Chapter 4
Current Status of Environmental and Economic Accounting: Review of Some Countries Experiences and Way Forward for India

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4.1 Introduction

Linking natural resources and economy, and efforts to find out contribution of natural resources to economic development can be found in the economic policies pursued by some countries even from the start of the second half of the last century. It all started with an attempt to correct shortcomings of the United Nations (UN) framework System of National Accounts (SNA) released in 1968 in the context of treatment of income from unsustainable use of natural resources (Peskin 1989, Peskin and Lutz 1990; Repetto 1989; Dasgupta 1990; Bartelmus et al. 1991; Dasgupta and Maler 1991). The developed countries taking a lead in natural resource accounting include Norway, Sweden, Netherlands, France, Canada, Germany and the USA. Norway, Netherlands, France and Canada were early users of natural resource accounting, developing country-specific methods during the 1970s and 1980s to meet their own economic and environmental policy requirements. Germany has taken a lead on material flow accounts (MFA) and land accounting. Attempts of natural resource accounting can also be found earlier in some developing countries like the Philippines, Indonesia and Namibia.

The methodology of integrated environmental and economic accounting first appeared as *Handbook of National Accounting: Integrated Environmental and Economic Accounting* published by the UN in 1993. The most recent version of the System of Environmental–Economic Accounting (SEEA) appeared in 2003 as a joint publication of the UN, the International Monetary Fund (IMF), the Organization of Economic Cooperation and Development (OECD) and the Statistical Office of the European Communities. The next version of the SEEA may appear soon with further revisions being attempted by the experts from different countries. This methodology has been developed out of decades of rich experience of several countries and international organizations in natural resource accounting. Even after almost two decades of its existence, it is now found that no country in the world has

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made full use of this methodology for estimating its green gross domestic product (GDP). Given that the full implementation of this methodology in national income accounting could provide an estimate of the comprehensive measure of a country's green GDP, it is therefore hard to find as of today reliable green GDP estimates even for a few countries in the world.

The remaining chapter is planned as follows. Section 4.2 reviews past practices and current initiatives in natural resource accounting by some developed and developing countries. Section 4.3 discusses attempts of some developed countries to integrate their current practices of natural resource accounting with the SEEA. Section 4.4 presents a brief account of some resource-specific studies attempted for implementing the SEEA methodology. Section 4.5 provides some suggestions for implementing the SEEA methodology in India. Finally Sect. 4.6 contains the conclusions.

4.2 Country Experiences of Resource Accounting: Lessons from Past Practices and Some Current Initiatives

4.2.1 Developed Countries

Norway is among the first countries to develop a system of natural resource accounting. Its work began in the 1970s in response to the Club of Rome's publication of *Limits to Growth* and a growing environmental movement. The Norwegian system of resource accounting (SRA) was developed with twin objectives: to develop regular reviews of the volume, quality and use of natural resources in the form of "resource accounts"; and to coordinate and present proposals regarding the future use of such resources in the form of "resource budgets". The resource-budgeting provision is peculiar to the Norwegian SRA, especially given that the accounts were developed entirely in physical units. The exclusion of monetary resource accounting grew from a Norwegian perception that monetary accounting may require the exclusion of vital resources from the framework and the use of unreliable valuation methodology.

In the early phase of natural resources and environmental accounting in Norway, accounts were prepared for a large number of natural resources. These included energy, minerals, sand and gravel, forests, fish, land use, fresh water, air pollution and waste. The accounts were published in annual reports from 1981 (Central Bureau of Statistics 1981). The material resources accounts were kept in physical units and consisted of three parts covering (1) reserves or capital accounts; (2) extraction, conversion and trade accounts; and (3) end use accounts of the resources. These accounts designed much earlier, provide a structure of information of natural resource accounting similar to the SEEA methodology which was developed much later. The salient features of these accounts are: (1) They provide information of stocks or reserves of the resources as well as their end uses; (2) they are provided in

physical units with information of market prices, if available; (3) they are classified such that natural resource accounts and SNA accounts are interlinked; (4) they are prepared such that specific characteristics of resources in terms of reserves and end uses are taken into account[1] and (5) most of the natural resources and environmental accounts were constructed using data from secondary sources.

A close look at natural resource accounting practices in Norway during the last two decades of the twentieth century reveals that significant efforts were made to integrate SNA and natural resource accounts as we currently see in the SEEA for estimating the green GDP. Norway has been making some limited efforts to implement the SEEA, especially in the context of developing a national accounting matrix including environmental accounts (NAMEA) as in other European countries like the Netherlands.

Sweden has been another European Union (EU) country very rigorously pursuing environmental accounting starting in the 1990s. Energy and air pollution accounts and climate change models constitute the core of environmental accounting of Sweden. The general equilibrium model of Swedish economy has been extended to include an environmental module. This helps to link emissions to productive sectors of the economy and assess the economic effects of different environmental objectives including Kyoto Protocol targets for all economic activities.

Attempts have been also made to estimate the green GDP for Sweden. Some work has been done towards it, essentially following the SEEA approach. Monetary values for the depreciation of natural resources and the costs of preventing further pollution by Swedish households and industry have been estimated on a regular basis. These estimates have been presented as shares of the GDP. Environmental valuation studies have been done in Sweden for assessing the costs imposed by pollution. These studies provide estimates of costs due to forest loss, crop loss, health impacts and declines in real estate values.

The Netherlands is pioneer in considering the extension of national input–output tables (IOT) for linking economic and natural resource accounts. It has developed the NAMEA. The NAMEA builds on the IOT of the national income accounts by introducing additional columns containing physical data on air pollutant emissions by sector. The tables also include imports of pollution from outside the national boundaries and exports beyond national boundaries. Using the NAMEA, some environmental indicators are created pertaining to international effects (greenhouse effect and ozone layer depletion) and domestic effects (acid rain, eutrophication and waste) of pollution. The NAMEA accounting system has been adopted by the EU, and the European Commission has been providing financial support to all countries to develop their own NAMEA systems.

[1] A biotic resource like fish required a relatively detailed reserve or stock account with specification of age structure and localization of the different fish stocks. The end use part of the accounts is, however, quite simple since relatively few sectors use fish as an input factor in their production. For other resources, like energy, the situation is different since energy is an important input factor in almost all sectors of the economy requiring detailed end use accounts, while the reserve account could be kept relatively simple.

In the scheme of the NAMEA mainly two types of extensions could be distinguished (see European Commission 2006):

a. Natural resources covering mineral and energy resources, water and biological resources flow from the natural environment into the national economy.
b. Residuals consisting of emissions to air, water and soil are the incidental and undesired outputs from the economy discharged into the environment.

In the environmentally extended input–output table (EEIOT), environmental extensions are considered in the form of satellite accounts. The conventional monetary IOT remains as it is and non-monetary environmental extensions are attached in the form of separate accounts underneath the monetary accounts. The satellite accounts of environmental extensions consist of an input matrix of environmental extensions and an output matrix. The inputs are primary natural resources (gifts from nature) and the outputs are emissions. The EU countries could use EEIOT for environmental policy analysis in three ways:

1. Environmental problem analysis: Analysis of the nature and causes of environmental problems, as related to resource use and emissions relevant for policy. For example, it includes the analysis of life cycle environmental impacts of product groups (cars, meat, houses, etc.), consumer groups (urban vs rural dwellers) and impacts related to primary resources used (oil, iron ore, coal, wood, etc.).
2. Prospective effect analysis of policies: ex ante prediction of effects of policy measures. These include economy-wise environmental implications of changes in lifestyle and consumption expenditure patterns, technological changes of products and processes, emission reduction measures, price effects of environmental taxation and other ways of internalizing the environmental externalities.
3. Monitoring and ex post effect analysis of policies: ex post analysis of impacts and effectiveness of policy measures. It involves the analysis of the relationship between environmental impact (emissions, material requirement) and economic output.

