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Natural resource accounting (NRA) for sustainable development: A survey

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ABSTRACT

Income has been fairly defined by Hicks as "the maximum amount which a person can consume during a week and still expect to be well-off at the end of the week as he was at the beginning". The concept of Hicksian income (i.e, sustainable income) can be extended to the macro level. The income of a country as measured by Gross Domestic Product (GDP) is considered to be an inappropriate measure of sustainable income, because of errors of *omission* and *commission* made in the estimation of GDP. The errors of omission are: (i) depletion and degradation of environmental resources, and (ii) the non-marketed environmental services provided by the environmental sector to various economic activities. On the other hand, GDP measurement includes a part of the expenditures incurred on environmental protection measures which do not increase the welfare of the society but *maintains* it. Since the traditional measurement of GDP does not address these issues properly, the Natural Resource Accounting (NRA) is a system which tries to address all these issues in a consistent manner.

The present paper tries to review the existing literature on NRA in the context of sustainable development. This paper also discusses the reasons for neglecting the environmental issues in the traditional measurement of GDP. There are two broad approaches namely, physical and monetary. After reviewing the physical approach, its merits and demerits, with illustrations from Norway and France, the paper goes on to concentrate on the monetary approach which is further classified into (i) The Defensive expenditure method (ii) The Depreciation method and (iii) The Peskin method. The final section concentrates on the NRA works done in India. The paper discusses the NRA Framework developed by Indira Gandhi Institute of Development Research (IGIDR), and empirical studies conducted by Tata Energy Research Institute (TERI), in respect of soil, forests, and coal resources of India.

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NATURAL RESOURCE ACCOUNTING (NRA) FOR SUSTAINABLE DEVELOPMENT : A SURVEY

Introduction

The System of National Accounts (SNA) developed by the United Nations and followed by almost all the countries in the world is undoubtedly a most important macro economic tool for economic analysis and policy prescriptions. This system is used for analysing the level of economic activity, its variations, the size of savings and investments, the income a society can consume during a period of time, factor productivity, industrial structure, comparative performance etc.,in a country. Its components such as Gross Domestic Product (GDP), Gross National Product (GNP), Net National Product (NNP) and so on are frequently used for many different purposes by development planners, economists and politicians (El Serafy and Lutz,1989). Among these components, GDP is the commonly used variant of aggregate income and measured as the total value of goods and services produced in an economy during an accounting year. Moreover, GDP is considered as an indicator of economic welfare of a country and is used to divide the globe into two namely, the developed and developing worlds(Repetto,et al. 1989).

Though GDP is used for many different purposes, it is considered to be an inappropriate measure of economic welfare (Steer and Lutz, 1993). This is because the measurement of GDP does not cover certain non-market economic activities such as housewives' service, personnel services, etc, which lead to understating GDP. The Organisation for Economic Co-operation and Development (OECD) conducted a survey among some developing countries to know the extent of the coverage of non-market activities in their national accounts (Blades, 1975). Out of the sixty five responding nations, forty eight countries were in a position to determine the share of the subsistence activities in their total income. In nineteen of these countries, the share of the non-market activities accounted for more than twenty percent of total GDP. Moreover, Blades (1975) points out that most countries surveyed by the OECD study did not make any estimate for food processing, water portage, construction, and transport activities in the household sector. Thus, the coverage of non-market activities is very limited in the national accounts of developing countries and the indicators of the economic performance of these countries are deficient (Peskin,1989).

Apart from these aspects, it is also argued that GDP is an inappropriate measure of *sustainable income* (Daly 1989, El Serafy and Lutz 1989, Repetto et al. 1989). Sustainable income is basically "Hicksian income". Hicks defined income as "the maximum value which a person can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning"(Hicks,1946). The concept of Hicksian income can be extended to the national level. National sustainable income is that income which can be consumed by a nation without eventual impoverishment(Daly,1989).

The GDP is an inappropriate measure of sustainable income because of errors of omission and commission made in the accounting procedure in relation to the environmental aspects of economic activities (Harisson,1989). The following are considered to be the omissions in relation to the environment:

(i) the concept of maintenance of capital (or depreciation of capital) applies only to man-made capital and no depreciation allowance is made for the deterioration of environmental capital (why the environment should be treated as capital is discussed later on in this paper).

(ii) the contribution of the environment to economic activity is given limited attention; and

(iii) the impact of the economy on the environment is also given limited attention (Lutz 1993, Harrison 1993).

