natural growth (0.96% of GDP) and regeneration of previously cleared land 0.41% of GDP). Net accumulation of (forest) carbon is equivalent to −0.31% of GDP, with the largest negative and positive components being logging (0.56%) and natural growth (0.32%) respectively. On balance, net timber and carbon accumulation in India's forests is respectively about −1.03% and −0.31% of GDP. The monetary accounts for different states are given in Table A4.

Regarding ntfps, the value of the ntfps recorded in the national accounts is Rs 20,608 million and the value of ntfps per hectare is estimated at Rs 305 per hectare. We have not attempted to contest the value recorded for ntfps in the national accounts, but we point out that the actual value of ntfps in India where the poor are dependent on ntfps as a significant component of livelihood income can be much higher, due to (a) significant unrecorded harvest of ntfps, (b) subsidized prices

Table 4 – Environmentally adjusted state domestic product for the Northeastern States

North-Eastern State	Unadjusted 2003 GSDP* (INR Mio)	Unadjusted 2003 NSDP* (INR Mio)	2003 adjusted NSDP** (INR Mio)	Adjustment as % of GSDP	Depletion and degradation (INR Mio)	2003 ESDP (INR Mio)	ESDP/ adjusted NSDP
Arunachal Pradesh	19,451	17,395	32,361	77%	390	31,169	1.01
Assam	354,314	317,208	318,911	0.5%	−663	318,070	1.00
Manipur	35,313	32,048	33,217	3.3%	11,325	44,433	1.34
Meghalaya	43,429	38,423	40,774	5.4%	2532	43,034	1.06
Mizoram	17,687	16,346	18,894	14.4%	−647	18,054	0.97
Nagaland	36,794	34,272	3392	−0.9%	1649	35,596	1.05
Tripura	60,617	56,603	55,950	−1.1%	4208	60,202	1.08
Sikkim	11,527	10,387	10,886	4.3%	296	11,131	1.03
Total: North-East	579,132	522,682	544,915	3.84%	19,090	561,689	1.04
Percentage of total	3.1%	3.2%	3.3%		−25.6%	3.4%	
Total: INDIA	18,539,943 (GDP)	16,387,846 (NDP)	16,542,370	0.1%	−74,639	16,449,724 (EDP)	0.99

Source: Table 5.
* Official figures provided by CSO.
** NSDP adjusted for unaccounted forest income.

Table 5 – Integrated forest accounts for 2002–2003 (in Rs millions) (using weighted net price of timber and fuelwood)