France has also been another country adapting environmental accounting as early as the 1980s. It developed its own method of environmental accounting resulting in what are known as the patrimony accounts. Three distinct accounts known as resource, place and agent accounts are prepared which are linked for policy analysis. Resource accounts in the form of stock and flow accounts are measured in physical terms. Apart from natural resource accounts, patrimony accounts also include cultural resources and any other assets. Geographical accounts provide physical data about assets organized by location and by ecological and land characteristics. The agent accounts show identity and actions of agents/people and institutions using the resources.

Germany is one of the EU countries which started working on environmental accounting as early as the 1980s. The main focus is on developing physical accounts of materials and energy flows, flows of air and water pollution, solid waste and land use by industry. Germany is a leader in the development of MFA and provides physical data of flows of materials. It has implemented a large part of the SEEA placing

a main emphasis on physical accounts. This has been done by extending physical input–output tables (PIOT) for integrating natural resource accounts with production accounts and by constructing the NAMEA. The PIOT describe the flows of materials and energy within the economic system, and between the economic system and the natural environment. These flows include changes in the natural environment caused by human activities like using natural assets as source of raw materials and as sink for residuals. It consists of input tables to show sector-wise use of different materials, output tables to show different sectors producing goods and materials as residuals and material integration tables showing the material flows between the sectors. All the flows are measured in physical units. NAMEA-type flow accounts have been prepared for different sectors like energy and emissions, materials, land and environmental protection expenditures. Germany publishes annually a *Report of the German Environmental–Economic Accounts* with analysis and detailed tables.

Canada has initiated in the late 1970s a framework of action in order to coordinate the collection, storage and manipulation of environmental statistics (Rapport and Friend 1979). The framework was called STRESS[2] with the ultimate goal to establish quantitative links between environmental systems and economic systems. Subsequently, the Environment and Natural Resources Division at Statistics Canada has started to implement a separate framework for natural resource accounting which is much more limited than the previous one with two main goals: to produce satellite accounts for natural resources and to value these natural assets for inclusion in the national balance sheets of the SNA. In this framework, only the economic reserves of commercial resources (resources which could be exploited at current market prices with available technology) form the core of the resource accounting system, at least in so far as the connection between the resource and economic accounts are concerned (Hamilton 1989). The natural resource accounting programme of Canada is named "Econnections: Linking the Environment and the Economy". This programme includes work on natural resource accounts, environmental protection expenditures, the environmental protection industry, MFA, and so on. Canada publishes all of its environmental accounts data, along with a comprehensive description of the methods used. Its publication entitled *Human Activity and Environment* provides both statistical data and syntheses of the links between economy and environment.

The *USA,* unlike the EU countries, has not made any efforts for formally constructing natural resource accounts. This has happened in spite of the existence of a rich data system in the country linking natural resources and various economic activities. The Environmental Protection Agency (EPA) provides databases on pollution control and emissions that could provide basic data for some parts of environmental accounting. Attempts have been made in the USA to integrate the EPA databases on emissions into a system analogous in some ways both to the NAMEA systems of many European countries and to the micro-level use of MFA. Attempts have also

[2] It is so named because the structure of the system is based upon the process of anthropogenic environmental stress and response and the implications of this process for human populations.

been made to build national MFA similar to the accounts in Germany described above. Even in the absence of an environmental accounting framework, considerable work has been done in the to assess the costs and macroeconomic impacts of greenhouse gases, estimate the physical stocks and flows of a wide variety of minerals and provide physical data of forests.

4.2.2 Developing Countries

Developing countries had not started working on developing databases linking natural resources with economic activities until the turn of the twenty-first century. However, one can find some case studies of selected sectors in some countries which were attempted independently of the government. A study by Repetto et al. (1989) for Indonesia was one of such attempts. This study looks into the problem of how some measure of natural resource depletion might influence estimates of the national income of Indonesia. It compiles accounts of stocks and flows of resources over time for timber, petroleum and soil resources. A measure of the stock at the beginning of the accounting period was listed together with the unit price and an estimate of the total value for each resource. Changes in the resource stocks are recorded together with changes in the unit cost over the accounting period. At the end of this period, final stock, closing unit price and final total value of the resource stock are recorded. This study assessed the effects of natural resource depletion on macroeconomic indicators of the Indonesian economy during 1971–1984. It is found that making corrections for resource depletion reduces the annual rate of growth of the GDP of Indonesia from 7 to 4 % during this period.

A study by Gilbert (1990) provides another case study of resource accounting in the context of developing countries. She suggested a framework consisting of three accounts: resource user accounts, ecological or stock accounts and socio-economic accounts and attempted a case study of natural resource accounting for Botswana. The system of resource user accounts is similar to an input–output approach describing the input of natural resources and environmental services to various economic sectors and the output of materials from these sectors to the natural environment. User accounts pertain to fisheries, livestock, crops, forestry, mining, conservation, recreation, water storage, urban transport and waste disposal. In these accounts, inputs are described as stocks of resources, effort, infrastructure, investment and government policy, while the outputs are yield, income, value added and environmental impact. The resource user accounts are prepared as both physical and monetary accounts. The ecological or stock accounts are classified as abiotic consisting of accounts of air, land, water and subsoil resources and biotic having accounts of ecosystems and ecosystem components. These accounts are only physical measures of resource stocks and changes. The socio-economic accounts have three subcomponents relating to economic, demographic and policy aspects of the economy. The economic accounts are derived from the SNA with reclassification of certain sectors. The demographic accounts describe aspects of societal interaction

with the environment, as for example information on direct relationships between local populations and natural resources. The policy accounts provide a description of existing government environmental policy.

The methodology of resource accounting described in Gilbert's and other early studies (Repetto et al.1989; Peskin 1989; Theys 1989) on the subject have paved the way for gradual development of more comprehensive and practical approaches of natural resource accounting during the last decade of the twentieth century and the first decade of the twenty-first century. The country-specific experiences of resource accounting in developed countries briefly described above and independent studies attempted by researchers during the end of the past century have helped to understand more clearly the relationship between economy and natural resources. This has led to undertake a number of studies in different countries and international organizations (UN; EU) to attempt necessary changes and extensions in conventional methods of measuring the GDP of a country in order to properly account for the contribution of natural resources to the well-being of the people. The currently developing methodologies of extended input–output tables for accounting of environmental externalities of the European Commission and the SEEA are offshoots of some of the past experiences in this area of research.

The *Philippines* is one of the first among developing countries that tried to implement the SEEA in national income accounting. In the mid-1990s, it received financial and technical support from the UN for implementing the SEEA. New methodologies of "green accounting", proposed as a satellite of the conventional SNA, were implemented by the National Statistical Coordination Board (NSCB) in collaboration with other national agencies and with the technical support of the UN Statistics Division (UNSD). This project has produced asset accounts of natural resources and estimates of the GDP for the Philippines. Prior to this work, there were also attempts publishing overall macroeconomic accounts for the years 1988 and 1992 including environmentally adjusted GDP estimates prepared, of course, using the Peskin approach which differs from the SEEA.

Estimates of physical and monetary accounts of SEEA asset accounts are prepared for a comprehensive list of natural resources mostly for the period covering 1988–1999. The list of resources includes land, minerals, coal, water, forests and fisheries. Also estimates of environmental protection expenditures of private and government sectors are obtained for the period of 1994–1998. These accounts show only the commercial or economic value of natural resource stocks as per the SNA and do not consider non-marketable environmental values of use and non-use values and option value. In the case of accounting for pollution, the SEEA application in the Philippines uses the maintenance cost method of valuation. The SEEA defines maintenance costs as those that could have been avoided if appropriate technologies or protection measures would have been applied during the accounting period. As explained in this report, these are hypothetical costs.