On the other hand, the expenditures incurred for the restoration of environmental resources are included in GDP which leads to overstating it (Daly 1989, Harisson 1989, El Serafy and Lutz 1989). Thus, the

current system of national income accounts-from both accounting as well as welfare point of view-includes the **undesirables** and excludes the **desirables** of the environmental sector which gives a wrong picture about GDP (Harisson, 1989).

There are two reasons why the traditional income accounts neglect the natural resource sector :

(i) the traditional economic thinking (Repetto et al, 1989); and

(ii) the institutional and economic context (Markandya and Perrings, 1991).

According to Repetto et al (1989), the classical economists treated income as a return to three kinds of assets: natural resources, human resources and man-made capital (ie, land, labour, capital). The classical economists perceived natural resources and economic development as inter-related to each other. For instance, Malthus predicted a stagnation through "absolute scarcity" of land resource which is characterised by diminishing return in the agricultural output after the absolute limit of the land availability is reached. Ricardo was concerned with "relative scarcity" in which both the cost of production and output will keep on increasing and argued that the diminishing returns start from the beginning. Though Ricardo predicted a temporary scarcity phenomenon, he was of the view that land is heterogeneous in nature (ie, fertility differs among different parcels of land) and argued that the temporary scarcity phenomenon can be eliminated by bringing different parcels of land with different quality under agricultural operation (Barnett and Morse, 1963). Mill not only accepted the Ricardo's relative scarcity of land resource but also brought the non-renewable resource into his analysis (Barnett and Morse,1963; Barbier,1990). So in one way or other classical economists were concerned with the resource scarcity and its impact on economic growth. But, according to Repetto et al (1989), the neo-classical economists have dropped natural resources from their analysis and concentrated mainly on invested capital and labour. it is this neo-classical analysis which formed the basis for the Keynesian approach. The present system of national income accounts are based on the Keynesian four sector income flow model which neglects natural resources (Repetto et al, 1989).

Markandya and Perrings (1991) give another set of reasons for the neglect of the environmental activities in income accounts. Since GDP estimation is based on the existing market prices, they argue that the institutional and the economic context in which the prices of the resources are determined is simply inadequate to pick up the environmental features of interest. Basically they list five reasons:

(i) the lack of properly defined markets in the relevant area;

(ii) uncertainty regarding future demands and future supplies of key natural resources;

(iii) the way in which societies make decisions of present versus future consumption;

(iv) government interventions in markets, undertaken for other often justifiable motives, resulting in prices that are not as conducive to natural resource conservation as they should be; and

(v) incomplete information on the external effects of economic activity.

Since both economic thinking and underdeveloped or undeveloped markets for natural resources are the reasons for the neglect of the natural resource sector in the income accounting system, these errors of omission and commission are not properly addressed in the SNA. Natural Resource Accounting(NRA) tries to include the "desirables" and exclude the "undesirables" so as to measure *sustainable income.*

When we deduct depreciation from GDP to obtain NDP, we are essentially estimating **Hicksian** income. But even after adjusting for depreciation, we cannot consume the NDP year after year without eventual impoverishment if the production of NDP results in depletion and/or degradation of natural resources (Daly, 1989). As we have already seen, the Hicksian NDP is one which should not result in an eventual impoverishment. The implication is that the natural resource stock should be maintained over a period of time or some allowance should be made for the depreciation of the resource stock. if the natural capital stock is to be maintained, then the question is at what level it should be maintained. Some authors do not even agree with the view that the natural capital stock should be maintained constantly (Dasgupta and Maler, 1990). Their argument is that

not the capital stock of the natural resources but the total capital stock (both man-made and natural) should be maintained in which case any reduction in the natural capital stock will be compensated by increasing the man- made capital stock (weak sustainability). But this argument is criticised. Maintaining the total capital stock assumes two things: one is that there is always a possibility of substitution between man- made and natural capital and the other is that the economic value of the natural capital can be measured in money terms. But both these assumptions are criticised by those who support the alternative view of maintaining the "natural capital stock" intact (strong sustainability). The strong sustainability school argues that some of the services provided by the natural capital such as life supporting system cannot be substituted by increasing the man-made capital. Moreover, it is not possible to measure the "total economic value" of the natural capital stock in money terms. Basically, a natural resource has four types of economic value. Take for instance forest. The types of economic value are: (i) the direct use value such as timber, minor forest produce etc, (ii) the indirect use value such as watershed protection, carbon sink etc, (iii) option value which is a premium that the people would be willing to pay for using it in future and (iv) existence value which is the people's willingness to pay for the mere existence of the forest though they are not going to use the forest in future (Dixon,1990). Measuring all these values in money terms is difficult in the real world. So the strong sustainability school argues that maintaining the natural capital stock intact is the way of achieving sustainable income (Pearce, Markandya and Barbier, 1989; Pearce, Barbier and Markandya, 1990; Pearce and Turner, 1990,).