States	GSDP	NSDP	Value added by timber and fw in national accounts	Value of ntfps in national accounts	Value of timber and fw this study	Value of ntfps as per the study	Value of grazing	Adjusted GSDP	Adjusted NSDP	Depletion of timber	Depletion of carbon	Depletion of ntfps	Total Depletion	ESDP	ESDP/ adjusted NSDP	Adjusted NSDP/ NSDP
A&N	11,564	10,408	106.1	16.3	2881.8	16.3	0.9	14,340	13,184	−3519	−16,079	8.1	−4320	8864	0.67	1.24
AP	160,7684	1,439,754	17,902.3	1063.2	9478.9	1063.2	174.6	1,599,261	1,431,331	−13,933	−274	−268.1	−1616	1,429,715	1.00	0.99
AR.P	19,451	17,395	824.7	101.1	15,790.3	101.1	8.4	34,417	32,361	−3642	784	−3.9	390	32,751	1.01	1.77
AS	354,314	317,208	5547.5	70.3	7250.8	70.3	18.7	356,017	318,911	−18,389	−1366	39.9	−663	318,248	1.00	1.00
BI	897,150	787,034	15,268.6	696.6	3586	696.6	5.8	885,467	775,351	−2254	−114	−54.8	−1032	774,319	1.00	0.99
GOA	77,711	67,357	95.3	16.2	7372.3	16.2	1.5	84,988	74,634	−13,155	−7810	31.6	−3889	70,745	0.95	1.09
GUJ	1,382,850	1,144,048	4169.4	54.3	5341.4	54.3	39.7	1,384,022	1,145,220	−10,673	−2249	−104.8	−1294	1,143,926	1.00	1.00
HAR	658,372	579,375	1975.6	42.6	510	42.6	4.9	656,906	577,909	−1589	−2055	−263.1	−967	576,942	1.00	1.00
HP	159,460	142,024	4089.3	1111.9	60,628	1111.9	51.6	215,999	198,563	−108,266	−6976	−18.6	−51,394	147,169	0.74	1.35
J&K	147,496	128,052	4464	251	53,805.8	251	118.6	196,838	177,394	−70,194	−4038	36.1	−2001	175,393	0.99	1.33
KAR	1,139,292	1,004,063	18,019.1	170.4	64,077.7	170.4	65.4	1,185,351	1,050,122	−94,194	−13,534	−294.9	−11,787	1,038,335	0.99	1.04
KER	761,820	696,021	12,788.5	35.1	26,739.9	35.1	38.4	775,771	709,972	−5734	2228	13.2	1056	711,028	1.00	1.02
MAH	2,951,912	2,632,253	31,071.6	6783.1	20,852.9	6783.1	209.8	2,941,693	2,622,034	−26,210	−3394	−2581	−4616	2,617,418	1.00	1.00
MANI	35,313	32,048	711.4	71.8	1880.2	71.8	14.2	36,482	33,217	28,608	5233	124	11,325	44,542	1.34	1.03
MEGH	43,429	38,423	375.3	95.7	2726.2	95.7	10	45,780	40,774	5036	4478	579.3	2532	43,306	1.06	1.05
MIZ	17,687	16,346	153	268.1	2700.5	268.1	71.4	20,235	18,894	−2745	−2191	1082.2	−647	18,247	0.97	1.14
MP	1,132,757	974,608	23,559.5	4795.2	21,079.8	4795.2	637	1,130,277	972,128	−20,090	1104	−1747.1	−4320	967,808	1.00	1.00
NAG	36,794	34,272	1300.6	0.9	952	0.9	67.8	36,445	33,923	3899.2	1752.2	208.8	1649	35,572	1.05	0.99
ORI	446,845	387,373	10,990	1958.7	4034	1958.7	153.8	439,889	380,417	−726	1984	−691.8	144	380,561	1.00	0.98
PUN	707,509	629,678	3297.3	124.1	172.5	124.1	2	704,384	626,553	−1130	−417	−1330.9	−1217	625,336	1.00	1.00
RAJ	873,718	768,878	15,093	104.6	1092.7	104.6	16.8	859,718	754,878	−2402	−2212	−206.6	−1266	753,612	1.00	0.98
SIK	11,527	10,387	175.8	51.7	674.5	51.7	0.2	12,026	10,886	89	583	33	296	11,182	1.03	1.04
TN	1,537,287	1,367,809	5853.6	242.1	22,390.8	242.1	93.1	1,553,824	1,384,346	10,957	2578	1149	2299	1,386,645	1.00	1.01
TRI	60,617	56,603	728.4	1083.9	75.5	1083.9	30.3	59,964	55,950	2903	3780	4744.2	4208	60,158	1.08	0.99
UP	1,796,015	1,568,625	30,715.2	1329.8	34,785.6	1329.8	38.1	1,800,085	1,572,695	−37,278	−12,982	1043.6	−8151	1,564,544	0.99	1.00
WB	1,671,371	1,537,807	12,529.7	69.5	5445.7	69.5	131.9	1,664,287	1,530,723	−3013	−439	2624.6	644	1,531,367	1.00	1.00
Total	18,539,943	16,387,846	221,805	20,608	376,326	20,608.2	2005.1	18,694,466	16,542,370	−387,643	−51,624	4152	−74,639	16,467,731	1.00	1.01

Source: Computed.

used by Forest Departments to charge for recorded ntfps usage and (c) social security benefits of avoided migration to urban areas by forest-dependent poor. There is not enough gathered data to support quantification and inclusion of these factors. However, we attempted to estimate the value of fodder using an alternate approach. Our study estimates the value of fodder at Rs 118 per hectare.