In *China,* measurement of the green GDP has been a topic of interest to policy makers and researchers for as long as the past three decades. This is evident from the following initiatives taken up in China towards measuring the green GDP since the 1980s (Yu et al. 2006): (1) The National Environmental Pollution Cost and

Ecological Damage Valuation was conducted by the Chinese Research Academy of Environmental Sciences in the 1980s; (2) the project team for resources accounting and integrating it into the National Economic Accounting System was set up by the Development and Research Centre of the State Council in 1988; (3) calculation of genuine saving was jointly conducted by the State Environmental Protection Administration (SEPA) and the World Bank in 1998; (4) at the beginning of the year 2000, the SEPA and the World Bank began to conduct research on valuation approaches for Chinese environmental pollution cost; (5) during 1998–2001, an energy account covering 25 kinds of major energy sources was developed jointly by the National Bureau of Statistics of China (NBSC) and Statistics Norway; (6) in 2002, the Program of Environmental Physical Quantification Calculation in the Reform of the National Economic Accounting System, namely the Environmental Satellite Account Program, was carried out by the SEPA at the request of the NBSC; (7) in 2004, the research on environmental index systems for building a well-off society in an all-round way and for assessment of leaders' performance was conducted by the SEPA with the aid of the NBSC and other agencies in China; (8) in 2004, the Framework Research on the Green National Economic Accounting System, one of the key technology R & D programmes during the Tenth Five-Year Plan period, was conducted by Renmin University of China in cooperation with the Chinese Academy for Environmental Planning (CAEP).

In the light of various initiatives of natural resource accounting as mentioned above, some attempts have been made in 1994 to estimate the gross ecological cost of China, and it was found to be 2000 billion yuan (Liu and Guo 2008). There have been a number of pilot studies focusing on accounting of pollution cost without paying much attention on extending the SNA framework or implementing the SEEA in China. However, things have changed in China during the start of this century. In a major development for implementing the SEEA in China, the research project of Integrated Environmental and Economic Accounting (Green GDP Accounting) of China was initiated in March 2004 by the SEPA and the National Bureau of Statistics (NBS). The report of this project, which was completed in 2006, contains physical and monetary accounts of water and air pollution and solid waste for different industrial sectors and 31 provinces and municipalities in China and calculations of an environmentally adjusted GDP. This study subscribes to only partial implementation of the SEEA in China because it studies only accounting of pollution but not other natural resources' depletion. Physical accounts of pollution consist of pollution generated (influent), pollution abated and pollution discharged (effluent) for various pollutants. Both methods of environmental valuation, maintenance costs and damage costs, are considered for developing monetary accounts of pollution.

In the case of maintenance cost estimates for the year 2004, there is a large difference between imputed or hypothetical costs and actual abatement costs implying that the investments in pollution abatement are much lower than required in China. The GDP of China was 15,987.8 billion yuan in the year 2004. The total imputed abatement cost or hypothetical cost required to reduce the pollution to a safe level is 287.44 billion yuan, which constitutes 1.8 % of the GDP. Therefore, the pollution-adjusted GDP is 1.8 % less than the conventional GDP in China. The estimated

damage costs of water pollution and air pollution in China were 286.28 and 219.8 billion yuan, respectively, in the year 2004. These costs together constituted 3.02 % of China's GDP in the year 2004.

There have been also attempts in China to go beyond air, water and solid waste pollution accounting described above in implementing the SEEA. There was research jointly conducted by the NBSC and Statistics Canada with emphasis on the accounting system for mineral resources. The Forest Resources Accounting Program was jointly conducted by the NBSC and the State Forestry Bureau. The Marine and Fishery Resources Accounting Program was launched by the State Oceanic and Fishery Administration. The detailed sector level studies of natural resource accounting initiated so far in China could ultimately provide a comprehensive database of linking economy and natural resources for estimating the green GDP using the SEEA methodology.

4.3 SEEA: The Current Status

Many countries as evident from the review of some country experience in the earlier section have started using some parts of the SEEA that could be easily integrated into natural resource accounting methods historically used by them. Also, countries may differ with respect to the importance of specific natural resources to their economies. For example, forestry or fisheries may not be a significant natural resource in some countries. Therefore, some countries have started implementing the SEEA for some selected sectors of the economy. Also, country experiences in using the SEEA differ with respect to developing both physical and monetary accounts of natural resources. Some countries like Germany have attempted to develop physical accounts (both asset and flow accounts) of natural resources recognizing the limitations on the monetary valuation of resources, especially non-marketable or non-commercial services offered by them. However, countries like Sweden, the Philippines and China have been trying to develop monetary accounts of specific environmental resources in an effort to estimate the green GDP. Some countries in Europe, for example the Netherlands, have tried to integrate the SEEA into the input–output matrix of the country that has been historically used for economic policy analysis. It could be useful here to attempt a brief discussion of recent experiences of implementing the SEEA in part or full. An attempt is made to describe the efforts made by some countries, especially EU countries, to integrate SEEA methodology with the methods of natural resource accounting they have been using historically.

Attempts have been made at *EU* level for developing a natural resource accounting system integrating some immediately implementable components of the SEEA with the methods of resource accounting currently used by many member countries. The commission of the EU suggested in 1994 a number of actions to be taken by member countries for developing environmental accounting in view of availability

of the SEEA 1993 handbook. As a follow up, the European Strategy for Environmental Accounting (ESEA) is defined by the Statistical Programme Committee of Eurostat. The contents of the ESEA, though similar to the accounting framework of the SEEA, are more practical. The ESEA is developed taking into account (a) the consideration of the user needs and of the actual use of environmental accounts, (b) the need to harmonize environmental accounting among EU member countries and (c) the identification within the SEEA 2003 of the accounts deemed to be particularly relevant in the European context.

Eurostat has developed handbooks and a standard set of tables for collection of data for environmental accounting in Europe which are consistent with both the SEEA 2003 and the ESEA. The handbooks are available for the MFA, NAMEA, environmental protection expenditures accounts (EPEA), and forest, water and subsoil asset accounts. Table 4.1 presents the main features of the accounting system of the EU.

Most countries in Europe now produce on a regular basis NAMEA, MFA and EPEA accounts. Table 4.2 presents a prototype of a NAMEA prepared and presented by many EU countries. These accounts describe the physical flows of environmental resources to the economy and from the economy back to environment media as residuals. These flows form part of production accounts of various economic activities, agriculture, industry, and services and consumption accounts of households.

A discussion of natural resource accounts of the UK, which is one of the major EU countries, could be useful to know about integration of current accounting practices with the SEEA in some of the EU countries. Environmental accounts of the UK provide natural resource accounts of land cover, forestry, fishing, oil and gas extraction and reserves. These accounts provide information of physical flows of fossil fuel and energy consumption, atmospheric emissions with a breakdown of greenhouse gas and acid rain precursor emissions by industry, material flows, solid waste and water. Monetary accounts of environment-related information are provided for environmental protection expenditures and environmental taxes. These accounts are developed as satellite accounts to the main national accounts. They use similar concepts and classifications of industry to those employed in the national accounts, and they reflect frameworks recommended by the EU and the UN.

Most of the environment accounts of the UK are physical flow accounts except the accounts of environmental protection expenditures and environmental taxes. The physical accounts contain a large part of information required by physical accounts of natural resources prescribed by the SEEA, particularly for the relatively more implementable parts of it. But the SEEA requires a full set of corresponding monetary accounts which current UK and many other European country environmental accounts do not provide. The SEEA requires the monetary evaluation of all environmental and material resource flows. It prescribes the valuation methods of maintenance cost or non-market valuation methods of revealed and stated preferences. The monetary accounts of environment protection expenditures provide information about the actual cost incurred by different economic activities to

Table 4.1 Key features of the environmental accounting framework adopted in the environmental stress screening (ESS)

Main types of accounts	Main objectives
Economy-wide MFA	To construct an economy-wide balance sheet inclusive of all material flows between the economic system and the natural system (in both directions) in order to quantify the extent to which the economy makes use—according to its own trends—of natural resources and environmental media, including those located abroad
NAMEA-type flow accounts	To account for the physical flows taking place between the economic system and the natural system (atmospheric emissions, intake of natural resources, etc.) in correspondence with the specific economic activities that generate them, in particular—for a given activity—side by side to distinct economic flows such as production, value added, etc.
Economic accounts for the environment (EPEA)	To account for the economic transactions connected with the environment (environmental protection expenditures, resource use and management expenditures, environmental taxes, etc.); to describe the economic activities that produce goods and services for the environment ("eco-industries")
Asset accounts in physical terms	To construct an asset account in physical terms for a given natural resource (initial stock, increases and decreases during the accounting period—both natural and anthropogenic—closing stock); quality aspects are taken into account as appropriate by means of indicators or by breaking down the account by quality classes
Integrated environmental and economic accounting for natural resources (NRIEEA)	To construct—for a given natural resource of interest (e.g. forests, subsoil assets, etc.)—an accounting system made up of NAMEA-type flow accounts, economic accounts for the environment (EPEA) and asset accounts in physical terms

MFA material flow accounts, *NAMEA* national accounting matrix including environmental accounts, *EPEA* environmental protection expenditures accounts

achieve the objective of sustainable use of environmental resources. If these expenditures fall short of expenditures required for sustainable use of the resources, the SEEA maintenance cost method requires the estimation of hypothetical additional costs to be incurred for achieving the sustainable resource use objective.