If we accept the notion of maintaining the natural capital stock intact, the next question is at what level? There are two levels of natural capital stocks namely, optimum level and existing level of stocks (Pearce, Barbier and Markandya 1990, Pearce and Turner, 1990).

The optimum level of natural capital stock is determined at the point where the difference between the total benefit curve and the total cost curve is maximum ie, (Ko) in Figure-1. The existing level of natural capital stock is the level which exists at present ie, (Ke). But these stock levels are determined on the basis of monetary values. Both the supporters and the critics of monetary valuation of natural capital stock accept that the existing level of natural capital is well below the optimum level of natural capital in developing countries (Pearce, Barbier and Markandya 1990, Pearce and Turner,1990). So, maintaining at least the existing level of capital stock is the necessary condition for ensuring the sustainable income. In this context, the role of natural resource accounting would be: (i) to identify the existing level of natural capital stock and its changes over a period of time in an economy; and (ii) to value the stocks and flows of natural capital in monetary terms so as to measure the Hicksian income and monitoring the changes of stocks and flows over a period of time. But another important aspect to be noted is that maintaining the natural capital stock in general applies only to renewable resources. In the case of non-renewable resources such as coal petroleum etc, a positive rate of extraction will lead to reduction in the amount of natural capital. In this context, natural resource accounting tries to provide a methodology to treat the income derived from the non- renewable resources in GDP so as to sustain the over all income of the economy.

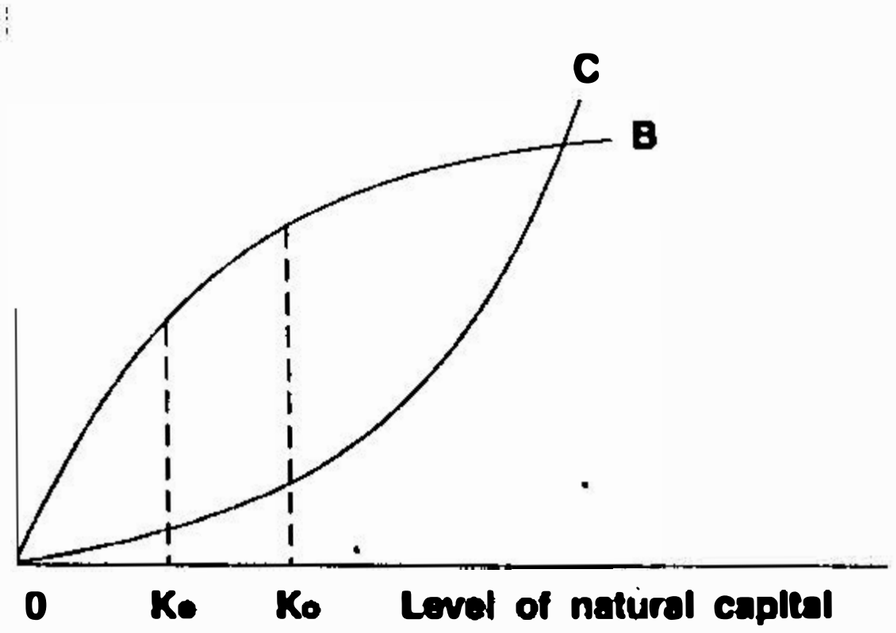


FIGURE - 1

NATURAL RESOURCE ACCOUNTING-DEFINITION

So far, no standard definition exists for natural resource accounting. The concepts Natural Resource Accounting (NRA) and Environmental Accounting are interchangeably used in the environmental economics literature. NRA can be defined either as a system which "accounts for environment" or more specifically a "double entry book keeping" of environmental activity (Peskin and Lutz, 1990). However, it is a system which covers the environmental aspects of developmental activities that are neglected by the traditional income accounts. The existing literature on NRA is both theoretical and empirical in nature. The approaches to NRA are broadly classified in two: physical accounting approach and monetary approach with each one having its own classification.