5.3. *Analysis of results and implications*

5.3.1. *National accounts*

Given that there are various beneficiaries of forest products and services including commercial logging operations, forest dwellers, subsistence users, non-local communities (indirect beneficiaries), and the global community, it is important to know the effect of the depletion or accumulation of forest capital on these stake holders. The answer is not easy, as it has to be considered from an intergenerational (forest wealth left to future generations) and intragenerational (implications for various stake holders) perspective. Our analysis shows that India overall and many of its states are liquidating natural capital to pay for current consumption. To achieve intragenerational equity, the distribution of benefits to different social groups and beneficiaries should be even. However, as mentioned earlier the poor subsistence users very often gain much less than the commercial users and equity is not satisfied.

Our results also show that the global community benefits from the services provided by the natural forests (in the form of carbon storage, as evaluated in this paper, and also biodiversity and ecotourism). Though Indian forests emit carbon, it is small in comparison to the total carbon emitted by various other sources. However, if forests accumulate carbon, global communities benefit far more than local communities. Though our study has not addressed the recreational benefits offered to the global community, the fact remains that in India the entry fee charged by most of these national parks is very meager and does not reflect its value to the global community. This under valuation of recreational services and the low economic value of this form of land use exert great pressure to convert such protected area to alternative uses. So far the accounts have not been used for analyzing trade-offs between different groups, but if so used they can help in identifying the vulnerability of social groups to these changes and design suitable compensation mechanisms.

The results also indicate that the current measures of national income in India underestimates the contribution of forests because of under-reporting and market failures (see Fig. 2). Though significant rent can be generated using forest resources, the forest department in India collects a small portion of this because trees and ntfp are usually provided free of charge or at very nominal prices. As a result, the real gains accrue to the private parties to whom the forest dependent communities sell their products. This does not send an appropriate signal for sustainable forest management. Developing countries such as India can sustain their consumption levels only if the accumulated stocks of forest capital match the economic depreciation of natural capital. In developing countries, government policy might accept the loss of renewable resource for the sake of economic development, in which case the rents captured by fees or taxation should be reinvested in natural capital (which can maintain some of the ecological functions of the original asset).

Given that a substantial proportion of deforestation occurs because of what can be broadly termed 'policy failures', correcting these failures assumes critical importance. Incorporating the available estimates of market and non-market value of forests can provide a powerful rationale for a significant increase in forest conservation (Torres, 2000; Costanza et al., 1997) and a comprehensive and unbiased framework for contingent valuations of a full range of forest goods and services is essential, with sufficient granularity to be policy-relevant and appropriate at the operative State level. Our paper has presented a methodology and an example of how some important components of forest value can be valued and accounted for in this manner.

5.3.2. *State accounts*

Our results show that it is the northeastern states that are also the most significantly understated in terms of the true economic size of their forest sectors, in the absence of any 'Green Accounting' adjustments (Table 4). Not only are their state incomes understated, but also, in most cases their net increases in natural capital escapes notice as well, an environmental 'double-whammy'. The extract below illustrates the point by combining the income and capital adjustments (i.e. ESDP/NSDP) and comparing them with the India average.