Many EU countries, with the exception of Sweden, do not aim to estimate the green GDP using the environmental accounts they have been currently preparing. Estimating the green GDP requires the information of a full set of monetary accounts corresponding to the physical accounts they have been publishing.

Table 4.2 Structure of a national accounting matrix including environmental accounts (NAMEA)

Economic activities and household consumption	Economic aggregates				Environmental pressures: pollution		Environmental pressures: intake of natural resources		
	Production	Value added	Employment	Final consumption	Atmospheric emissions	Water emissions	Fossil fuels	Minerals	Biomass
Agriculture									
Industry									
Services									
Household consumption Transport Heating Others									

Table 4.3 Implementation of the SEEA. (Source: UN 2000)

Adaptation of the national accounts for environmental analysis
Step 1: Compilation of the supply and use accounts
Step 2: Identification and compilation of environmental protection expenditures
Step 3: Compilation of produced natural asset accounts
Natural resource accounting
Step 4: Compilation of physical natural resource accounts
Step 5: Valuation of natural resources—compiling the monetary accounts
Accounting for environmental assets
Step 6: Compilation of physical environmental asset accounts
Emission Accounts
Step 7: Compilation of emissions by economic sector
Step 8: Maintenance cost of emissions
Presentation and analysis
Step 9: Aggregation and tabulation
Step 10: Comparison of conventional and environmentally adjusted indicators

They perhaps believe that monetary valuation of non-market environmental services requires a lot of data and models with a host of assumptions. However, the SEEA-prescribed method of maintenance cost to account for degradation of environmental resources in measuring the green GDP could be a feasible method for developing monetary accountings of environmental resource flows.[3] In this context, the monetary accounts of environmental protection expenditures of industries and environmental taxes currently prepared by many EU countries already provide useful information for making use of the maintenance cost method of valuation.

4.4 SEEA Accounts of Different Sectors

4.4.1 Implementation of SEEA

The *Handbook of National Accounting: Integrated Environmental and Economic Accounting—An Operational Manual* (UN 2000) explains step by step the implementation of the SEEA and provides methodologies and case studies of preparing accounts for specific resources like forests, subsoil resources, renewable aquatic resources, soil degradation and air emissions. Table 4.3 explains these steps.[4]

[3] As explained in the earlier section, China has used the maintenance cost method to account for air and water pollution and solid waste in estimating the green GDP.

[4] Table 4.4 provides a list of worksheets for preparing SEEA accounts.

A number of case studies using EU framework for natural resource accounting and the SEEA are being attempted by some countries and institutions to prepare natural resource accounts for different resources/sectors. Physical and monetary accounts of forest resources have been prepared by some EU countries on a regular basis. In the case of land resources, physical accounts of land use changes are prepared by many of these countries. The Food and Agriculture Organization (FAO) has discussed SEEA methodology for preparing fisheries accounts and provided case studies of some countries. The UNSD has discussed the methodology of integrated environmental and economic accounting for water resources and attempted some country case studies.

4.4.2 Forestry Accounts

EU countries adopted some resolutions at a ministerial conference held in Helsinki 1993 on the protection of forests in Europe. These resolutions provide general guidelines for sustainable management of forests and the conservation of biodiversity in Europe. As a follow-up pan-European criteria and indicators were defined for gathering and assessing information to monitor the development of European forests. These are:

(i) Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles
(ii) Maintenance of forest ecosystem health and vitality
(iii) Maintenance and encouragement of productive functions of forests
(iv) Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems
(v) Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)
(vi) Maintenance of other socio-economic functions and conditions

Consequently, proposals for a "European Framework for Integrated Environmental and Economic Accounting for Forests" were developed and tested by the Eurostat Task Force on Forest Accounting. The objective of this framework is to consistently link forest balance sheets and flow accounts, forest-related economic activities and the supply and use of wood within the economy in physical and monetary terms. Moreover, the forest accounting framework contributes to the issues of classification and valuation of forest-related assets within the European System of Accounts (ESA), the SNA, the new Economic Accounts for Forestry and the SEEA. In order to implement the forest accounting framework, accounting tables were drafted covering physical stocks and flows of forests, monetary accounts of stocks and flows, balance sheets for land and standing timber, economic accounts of forestry and supply–use tables (see European Communities 1999). All these tables together provide a large part of forestry accounts required as per SEEA methodology and NAMEA accounts.

Physical stocks and flows accounts of forests provide information of forest cover and volume of standing timber. This account provides stocks and changes in stocks due to human activities, natural or accidental processes as well as changes in classification of land and standing timber. Monetary stock and flow accounts describe in monetary terms the stocks and changes in stocks of land and standing timber. Land and biological assets of forests, say for example commercial timber, differ from an economic point of view and therefore require separate valuations. These accounts present only economic or commercial value of forest stocks using standard valuation methods prescribed in the SNA and SEEA. However, they fall short of SEEA forest accounts for not presenting environmental values of forest resource stocks.

Economic accounts for forestry and logging link the value of forest assets with the economic benefits of different activities related to forests. These accounts are dedicated to the establishment of economic accounts for all industries which use "wooded land" as a basis for their activity. For example they present detailed production accounts of forestry and logging describing detailed output related to woodland, and primary and intermediate inputs used including land, inventories and value added.

Supply and use of wood accounts describe in physical and monetary units the transformation of wood from the stage "output of forestry" to the final products and establish a link between the supply and use of wood, the forest balances and the economic accounts. The use tables show the uses of wood products as intermediate input uses of industries and final uses (final consumption, changes in inventories and exports). The supply tables show the supply of wood products (output of industries and imports). A complementary use table serves to record residuals (wood waste, paper waste and other residuals containing wood, e.g. black liquors) which are not accounted for as intermediate consumption of industries and waste treated by external recycling activities. A complementary supply table records production of waste not counted as output of industries. The supply and use tables are drawn up both in monetary and physical terms, leading to physical material balances.

Mass balance accounts integrate wood and wood products material balances into the forest accounting framework. Mass balances are disaggregated into two tables: use tables and make tables. The use table shows the wood content of the intermediate input use of industries in selected wood products. The make table shows the wood content of the output in selected industries. A complementary table shows the wood content of waste and residuals not accounted for in the output of industries. Therefore these accounts are useful to know the total storage of carbon dioxide (CO2) in wood products and standing timber. They facilitate linking of mass balances to balances of CO2 and activities in the NAMEA-type of accounting. These balances could be further allocated to global environmental problems like greenhouse effect.