PHYSICAL ACCOUNTING APPROACH

The physical accounts measure the natural resources in physical units and provide material and energy flows between sectors and within the sector. The main purpose of preparing natural resource accounts in terms of physical units is to provide an integrated information system in which the whole resource process ranging from extraction to end use disposal could be shown. These accounts are also monetized wherever possible, so as to integrate it with the income accounts for economic forecasting and analytical models(Lone cited in Solesberg,1992).

According to Pearce, Markandya and Barbier (1989), the objectives of physical accounts are:

(i) to prepare a balance sheet giving a profile of the stocks of resources available at a given point in time,

(ii) to prepare an account of what uses are made of these stocks; what sources they are derived from and how they are added to or transformed over time and,

(iii) to ensure that stock and flow accounts are consistent so that the balance sheet in any year can be derived from the balance sheet of the previous year plus the flow accounts of that year.

The physical accounts are prepared for both renewable and non-renewables resources. The individual resource accounts are so constructed that they can shed light on various aspects such as the amount of resource left, the amount harvested and extracted, the efficiency of the harvest, the amount imported \or exported, the amount domestically used, the sector- wise usage of resource, the efficiency of usage, the amount of waste generated from each sector, the amount re-used and recycled, the amount available in the future, and the future demand. These informations are shown in a different set of accounts. This physical accounting approach has been tried in various countries and the following section reviews some of these attempts.

NORWEGIAN RESOURCE ACCOUNTS

In the Norwegian resource accounts, the resources are divided into two broad categories; material resources and environmental resources (Table-1)

TABLE 1

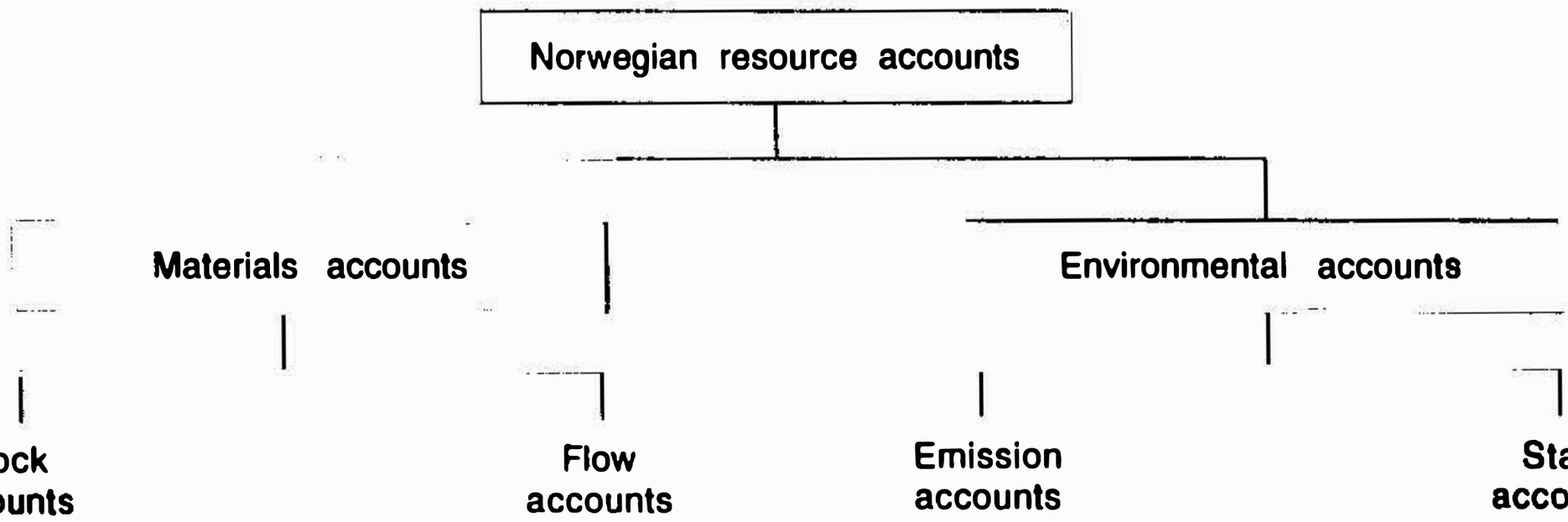
Classification of Resources in the Norwegian Accounting System

Resource	Physical classification	
Material	Minerals	: minerals, hydrocarbons, stone gravel and sand.
	Biological resources	: in the air, water, on land and in the ground.
	inflowing resources	: solar radiation, hydrological cycle, wind ocean currents.
	Environmental Status resources	: air, water, soil and space.