Table 5 gives the integrated national and forest accounts for Gross State Domestic Product (GSDP), Net State Domestic Product (NSDP) and Environment-adjusted State Domestic Product (ESDP). The gap between GSDP and ESDP indicates the extent of environmental degradation caused due to economic activity. If the ratio of ESDP to NSDP is greater than or equal to 1, growth is sustainable otherwise the growth has come at the expense of environmental degradation for these states. Although logging and other disturbances which damage the growing stock of forests also occurs in the states where the ratio of ESDP/NSDP is above 1, in these states the regeneration of forests or mean annual increment in forests compensates for these losses. Existing national and state accounts do not factor in changes in value due to additions and reductions in forest stock, an essential data point to

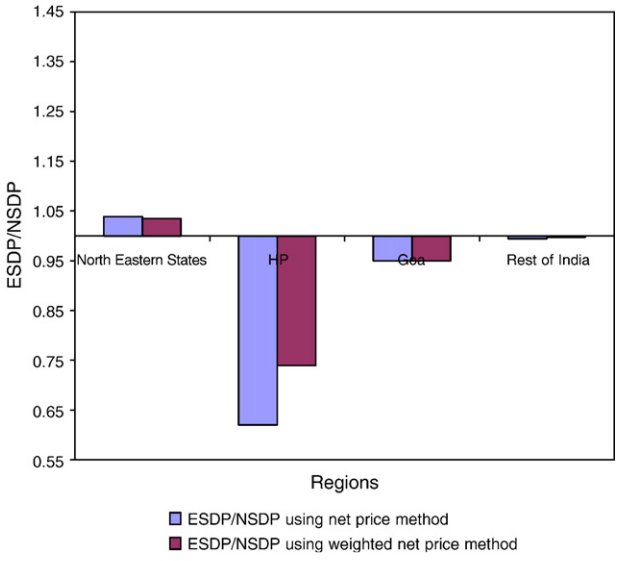

Fig. 3 – Depletion adjusted NSDP (ESDP) to NSDP.

Table 6 – Integrated forest accounts for 2002–2003 (in Rs millions) (sensitivity analysis using net price of timber)