The ESA accounts of forest resources described above consider only economic assets as in the SNA. The SNA defines economic assets as assets over which "ownership rights are enforced and from which economic benefits are derived by their owner(s) by holding them or using them over a period of time". However the SEEA extends the asset boundary of forest resources by including also non-economic assets. It accounts for forest land and related ecosystems, biological assets

(plants, animals, etc.) in the forest and other assets related to forests. The *Handbook of National Accounting* of the UN (2000) describes the methods of preparation of a country's forestry accounts as per the SEEA. It defines non-economic environmental forest land covering land of both protected and non-exploitable forests as corresponding to forests that are not exploitable for economic reasons including virgin forests, and to forests where the exploitation of biological resources is severely restricted by virtue of the protection status. The UN Handbook describes the compilation of forestry accounts in the following eight steps:

Step 1: Compilation of the Supply and Use Accounts
These accounts identify and separate, within the general supply–use tables, the transactions that are relevant for the description of forest assets and forest-related activities. The main activities are forestry and logging, gathering of non-wood forest products, hunting, etc. and also activities that result in deforestation (e.g. agriculture, construction, etc.).

Step 2: Identification and Compilation of Environmental Protection Expenditures Related to Forests
Environmental protection expenditures of forests consist of costs of fire protection, afforestation, the improvement of forest soils and protection against game, insect attacks, etc. These also include costs of sustainable use of forests such as forest protection costs.

Step 3: Compilation of Produced Forest Asset Accounts
Produced forest assets accounts consist of the value of standing timber located on land cultivated for wood production.

Step 4: Compilation of Physical Forest Accounts
Two main categories of non-produced economic assets are detailed here: (a) economically used land (specifying forest land) and (b) standing timber in economic non-cultivated (native) forest.

Step 5: Valuation of Forests: Compiling the Monetary Accounts
A monetary value is given to stocks and flows related to non-produced economic assets.

Step 6: Compilation of Physical Environmental Forest Accounts
This step is necessary to complete the description of all stocks of forest land and standing timber and all changes that affect these stocks. It describes accounts of (a) all non-economic land, in other words, all the land that is not described in step 4, except forest land and associated ecosystems; (b) all non-economic forests (areas of forest land and volume of standing timber) and associated ecosystems; (c) other environmental, in other words non-economic, assets—fauna, flora, water and air. The comprehensive description of non-economic forests necessitates a classification of ecosystems (type of forest, etc.) and state of forests from an environmental and ecological point of view.

Table 4.4 List of worksheets of SEEA implementation

WS 2, 2A Environmental protection expenditures
WS 3, 3A Monetary asset accounts: produced assets, including natural assets
WS 4, 4A Physical asset accounts: non-produced economic assets
WS 5 Monetary asset accounts: non-produced economic assets
WS 5A Market valuation of non-produced economic assets
WS 5B Monetary asset accounts: non-produced economic assets
WS 5C Allocation of depletion costs to economic activities
WS 6 Physical asset accounts: non-produced

Step 7: Compilation of Emissions by Economic Sector
Accounts are prepared for three main categories of emissions: (a) emissions by forestry and related industries, (b) emissions that affect forests, and (c) absorption of CO2.

Step 8: Maintenance Cost of Environmental Degradation
Maintenance cost accounting requires the assessment of the extra cost for the maintenance of the state of forests from a quantitative and qualitative point of view. Maintaining the state of forests requires restricting forest-related activities like logging to sustainable levels and reducing the impacts of non-forest-related activities like agriculture and construction to the sustainable levels.

The natural resource accounts of EU countries as described above (natural resource accounts of the UK and forestry accounts of the European framework) have come close to the implementation of the SEEA in these countries. However, these accounts and the SEEA differ mainly with respect to the definition of the asset boundary of natural resource stocks and monetary valuation of especially stocks and flows of environmental resources. The EU countries' accounts consider only economic assets as defined in the SNA, while the SEEA considers both economic and non-economic assets of natural resources by extending the asset boundary. EU countries mainly focus on physical accounts, especially of environmental resources. They do not aim at measuring the green GDP given the limitations on measuring non-marketable environmental services. However, the SEEA provides for developing monetary accounts of environmental resource stocks and flows, especially in the context of sustainable use of these resource stocks (Table 4.4).

4.4.3 Some Other Sector-Specific Studies

4.4.3.1 Fisheries

The UN Handbook 2000 and the FAO *Handbook of National Accounting: Integrated Environmental and Economic Accounting for Fisheries* (FAO 2004) discuss

the methodology of preparing natural resource accounting for fisheries resources. The case of preparing natural resource accounting for fisheries using the procedure prescribed in the SEEA given in Tables 4.3 and 4.4 requires to note specific characteristics of this resource. The approaches to be adopted for defining production and asset boundaries, and developing accounts of physical asset and flow accounts will be different from those for other resources.

In defining the production boundary of resources, natural growth of fish stocks in open seas is not counted as production, as the process is not fully managed as required by the SNA. On the other hand, the growth of fish in fish farms and fish harvested in open seas from commercial or recreational fishing are treated as processes of production. The SEEA for fisheries accounting considers all fish stocks within the exclusive economic zone (EEZ) of a country as an economic asset and therefore included in environmental assets, for example, marine and freshwater ecosystems. Physical accounts of fisheries have to be developed using the concept of sustainable use or harvesting and using different approaches for cultivated and wild fish stocks. The production and use tables showing the relationship between fisheries and fishery-dependent activities and ecological resources and accounts of environmental protection expenditures require specific approaches to develop them.

4.4.3.2 Water Resources

Integrated Environmental and Economic Accounting for Water Resources (United Nations Statistics Division 2005) and the UN Handbook 2000 provide detailed methodology and description of data requirements for preparing natural resource accounts for water resources. This report first discusses how to develop physical supply and use accounts of water resources and provides some case studies at a country as well as river basin level. It also describes monetary accounts of supply and use of water, water protection and other water-related activities. Asset accounts of water resources are developed by extending the asset boundary of the SNA to account for aquatic ecological resources. This also provides a description of emission accounts for a river basin with a case study.

4.5 A Way Forward for Measuring Green GDP of India

4.5.1 Some Studies Funded by CSO in India

An attempt to develop a comprehensive database for measuring the green GDP of India requires a review of currently available data sources and methods giving the information about the natural resource stocks and their links to various economic activities in India. In this context, the Central Statistical Organization (CSO) has initiated some studies for developing databases and methodologies for specific sectors in India. Table 4.5 provides a brief description of CSO-funded projects.

Table 4.5 Summary features of CSO-funded studies

Authors	Sectors covered	Valuation methods	Data	Observations
Murty and Gulati (2006)	Air and water pollution	Maintenance cost valuation methods using production function and cost function methodologies Non-market valuation method of hedonic prices	Both primary and secondary sources	Methods of developing physical and monetary accounts of water and air pollution are described with the help of case studies from Andhra Pradesh and Himachal Pradesh Methodologies for estimating maintenance costs of air and water pollution are described, and estimates are provided for thermal power generation, industry and transport sectors Estimates of benefits from urban air quality improvements are provided A method for the generalization of industry and farm production accounts in India for estimating environmentally corrected net value added is described with the help of case studies
Roy et al. (2008)	Air and water pollution	Maintenance cost valuation method using cost functions Non-market valuation method of household health production function	Both primary and secondary sources	Methods of developing physical accounts of water and air pollution are described for West Bengal Maintenance cost estimates are made for water pollution of paper and pulp industry Estimates of benefits from reduced arsenic pollution of groundwater and air pollution are obtained
Parikh et al. (1992, 2008)	Solid waste, forests and land quality	Review of valuation methods Surveys used to collect data Maintenance cost method used	Both primary and secondary	Physical and monetary accounts of forestry and land sectors are described for Goa Information about the status water quality in Goa is provided Industrial, vehicular and indoor air pollution valued using abatement cost method Physical and monetary accounts of municipal solid waste are developed using surveys and abatement cost method Environmentally adjusted SDP for Goa presented

Table 4.5 (continued)