Source : Pearce, Markandya and Barbier, 1989.

The accounts are prepared for both materials as well as environmental resources. The Norwegian materials accounts are broadly classified into two : stock accounts and the flow accounts.

CHART 1



The stock account consists of the "opening stock" and "closing stock" of a resource base. Opening stock indicates the stock at the beginning of the accounting period and the closing stock refers to the stock at the end of the period which is derived by adjusting for the changes occurring to the resource base during the accounting period (Table 2). The closing stock will become the opening stock for the next accounting period. These stocks are measured in terms of physical units.

TABLE 2

Stock and Flow accounts in Norway

I. Reserve Accounts :	
Beginning of period :	Resource base
	Reserve (developed, non-developed)
	Total gross extraction during period
	Adjustments of resource base (new discoveries, reappraisal of old discoveries)
	Adjustments of reserves (new technology, cost of extraction and transport etc, price of resource)
End of period	Resource base
	Reserves (developed, non-developed)
II. Extraction, conversion and trade accounts :	
	Gross extraction (by sector)
	(-) Use of resource in extraction sectors = *Net extraction (by sector)*
	Import (by sector) (-) Export (by sector) = *Net Import (by sector)*
	Changes in stocks
For domestic use :	Net extraction + Net Import +/- Changes in stock
III. Consumption accounts :	
	Domestic use (final use category, commodity)

Source : Alfsen, Bye and Lorentzen, 1987.

In the case of mineral stock, the categories such as developed reserves, undeveloped reserves, new fields, revaluation and extraction are included in addition to the opening stock and the closing stock (Table 2). Reserves are classified into two: developed and non-developed. If the investment has been made and the ordinary production is started, then the reserve may be considered as developed. Adjustments to the reserves are made for the new technological developments, changes in the cost of extraction, transportation and changes in the price of the resource.

Following the stock accounts, the flow accounts are prepared to show the amount extracted, imported and exported by sector and various end uses made by final use category such as industry, household, etc. The flow accounts are prepared on the basis of the Input-Output models with which one can measure the flow of materials within the sector and among the sectors. For instance, the flow accounts for the forest sector show the amount of timber used by the extracting sector, the amount which goes to various forest based industrial units, the amount exchanged between the units, and the amount of pollution discharged during the entire resource process. For the flow accounts to be meaningful, the Input-Output tables of the industries should be reliable.

The second type of physical account is *environmental accounts*. These accounts consist of two parts: an emission account in which estimates of emissions into air, water, and land are indicated; and the state account, which shows the state of the environment at different periods. The environmental accounts give greater priority to the geographical dimensions for better environmental management such as land use planning at the local level.

In Norway basically seven resources - energy, minerals, fisheries, forests, agriculture, land use and air quality - are accounted for. The NRA has been most successful in preparing energy accounts which have influenced the energy demand forecasting models, whereas the accounts on fisheries were not satisfactory for policy analysis (Solesberg, 1992). In the case of forestry, the accounts are technically standard. Since the degradation of the forest is not a major problem , the accounts were not much utilised for the management of the forestry sector (Solesberg 1992).

THE FRENCH ACCOUNTS

The French environmental accounting system is more comprehensive than the Norwegian resource accounting system. Basically the French system is called the "natural patrimony" account which is similar to the Norwegian system in many respects but also includes a historical or cultural value. The "patrimonial accounts" intend ultimately to relate economic growth to quantities of natural resources which have to be used up or imported to make economic growth possible (El Serafy and Lutz 1989).

The classification of the resources in the French patrimony accounts is analogous to the Norwegian classification (Table 3).

TABLE 3

Frennch and Norwegian Accounting Classifications

	French classification	Norwegian classification
1.	**Type of environment**	**Environmental resources**
	Inland waters	
	Water	Water
	Air	Air
	Soil	Soil
2.	**Living organisms**	**Biological resources**
	Fauna	
	Flora	
3.	**Land**	**Land resources**
	Unbuilt areas	
4.	**Underground resources**	**Mineral resources**
	Mineral and energy resources	

Source : Pearce, Markandya and Barbier, 1989.