States	GSDP	NSDP	Value added by timber and fw in national accounts	Value of ntfps in national accounts	Value of timber and fw this study	Value of ntfps as per the study	Value of grazing	Adjusted GSDP	Adjusted NSDP	Depletion of timber	Depletion of carbon	Depletion of ntfps	Total depletion	ESDP	ESDP/ adjusted NSDP	Adjusted GSDP/ GSDP
A&N	11,564	10,408	106	16.3	4664.8	16.3	0.9	16,123	14,966.8	−5696	−16,079	8	−4964	10,002.8	0.67	1.39
AP	1,607,684	1,439,754	17,902	1063.2	119,375	1063.2	174.6	1,709,157	1,541,227	−175,474	−274	−268	−17,526	1,523,701	0.99	1.06
AR.P	19,451	17,395	825	101.1	39,492.2	101.1	8.4	58,118	56,062.2	−9109	784	−4	390	56,452.2	1.01	2.99
AS	354,314	317,208	5548	70.3	27,971	70.3	18.7	376,737	339,631	−709,38	−1366	40	−663	338,968	1.00	1.06
BI	897,150	787,034	15,269	696.6	26526.3	696.6	5.8	908,407	798,291.3	−16,674	−114	−55	−7420	790,871.3	0.99	1.01
GOA	77,711	67,357	95	16.2	13,853.6	16.2	1.5	91,470	81,115.6	−24,719	−7810	32	−3889	77,226.6	0.95	1.18
GUJ	1,382,850	1,144,048	4169	54.3	38,802.3	54.3	39.7	1,417,483	1,178,681.3	−77,535	−2249	−105	−2219	1,176,462.3	1.00	1.03
HAR	658,372	579,375	1976	42.6	1302.5	42.6	4.9	657,699	578,701.5	−4059	−2055	−263	−1983	576,718.5	1.00	1.00
HP	159,460	142,024	4089	1111.9	113,374.4	1111.9	51.6	268,745	251,309.4	−202,457	−6976	−19	−95,934	155,375.4	0.62	1.69
J&K	147,496	128,052	4464	251	155,270.5	251	118.6	298,303	278,858.5	−202,562	−4038	36	−2001	276,857.5	0.99	2.02
KAR	1,139,292	1,004,063	18,019	170.4	328,071.2	170.4	65.4	1,449,344	1,314,115.2	−482,265	−13,534	−295	−35,231	1,278,884.2	0.97	1.27
KER	761,820	696,021	12,789	35.1	126,211	35.1	38.4	875,242	809,443	−27,065	2228	13	882	810,325	1.00	1.15
MAH	2,951,912	2,632,253	31,072	6783.1	64,294.7	6783.1	209.8	2,985,135	2,665,475.7	−80,812	−3394	−2581	−8513	2,656,962.7	1.00	1.01
MANI	35,313	32,048	711	71.8	2395	71.8	14.2	36,997	33,732	36,441	5233	124	14,223	47,955	1.42	1.05
MEGH	43,429	38,423	375	95.7	4256.2	95.7	10	47,310	42,304.2	7862	4478	579	2547	44,851.2	1.06	1.09
MIZ	17,687	16,346	153	268.1	1799.8	268.1	71.4	19,334	17,992.8	−1829	−2191	1082	−494	17,498.8	0.97	1.09
MP	1,132,757	974,608	23,560	4795.2	77,474.5	4795.2	637	1,186,672	1,028,522.5	−73,835	1104	−1747	−14,459	1,014,063.5	0.99	1.05
NAG	36,794	34,272	1301	0.9	1046.2	0.9	67.8	36,539	34,017.2	4285	1752	209	1769	35,786.2	1.05	0.99
ORI	446,845	387,373	10,990	1958.7	29,804.3	1958.7	153.8	465,659	406,187.3	−5362	1984	−692	−716	405,471.3	1.00	1.04
PUN	707,509	629,678	3297	124.1	243.7	124.1	2	704,456	626,624.7	−1596	−417	−1331	−1441	625,183.7	1.00	1.00
RAJ	873,718	768,878	15,093	104.6	3908.8	104.6	16.8	862,534	757,693.8	−8594	−2212	−207	−3118	754,575.8	1.00	0.99
SIK	11527	10387	176	51.7	115.4	51.7	0.2	11466	10326.4	15	583	33	294	10620.4	1.03	0.99
TN	1,537,287	1,367,809	5854	242.1	104,562.8	242.1	93.1	1,635,996	1,466,517.8	51,167	2578	1149	4387	1,470,904.8	1.00	1.06
TRI	60,617	56,603	728	1083.9	291.5	1083.9	30.3	60,181	56,166.5	11,208	3780	4744	4724	60,890.5	1.08	0.99
UP	1,796,015	1,568,625	30,715	1329.8	4543.2	1329.8	38.1	1,769,843	1,542,453.2	−4869	−12,982	1044	−5241	1,537,212.2	1.00	0.99
WB	1,671,371	1,537,807	12,530	69.5	25,437	69.5	131.9	1,684,278	1,550,714	−14,073	−439	2625	−1282	1,549,432	1.00	1.01
Total	18,539,943	16,387,846	221,805	20,608.2	1,315,088	20,608	2005.1	19,633,227	17,481,131	−1,378,544	−51,624	36,886	−177,882	17,303,253	0.99	1.06

Source: Computed.

assess whether a state economy is sustainable (within the context of 'weak sustainability') after accounting for forest losses.