Authors	Sectors covered	Valuation methods	Data	Observations
Singh et al. (2008)	Forests and land quality	Benefit transfer methods	Secondary	Compiled data on natural resources, particularly land and forests of Meghalaya, which could be used for developing physical and monetary accounts Information about expenditures made for soil and forest conservation in Meghalaya is provided
Haripriya et al. (2007)	Forests and land quality	Maintenance cost and non-market valuation methods of travel cost and benefit transfer methods	Secondary and primary	Physical and monetary accounts of forests and land quality for Tamil Nadu are developed Methods for estimating maintenance costs are discussed with case studies of land quality in Tamil Nadu
Verma and VijayKumar (2006)	Forests and land quality	Maintenance cost and non-market valuation methods of travel cost and contingent valuation	Secondary and primary	Physical and monetary accounts of forests and land quality for Madhya Pradesh and Himachal Pradesh are developed Methods for estimating maintenance costs are discussed with case studies of land quality in these states
Panchamukhi et al. (2008)	Forest and land quality	Maintenance cost and non-market valuation methods of travel cost and contingent valuation	Secondary and primary	Information for developing physical and monetary accounts of forests and land in Karnataka is provided A case study of valuation of sacred groves is attempted
Datt et al.	Exhaustible resource coal	User cost, net price and net present value methods	Secondary and primary	Physical and monetary accounts of coal resources for Madhya Pradesh and West Bengal Environmental costs of mining coal are also estimated

SDP state domestic product

4.5.2 Possible Methods for Measuring Green GDP in India

The recent literature on the measurement of sustainable income has developed in two important ways for accounting of contribution of natural resource stocks. One set of studies directly addresses the problem of measuring genuine savings or extended wealth formation including changes in human resource capital and natural capital. The second set of studies use the extended conventional national income accounting methods for accounting of changes in natural resource stocks (SEEA and extended IOT). The international experience in integrating natural resource accounts with the SNA has been progress in three directions: (a) attempts to estimate genuine savings for different countries, (b) implementation of practical aspects of the SEEA and their integration into the national accounts and (c) using SEEA methodology for preparing natural resource accounts of specific resources and sectors. In India, an attempt could be now made for integrating practical aspects of the SEEA with current national income accounting practices.

4.5.3 Developing MFA and NAMEA for India

Develop a strategy plan as the European Strategy for Environmental Accounting (ESEA) for integrating currently used national income accounting methods with the SEEA. Unlike some EU countries, India had not made any advancement in natural resource accounting prior to the publication of the SEEA methodology. European countries currently prepare and publish regularly material flow- and NAMEA-type of accounts. These accounts are still short of information for estimating the green GDP since they avoid putting values on environmental changes reported in these accounts.

It is surprising that a major developing country like India has not yet attempted to develop databases for preparing these accounts. The NAMEA-type of accounts given in Table 4.2 could be prepared using information from extended databases of Annual Survey of Industries (ASI) accounts, input–output accounts, cost of cultivation accounts of agriculture and National Service Scheme (NSS) consumer expenditure accounts in India. In addition, preparation of emission and MFA is needed to have environment-related information of various economic activities. India has been preparing a very detailed input–output matrix for the Indian economy on a regular basis. Environmental extensions of this matrix could be attempted to produce NAMEA-type of accounts.

In extending IOT, mainly two types of extensions could be distinguished:

a. Natural resources covering mineral and energy resources, and water and biological resources flow from the natural environment into the national economy.
b. Residuals consisting of emissions of air, water and soil are the incidental and undesired outputs from the production activities discharged into the environment.

The conventional monetary IOT remains as it is, and non-monetary environmental extensions are attached in the form of separate accounts underneath the monetary accounts. The satellite accounts of environmental extensions consist of an input matrix of environmental extensions and an output matrix. The inputs are primary natural resources (gifts from nature) and outputs are emissions. The ongoing project of the European Commission (EXIOPOL Project) in which many institutions from Europe are collaborating is going to come out soon with an environmentally extended input–output matrix for Europe and some EU countries.

4.5.4 Preparing Monetary Accounts of Environmental Changes

To start with, India should aim at developing an NAMEA reporting physical flows of environmental resources and emissions along with flows of goods and services in the economy. The SEEA mentions maintenance cost and non-market methods of valuation for estimating monetary accounts of environmental changes. The CSO-funded projects mentioned above and some recent studies in South Asia (see Haque et al. 2011) provide good case studies using both maintenance cost and non-market valuation methods. The SEEA recommends the maintenance cost method of valuation for developing monetary accounts recognizing the limitations on the non-market valuation methods.

In India, and for that matter in any country thinking of using SEEA methodology, it is useful to start with the maintenance cost method of valuation for developing monetary accounts. This method of valuation is based on the concept of strong sustainability. Maintenance cost is a more objective and quantifiable method of valuation, while the methods of non-market valuation are more subjective and normative. Maintenance cost depends upon the available technologies of pollution abatement, afforestation and methods of resource conservation. Maintenance cost studies have to be done for different sectors: industry, agriculture, forestry and households. Maintenance cost could vary across sectors depending upon sector-specific environmental and resource depletion problems. Using the maintenance cost method, monetary accounts of changes in environmental resource stocks could be unambiguously constructed for different sectors at national level.

Monetary valuation of environmental changes could be region specific as could be seen in some case studies of non-market valuation done in India and South Asia (Murty 2010; Haque et al. 2011). Learning from a number of non-market valuation studies already done in India and the South Asian region, it is also important to have more similar studies sponsored by the CSO and other relevant government and non-government agencies in future as a long-run strategy for having more accurate estimates of the green GDP of India. These studies could be specific to households and regions and could be used to develop region-specific monetary accounts of environmental changes.

4.5.5 Using SEEA in India

Implementation of SEEA methodology for estimating the green GDP for India requires development of physical and monetary accounts of natural resource stocks at national level. A top-down approach of developing these accounts may not be feasible in big countries like India, the USA and China. Physical changes in environmental resource stocks could be valued differently in different regions, especially in the context of non-market valuation. A bottom-up approach in developing these accounts could ensure to take into account region-specific values of environmental changes.

The SEEA could be applied at subnational or regional level in big countries for developing region-specific physical and monetary accounts of environmental changes. National accounts could be developed by aggregating over the regional accounts. In the Indian context, attempting to apply the SEEA at state level could be a right approach. In this context, the CSO-funded projects addressing the problem of developing natural resource accounts at state level are a good beginning in using the SEEA for measuring the environmentally corrected net national product in India.

4.5.6 Resource-Specific Studies

4.5.6.1 Forestry

Forestry accounts similar to the accounts of EU countries described above have to be developed in India in the near future. Attempts already made by some CSO-funded projects and other studies using SEEA methodology for developing forestry accounts could provide some leads for developing forestry accounts at subnational or state level in India. Given the difficulties involved in monetary valuation of non-marketable services of forest resources and the absence of a comprehensive set of valuation studies for forests even while using maintenance cost methods in India, it is feasible to develop detailed physical accounts of forests in the near short run. Data from secondary sources could be used to develop physical accounts of changes in forest resource stocks at some level of species-wise disaggregation. CSO-funded studies of Verma and Kumar, Haripriya and Panchamukhi et al. have shown how this data could be used for developing physical accounts of forest resource stocks. These studies also show the risk of having unreliable estimates in preparing monetary accounts in the absence of information from more needed valuation studies.

Preparation of monetary accounts of forests has to be treated as long-run objective in India waiting for more comprehensive valuation studies of forest services. The CSO-funded studies, while providing some insights for using both maintenance cost and non-market valuation methods in preparing forestry accounts, underscore the need for more valuation studies in India. In the medium run, priority should be given in India to having more valuation studies of using maintenance cost methods.

Monetary valuation of changes of forest stocks requires disaggregated physical accounts by types of forests, which could differ with respect to the ecological services they offer (biodiversity, carbon sequestration, recreation, etc.). This is especially so in the context of non-market valuation of forest services.