The patrimony accounts consist of three sub-accounts:-

1. Central account that shows the stock of a resource and its variations in between two time periods. This account is shown as a double entry system in which the sources are indicated on one side and the uses on the other side (Table 4). This account is analogous to the Norwegian stock account.

TABLE 4

Example of Central Account : Growing Stock of a commercial forest, 1969 to 1979

(thousands of cubic meters)

Resource\ assets	Broad-leaf	Conife-rous	Total	Use	Broad leaf	conife rous	Total
Volume of growing stock, 1969	980.1	6526.5	7506.6	Natural reduction	5.6	21.0	26.6
Natural growth of initial stock	401.9	2583.5	2985.4	Accidental reduction	9.7	481.2	490.9
				Resource extraction	92.0	1474.0	1556.0
Natural growth by production (recruitment)				Self consumption	13.6	395.0	408.6
				Adjustment	29.4	1239.9	1209.8
				Volume of growing stock in 1979	1330.7	5758.0	7088.7
Total	1422.2	9368.4	10790.6		1422.2	9368.4	10790.6

Source : Theys,1989.

2. The peripheral account assembles data on various aspects with the geographical dimensions. For eg: eco systems such as forests, wetlands, coastal lands etc., are accounted for by giving more importance to geographical aspects. In the case of peripheral accounts for water, a balance sheet is prepared by showing the origins such as evaporation from the sea, evapo-transpiration of plants, soil, air on the one side and the destination such as run-off, percolation, infiltration and interception on the other side (Table.5).

TABLE 5

Peripheral Accounts of Water in France

(billions of cubic meters)

Origins			Destinations	
Evaporation from the sea		209	Run-off	165
Evapotranspiration of which :			Percolation	90
	Plants	166	Infiltration	117
	Soil	59	Interception	68
	Air	6		
		440		440

Source : Pearce, Markandya and Barbier, 1989.

The peripheral account shows circular flow of the water between natural elements such as soil, air, flora and fauna and the sea water to clearly indicate the relationship between one resource to another one and between human activities and a particular resource.

3. Finally the agent accounts show the flow of resource to various economic activities in terms of physical units. These accounts shed light also on the monetary aspects of concerned resource such as the expenditure approved for the maintenance, repairs, supervision or development (Cornier, 1986). The main purpose of these accounts is to show the relationship between people and nature such as extraction, pollution, non-destructive use of the environment, access, land use planning, development, and selection (Theys, 1989). it should be noted that the central, peripheral and agent accounts estimate the ecological, social and economic values of the natural patrimony (Theys, 1989).

CRITICISMS OF PHYSICAL ACCOUNTS

Physical accounting poses both practical and conceptual problems. Peskin and Lutz (1990) point out that there is the practical problem of what to collect and in what detail, apart from the problem of compiling data on the stock of physical resources, their changes and their information into products and waste materials. They also argue that a lack of a common unit of measurement makes the comparative analysis a difficult task. The information provided by the physical accounts may give greater priority to a relatively less important problem and lower priority to more important problem. The lack of common monetary unit of measurement creates conceptual problem also. Because in the physical accounting, different aspects are measured in different units (for example, weight, volume, mgms etc.) which will lead to problems of aggregation (Peskin and Lutz, 1990).

Another aspect is that though the natural resource base is physically kept intact, its economic value may change over a period of time(Peskin 1991). To illustrate this aspect, Peskin takes two resources: one is a lake and the other is the seashore. in the case of the lake, the only service that it provides is supply of drinking water. Assume that there are two parties X and Y consuming equal amounts of water. Suppose in period 1, water available in the lake is 100 units and consumers X and Y consume 40 units each. in this case, the economic value of the physical depletion is zero since the supply exceeds the demand by 20 units. in other words, though 80 units of water has been depleted in the lake, the economic value of this depletion is zero. Suppose in period 2, the water available in the lake is only 70 units. Now only, the economic value of the depletion becomes positive, due to disutility of not consuming the 5 units(because parties X and y consume only 35 units each). in the case of the seashore, suppose 100 people are visiting the seashore and the supply of the seashore is fixed but greater than the demand in time period 1. in period 2, the number of people visiting the seashore increases to 200. In this case, while the supply of the stretch of the seashore remaining constant, the marginal disutility of the people may increase due to increased number of visitors. From the above illustration, it is clear that measurement of the resources in physical units will not always be reflecting the real problem.