It can be seen from Table 5 and Fig. 3, that for the states Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tripura, Kerala and Tamil Nadu the ratio of ESDP to adjusted NSDP (i.e. adjusted for unaccounted forest income) is greater than 1 whereas for other states it is at or below 1. We find that some of these states are experiencing great stress on their forests (especially states which are highly dependent on tourism) and others has experienced stress due to very state-specific factors. For the state of Goa, well known for tourism, we find that there is significant depletion of 5% of adjusted NSDP. In Himachal Pradesh, depletion as per cent of adjusted NSDP works out to almost 26%. Further inquiry on Himachal Pradesh drew to our attention the fact that the Government, Forest Corporation, does not only log timber and agencies with logging permits but also by local residents as Tree Distribution Scheme ("T. D. S.") right holders. This timber is given away at nominal rates (e.g.: Rs 5 per cubic metre) for a premium endemic hardwood (Deodar) worth Rs 9000 per cubic metre. This perverse incentive to "T. D. S." right holders tends to target the Deodar tree, and in the absence of adequate controls, the rate of removal escalates. High depletion rates observed in the state of Himachal could be attributed in part to such unplanned removals that go unrecorded in national accounts, a sum conservatively estimated by us at INR 750 million per annum over the period 2001–2004. At the time of writing, the State Government had approved changes to their Forest Policy that would significantly reduce this problem.

It should be noted here that these two States (i.e. Goa and Himachal Pradesh) also had two of the three highest CSO weights for timber (43%) in the CSO Weighted Net Price for timber and fuelwood that we have used as our preferred price assumption (see Table A4 and derived monetary accounts in Table 4). In order to ensure that this observation was not merely a reflection of that high timber weight and a nation-wide trend towards deforestation, we lifted the CSO assumption and worked out a sensitivity analysis on a "worst case" assumption using only net timber prices by State (see Table 6). This can be seen in Fig. 3 as well. As expected, this increases unaccounted incomes significantly across the board (see Adjusted GSDP/GSDP ratios, Table 6) but it does not alter the observation that Goa and Himachal Pradesh fare poorly by our sustainability yardstick when compared to other States.

6. Conclusions

Accounting for forest wealth has a number of useful policy benefits including the provision of a framework for analysing and presenting detailed and diverse data in a manner which supports economically informed policy choices. The forest accounts that we have presented for India's forests have described forestry-related stocks and flows in terms of land area (under forest), physical volume (of timber and carbon) and, finally, monetary values. Such disaggregated analysis at the state level provides a unique opportunity to understand whether or not state economies are growing in a sustainable manner.

Forests have several use and non-use values, however, our analysis in this paper is confined to the use values of timber, fuelwood and non-timber forest products and global services provided by carbon storage. It is well recognised that forests are often under valued due to market imperfections and it is important to value the goods and services more accurately. In this paper we have made a partial attempt to value forest goods and services by accounting for some of these imperfections. However, in order to fully integrate forest values into national accounts, a comparable build-up of methodology and working assumptions will be required for bio-diversity values (eco-tourism, bio-prospecting, flagship species non-use values) as well as the value of ecological services (water augmentation, mitigation of flood damage, mitigation of soil erosion).[20] Hence, our estimates from this paper should be treated as illustrative lower bounds.

The study has confirmed that if the limitations of the current data on production and prices are addressed, the value added by forestry will be much more than reflected in GDP/GSDP accounts today. This illustrates the need to value the forest resources accurately and fill the gaps in the existing data by providing a proper accounting framework to better reflect the state of country's total wealth. A more accurate estimate of GDP/GSDP that reflects all the contribution of forests can prove to be an effective tool for evaluating policy choices for "conservation versus conversion" of forest assets, including the need to associate economic costs with and ascribe meaningful prices to (for example) choices where the 'user pays' principle may be applied.

For an economy to be on a sustainable path the ratio of ESDP to NSDP should be greater than one. Goa and Himachal Pradesh are examples of states where this is not the case, and specific local pressures on forests have been identified which are consistent with our results. In the latter case, corrective executive action has recently been taken by the State Government in the form of an appropriate change in the State's Forest Policy.

The North-Eastern states stand out as economies where both the current period value of forest services as well as the capital gains due to natural growth (neither being accounted for) are very significant as compared to their NSDP, pointing to the need for a different Central perspective for investment and funding for these States.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ecolecon.2006.07.035.

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