4.5.6.2 Soil Quality

The UN Handbook 2004 provides a detailed discussion of preparing accounts of soil degradation. Soil quality is an environmental good affected by anthropogenic activities and natural causes. Measurement of physical changes in land quality requires information from land quality modelling finding the relationship between soil quality and changes in land use patterns. The SEEA classifies land area as (a) soil; (b) area of land under economic uses such as land underlying buildings, land under cultivation, recreational land and forest land; and (c) non-economic land areas with connected ecosystems. In an attempt to prepare physical accounts of land quality changes using the SEEA in India, it is important to have studies of land quality modelling for different geographical regions. The discussion of land use changes in agriculture and attempting to relate these to soil quality changes in some CSO-funded studies underscore the need for having these studies. Studies of land quality modelling and preparation of physical accounts of land quality changes for different agro-climatic regions should be one of the short-run objectives of natural resource accounting in India.

An attempt to develop monetary accounts of soil quality changes using the SEEA in India should be treated as a medium-term objective. The UN Handbook considers expenditures on improvement in land quality as gross fixed capital formation. This cost covers land reclamation from the sea and forest clearance, and expenditures on soil conservation measures. The maintenance cost method is recommended for compiling comprehensive estimates of cost of soil degradation for a given area. This cost could be estimated as cost of replacement and restoration. Some of the CSO studies discuss and provide some information about replenishment and restoration costs.

Alternatively, monetary accounts of land degradation could be developed using the productivity change method. This is the value farmers place on land quality which has to be measured by estimating production functions considering land quality as one of the inputs in agriculture. There are some available studies in India estimating loss of land productivity due to increased land salinity, soil erosion and nutrient loss. A number of similar studies have to be done on a regular basis in India for estimating hypothetical agricultural production losses from land degradation.

4.5.6.3 Water Resources

Integrated Environmental and Economic Accounting for Water Resources (United Nations Statistics Division 2005) and the UN Handbook 2004 provide detailed

methodology and description of data requirements for preparing natural resource accounts for water resources. It provides case studies of preparing accounts at country as well as river basin level. It is therefore useful in India to make immediate attempts to prepare water resource accounts for all its major river basins in a step towards implementing the SEEA.

Preparing physical accounts of water quality requires studies of water quality modelling for each river basin relating water pollution from sources with ambient quality of surface and groundwater. The information from these studies is important for developing physical accounts of ambient water quality and water quality changes attributed to specific sources, and also for designing an environmental policy for sustainable water resource development. Preparing physical accounts of water resources could be again one of the short-run objectives of natural resource accounting in India.

Some of the CSO-funded studies provided some insights in preparing monetary accounts of water quality using both valuation methods of maintenance cost and non-market valuation. However, preparation of monetary accounts could be a long-run objective for India waiting for information from more valuation studies of water quality and quantity in India.

4.5.6.4 Air

The UN Handbook 2004 explains how physical and monetary accounts of emissions have to be prepared. For preparing monetary accounts of air quality, information from studies of air quality modelling at regional or subregional level is required. Industry-level physical accounts of air quality could be prepared, and corresponding monetary accounts could be obtained using the valuation method of maintenance cost. Again, preparation of physical accounts of emissions could be one of the short-run objectives in India waiting for more valuation studies to prepare monetary accounts in the long run.

Some of the CSO-funded studies have done case studies of air pollution at sources as well as ambient pollution for preparing physical and monetary accounts at sector and regional levels. Data from both primary and secondary sources are used for this purpose. These studies have prepared monetary accounts using both maintenance cost and non-market valuation methods. Estimates of maintenance cost are obtained for the thermal-power-generating sector using the methodology of production function and for industrial water pollution using the methodology of cost function. A case study of estimating maintenance cost for the road transport sector is also provided by one of these studies. Estimates of benefits of air and water quality improvements are obtained using revealed preference methods of valuation. The hedonic property price method is used by one study for estimating monetary benefits of urban air quality improvements. Another study has used the household health production function method for estimating benefits of reducing arsenic pollution of groundwater.

4.5.6.5 Subsoil Resources

Physical accounts of exhaustible resources account for depletion of the resources during an accounting period. The depletion has to be measured with respect to proven and utilizable resource stocks. Valuation methods of net price, net present value and user cost are discussed in the literature for developing monetary accounts of exhaustible resources. The net price or resource rent is not an appropriate method of accounting for depletion for it cannot give credit to a country rich in exhaustible resources in relation to a country poor in these resources in measuring the GDP. Similarly, net present value is a measure of stock of a resource which cannot be used to measure the effect of resource depletion on the GDP, a flow.

Any method of valuation of resource depletion has to take into account the property rights of both present and future generations to an exhaustible resource stock and the problem of inter-temporal equity in resource use. The user cost could be an appropriate method for valuing the depletion of the resource because it is based on the concept of weak sustainability (manmade capital could be a substitute for natural capital) ensuring the same level of real income to the present as well as future generations from resource extraction.

In the context of preparing satellite accounts of exhaustible resources as per the SEEA in India, studies have to be done to estimate user cost of resource stocks of minerals, metals and fossil fuels. User cost depends on the life of proven reserves and rate of discount used to address the problem of inter-temporal equity. It decreases with the rate of discount and life of the resource stock making it resource specific. The rate of discount depends on the value judgements of the government on the property rights of present versus future generations to the resource stock. Studies have to be done on a regular basis for estimating user costs for all minable resource costs in India to implement SEEA methodology.

One of the CSO-funded projects has shown that the physical accounts of resource depletion in the case of coal reserves in India could be developed using data from secondary sources. The same could be true for other exhaustible resource stocks in India. Using data for a sample of mines, this study provides estimates of net price, net present value and user cost per tonne of coal extracted in India. It found that the user cost component for coal as percentage of mining sector state domestic product (SDP) in Madhya Pradesh is 2.5 % at a 6 % rate of discount during the years 2001–2002 at 1993–1994 prices.

A number of studies similar to this study have to be done in India for accounting the effects of mining of exhaustible resources in the measurement of the green GDP using SEEA methodology. These studies have to be done for all minable resource stocks in the country with a frequency of at least once in five years as proven reserves increase with new discoveries.

4.5.7 Attempting to Make Estimates of Genuine Savings for India: An Approach to Measure Green GDP

Methodology of genuine savings and estimates of genuine savings prepared currently for different countries by the World Bank provide a way forward to develop a database for preparing natural resource accounts of India. Data from secondary sources could be reorganized to develop this database. The World Bank group of economists has already developed some database for making genuine saving estimates for different countries including India on a regular basis. It could be useful if the Indian government made its own estimates of genuine savings with a more comprehensive database for India.

Estimates of adjusted net GDP or GDP adjusted for depletion and degradation of natural resources could be obtained given an estimate of the rate of genuine savings. If the difference between conventional net rate of savings and the rate of genuine savings is positive, the adjusted net GDP is lower than conventional net GDP for a country. As per the estimates of genuine savings in India made by the World Bank, the costs of rates of depletion of energy and mineral resources and degradation of forests and CO_2 emissions will be added up to 8.22 % of the GDP. Therefore, according to these estimates, the green GDP in India is 8.22 % lower than the conventional GDP. It is also important to know that the actual rate of adjustment for this purpose could be much higher than 8.22 % because the World Bank estimates do not account for the full cost of forest degradation, and the cost of soil erosion and domestic water and air pollution.

4.5.8 Main Recommendations

1. A feasible work plan for preparing natural resource accounts in India has to be implemented in the following three stages:

4.5.8.1 Stage I

Attempt to prepare physical asset and flow accounts for all the natural resources using secondary data sources in the near future. These data could be organized to generate physical accounts by either SEEA methodology or extended national IOT or both. Given that data from secondary sources are incomplete as of today to prepare these accounts for India, the accounts prepared could only provide rough estimates. However, in the case of preparing accounts of exhaustible resources, the secondary data sources could provide full information, and therefore more reliable estimates of these accounts could be obtained for India.

To have more accurate estimates of physical accounts of water, air, forests and land resources, new information has to be generated by having studies of air quality modelling of urban air sheds, water quality modelling of river basins and land quality modelling of agro-climatic regions. These have to be undertaken on priority basis.