However, it should be noted that though the above criticisms are valid, the physical accounting system is very useful for deriving some inferences about the interaction between environment and development. From these inferences it is possible to frame a better environmental policy as well as an efficient production strategy for reducing both the amount of resource used and the waste generated. As Pearce, Markandya and Barbier (1989) summarise "there is in fact no reason why such accounts should not be presented in physical units as long as they present the stocks and flows in a clear identifiable way and as long as they achieve the reconciliation between the sets of stock and flow accounts".

Monetary Approach

The monetary approach is broadly classified into three : (i) Defensive Expenditure approach (ii) Depreciation approach and (iii) Peskin's approach.

DEFENSIVE EXPENDITURE

The defensive expenditure approach is one which tries to address the issues involved in treating the costs incurred for protecting the environment from the side effects of economic activities in GDP. In the environmental economics literature, these costs are called *defensive* expenditures. One needs to be clear about what is a defensive expenditure because the category of defensive expenditures can be large or small depending on where the boundaries are drawn (E1 Serafy and Lutz 1989; Daly, 1989).

Christian Leipert suggests five broad categories of defensive expenditures (cited in Daly, 1989):

- ☆ Defensive expenditures induced by the over-exploitation of environmental resources in the general course of economic growth, such as costs of environmental protection activities.
- ☆ Defensive expenditures induced by spatial concentration, centralisation of production and associated urbanisation such as increased commuting costs, housing etc.
- ☆ Defensive expenditures induced by the increased risks generated by the maturation of industrial systems, such as increased expenditures for protection against crime, accident, sabotage, and technical failure.
- ☆ Defensive expenditures induced by the negative side effects of car transport, such as traffic accidents.
- ☆ Defensive expenditures arising from unhealthy consumption and behavioral patterns and from poor housing and living conditions.

According to Daly (1989) these categories are neither exhaustive nor exclusive and are naturally somewhat arbitrary. But for the environmental accounting purpose, as already mentioned, only those expenditures that are incurred mainly for protecting the environment from side effects of development (i.e., the first category) should be considered as defensive expenditures.

The Treatment of Defensive Expenditures

An important issue involved regarding defensive expenditures is the treatment of these expenditures in the estimation of Gross Domestic Product (GDP). This is because the nature of these expenditures differs among different economic agents in an economy. These expenditures are undertaken by firms, by the government, and by households. Firms net out these expenditures from the value added treating them as "intermediary expenditures". Since the GDP is the value of all final goods and services, such expenditures will not be reflected in GDP. If these expenditures are undertaken by households (for instance, purchase of water filter, gas mask,etc), they are treated as final demand expenditures which automatically enter into GDP. In the case of government enterprises, the defensive expenditures undertaken by those enterprises where a user charge is levied are considered as intermediate expenditures, whereas the expenditures incurred out of general taxation are treated as final output (Markandya and Perrings, 1991). It is obvious that these expenditures are asymmetrically treated in the SNA. Redefining and reclassifying these expenditures for accounting purpose is of crucial importance (Peskin and Lutz,1990).

One of the more frequently made suggestions for making the SNA as an environmentally modified one is to reclassify the final demand expenditure on environmental protection measures as *intermediate* so as to subtract them from GDP. The argument is that the defensive expenditures are regrettable expenditures which "yield no direct satisfaction" (Nordhaus and Tobin 1977). Nordhaus and Tobin (1977) perceive the defensive expenditures (such as police protection, public health expenditures, etc,) as regrettable expenditures and argue "even if the regrettable outlays are rational responses to unfavourable shifts in the environment of economic activitv, we believe that a welfare measure, perhaps unlike a production measure, should record such environmental change" (Nordhaus and Tobin, 1977).

Hueting (1980), argues that the defensive expenditure needed for maintaining and restoring the functions provided by the environment (which he calls "the elimination cost") should be estimated and subtracted from the GDP to arrive at an environmentally corrected GDP.

The same line of argument is also put forward by El Serafy and Lutz (1989) in favor of subtracting the defensive expenditures from GDP. According to the authors, incorporating expenditures, incurred to redress some or all of the negative consequences of production or consumption activities in the stream of income generated by economic activity does not make sense. So they propose that such outlays should not be counted as final expenditure as is currently the case, but rather as "intermediate".

Daly (1989), while defining the "Sustainable Social Net National Product" (SSNNP), points out that defensive expenditure, along with depreciation of natural capital, should be netted out from NNP for deriving SSNNP. In his view, defensive expenditure does not reflect any increase in the "net product" available for consumption without eventual impoverishment.