4.5.8.2 Stage II

Attempt preparation of monetary accounts of natural resource stocks using the maintenance cost method of evaluation in the medium term. This requires the commissioning of a new set of sector- or industry-specific studies for having the estimated maintenance cost described in this report. Some available studies in India including some from CSO-funded studies have attempted to estimate the maintenance cost for some specific sectors in India such as road transport, coal-fired thermal power generation in the case of air pollution, some manufacturing industries in the case of water pollution and agricultural practices in the case of soil degradation.

4.5.8.3 Stage III

Attempt to use non-market valuation methods for preparing monetary accounts of natural resource stocks in the long run. This requires the monetary valuation of all ecological services provided by natural resources in India. A number of region-specific valuation studies for air and water and forest resources have to done in India for this purpose. There are already some environmental valuation studies using non-market valuation methods in India and the South Asian region. These could provide helpful insights for undertaking many future studies to have more reliable estimates of values of ecological services in India.

The tasks set for three stages of research work described above have to be concurrently undertaken with the priority to complete them in different stages. This is required especially because the empirical studies for obtaining reliable estimates of environmental values are more time-consuming and demanding of budgetary resources.

1. Prepare NAMEA-type of accounts using information from the extended database of ASI accounts, input–output accounts, cost of cultivation accounts of agriculture, and NSS consumer expenditure accounts in India. In addition, prepare emission and material flow accounts to have environment-related information of various economic activities. Attempts could be made to make environmental extensions of the input–output matrix for the Indian economy on a regular basis.
2. Attempt using SEEA methods and environmental extensions of IOT at subnational or regional level (state level) in India. Given that data of IOT are not available at the state level in India, environmental extension of these tables at the state level could be made with the assumption that the production technology is the same at national and regional level.
3. Use the maintenance cost method of valuation for developing monetary accounts to start with. Maintenance cost studies have to be done for different sectors: industry, agriculture, forestry and households. Maintenance cost could vary across sectors depending upon sector-specific environmental and resource

depletion problems. Using the maintenance cost method, monetary accounts of changes in environmental resource stocks could be unambiguously constructed for different sectors at national level.

4. Attempt to prepare forestry accounts similar to accounts of EU countries. Given the difficulties involved in monetary valuation of non-marketable services of forest resources and the absence of a comprehensive set of valuation studies for forests even while using maintenance cost methods in India, it is feasible to develop detailed physical accounts of forests in the near short run. Data from secondary sources could be used to develop physical accounts of changes in forest resource stocks at some level of species-wise disaggregation.
5. Attempt and commission studies of land quality modelling and prepare physical accounts of land quality changes for different agro-climatic regions.
6. Commission studies of water quality modelling for each river basin. The information from these studies is important for developing physical accounts of ambient water quality and water quality changes specific to sources and also for designing an environmental policy for sustainable water resource development. On priority basis, it is good to start with preparing physical and monetary accounts of the Ganges basin taking advantage of data generated by the national project Ganga Action Plan.
7. Attempt studies of air quality modelling at regional or subregional level. Many urban airsheds in India have been experiencing very serious air pollution problems imposing enormous health and other costs to urban households. The problem of preparing physical and monetary accounts of air pollution in major urban areas should be taken up on priority basis. This helps not only in measuring effects of urban air pollution on the green GDP of India but also to design an environmental policy for reducing urban air pollution to safe levels in India.
8. Commission studies to estimate user cost for subsoil resources on a regular basis probably with an interval of every five years. It depends on the life of proven reserves and the rate of discount used to address the problem of intertemporal equity. It decreases with the rate of discount and life of the resource stock making it resource specific. The rate of discount depends on the value judgements of the government on the property rights of present versus future generations to the resource stock.
9. The CSO and other concerned organizations could take advantage of information provided by genuine savings estimates by the World Bank and other agencies in preparing natural resource accounts for India, especially the accounts of exhaustible resources.
10. Given the difficulties in preparing natural resource accounts for India in the near future with the very weak database we are currently having, it is important to have a standing committee of a small group of dedicated experts to advice and monitor projects and programmes for generating data from primary sources and reorganizing data from the existing secondary sources. When data themselves are incomplete or absent, it is difficult for an expert group to make inroads into the complex problem of measuring the green GDP for India in a short time span. The literature provides well-developed and usable methodologies for measuring

the green GDP, but what we require in India is the development of a comprehensive database of natural resources and their links to the economic activities. Therefore, all efforts of concerned governmental agencies including the CSO have to be urgently diverted towards preparing a comprehensive database of natural resources.

4.6 Conclusion

Recognition of contribution of natural resources to economic development could be found in the economic policies pursued by some countries even from the start of second half of last century. It was found that the UN framework System of National Accounts (SNA) released in 1968 is inadequate for accounting of contribution of natural resources to the well-being of people in a country. Many developed countries and even some developing countries have started in the direction of preparing some form of natural resource accounts in addition to standard national income accounts of the SNA. These are mainly in the form of physical supply and use accounts linking natural resources with the natural resource-related economic activities and MFA and monetary accounts of environmental protection expenditures and taxes.

The methodology of the SEEA which first appeared as *Handbook of National Accounting: Integrated Environmental and Economic Accounting'* published by the UN in 1993 and its next version from 2003 is now available for the countries for integrating the conventional national income accounts with natural resource accounts. However, even after almost two decades of its existence, it is now found that no country in the world has made full use of this methodology for estimating its green GDP.

Many countries have started using some parts of the SEEA that could be easily integrated into natural resource accounting methods historically used by them. Also, countries differ with respect to the importance of specific natural resources to their economies. For example, forestry or fisheries may not be a significant natural resource in some countries. Therefore, some countries have started implementing the SEEA for some selected sectors of the economy. Also country experiences in using the SEEA differ with respect of developing both physical and monetary accounts of natural resources.

In the context of developed countries, attempts have been made, for example at EU level, for developing a natural resource accounting system integrating some immediately implementable components of the SEEA with the methods of resource accounting currently used by many member countries. Many of these countries, especially those from Europe, regularly prepare natural resource accounts consisting of MFA, NAMEA, environmental protection expenditures accounts (EPEA), and forest, water and subsoil asset accounts. These are mostly physical accounts with the exception of the EPEA accounts. Sweden has gone a step further in preparing monetary accounts with an objective of measuring the green GDP.

Most of the developing countries had not started working on developing databases linking natural resources with economic activities until the turn of this century. However, one could find some case studies of selected sectors in some countries which are attempted independently of the government. The Philippines is first among these countries trying to implement the SEEA in national income accounting even during the mid-nineties of the past century. Estimates of physical and monetary accounts of SEEA asset accounts are prepared for a comprehensive list of natural resources including land, minerals, coal, water, forests and fisheries. However, these accounts show only commercial or economic value of natural resource stocks as per the SNA and do not consider non-marketable environmental values of use and non-use values and option value. China and India have taken initiatives mostly during the past ten years for developing natural resource accounts. China now develops on a regular basis physical and monetary accounts of air pollution, solid waste and natural resource accounts of fisheries and forests.

The *Handbook of National Accounting: Integrated Environmental and Economic Accounting—An Operational Manual* (UN 2000) explains step by step the implementation of the SEEA and provides methodologies and case studies of preparing accounts for specific resources like forests, subsoil resources, renewable aquatic resources, soil degradation and air emissions. A number of case studies using the EU framework for natural resource accounting and the SEEA are now being attempted by some countries and institutions to prepare natural resource accounts for different resources and sectors.

In a feasible work plan for preparing natural resource accounts in near-future India, first an attempt has to be made to prepare physical asset and flow accounts for all the natural resources using secondary data sources. These data could be organized to generate physical accounts as per either SEEA methodology or extended national IOT or both. Second, prepare monetary accounts of natural resource stocks using the maintenance cost method of evaluation. Third, prepare NAMEA accounts using information from the extended database of ASI accounts, input–output accounts, cost of cultivation accounts of agriculture, and NSS consumer expenditure accounts in India. Fourth, attempt to use non-market valuation methods for preparing monetary accounts of natural resource stocks in the long run. This requires the monetary valuation of all ecological services provided by natural resources in India.

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