A conceptually different approach has been proposed by Harisson (1989). Harisson's approach tries to show how to avoid an apparent increase in GDP due to defensive expenditure. The renewable resources are considered to be permanent resources and the permanent resources are treated as "natural

TABLE 6

Effect on GDP of introducing an Environmental protection program

	Present SNA		Proposed SNA	
	Without Program	With Program	Without Program	With Program
GDP	100	105	105	105
Consumption of man-made capital	10	10	10	10
Consumption ofNatural capital	–	–	5	0
NDP	90	95	90	95

Source : Harisson,1989.

capital". If a resource is recognised as "capital", the amount of capital depreciation should be separately shown in the income accounts. This amount according to Harisson(1989) should be included in the GDP, irrespective of whether defensive expenditure is incurred or not. Harisson's approach can be illustrated as follows :

From the above table it should be noted that, in the proposed SNA, the consumption of natural capital is $5 in the absence of any program and this is corrected if the program is undertaken. In both cases (with program and without program) the GDP is same-ie $105. This approach avoids an increase in the GDP due to incurring defensive expenditure. But the defensive expenditure actually incurred and the depreciation of the environmental capital are reflected at the level of NDP. However, Harisson's approach requires information on the value of the consumption of natural capital.

Dasgupta and Maler (1990) divide the defensive expenditures into two categories: (i) expenditure incurred for redressing the environmental damage and (ii) expenditure for enhancing the stock of the environment. According to the authors, the nature of the defensive expenditure determines the act of either including the defensive expenditure in GDP or deducting it. If such expenditures are for the

purpose of redressing a flow of environmental damage, then the defensive expenditure should be included in GDP. If they are for enhancing stocks of environmental resources, they should be excluded. Dasgupta and Maler (1990) put it as follows:

> "To take up as example, expenditures for liming lakes to counter the flow of acid rains maintains environmental quality. Where this is not to be included in final demand increased liming (which increases well being) would be recorded as a decline in NNP. Similarly, capital expenditures (for example, the construction of stock-gas scrubbers, sewage treatment plants, and solar energy equipment) should also not be deducted from estimates of NNP, for they augment the durable capital base. On the other hand, those expenditures which go to enhance resource bases, such as forests, get reflected in the value of changes in resource stocks. In order to avoid double counting of such expenditure, the defensive expenditures should be excluded from NNP computation".

Pearce, Markandya and Barbier's (1989) argument is strong in favour of subtracting the defensive expenditure from GDP. They argue along the line of Nordhaus and Tobin (1977), that incurring defensive expenditure does not improve the welfare but just brings back the welfare to that level prevailing before pollution. As they put it:

> "Equally, it could be argued that expenditures by households to protect themselves against the adverse consequences of production process - air and water pollution, noise nuisance etc - are properly regarded as cause of producing the goods and services that individuals enjoy and should therefore not be included as final expenditures giving rise in utility. If I double glaze my house when there is an increase in road traffic in the street, the expenditure incurred as a result does not raise my welfare relative to what it was, but only helps me to return to the level I enjoyed prior to the traffic increase" (Pearce, Markandya and Barbier, 1989).

Markandya and Perrings (1991) argue that including or subtracting the defensive expenditures in GDP depends mainly on the value of the damages and the services brought back by defensive expenditure. According to the authors if the change in the depreciation cannot be measured and if the correction for environmental damages cannot be estimated, including the defensive expenditures in GDP would be the better course of action, although it is not perfect. On the other hand if such expenditures are not included in GDP, it is important to account for the damage that is done to the natural environment and for the benefits of the expenditures. The points suggested by Markandya and Perrings (1991) regarding the treatment of defensive expenditures are:

(a) Since measures of depreciation and environmental damage are hard to obtain there is a case for including defensive expenditures in GDP.

(b) If defensive expenditures are not included in GDP, correcting for *differences* in the value of environmental services is even more important for measuring GDP.

(c) In both the cases Net Domestic Product is a better measure than GDP.

(d) If defensive expenditures are included and corrections are made for differences in environmental services and natural capital depreciation, the difference between with and without defensive expenditure is exaggerated (Markandya and Perrings, 1991).

So far, the discussion has revolved only around reclassifying the defensive expenditures so as to either subtract them or include them in the GDP. But this is not sufficient for accounting purposes. Rather, identification of these expenditures is the more important aspect of the defensive expenditure approach. The problems involved in identifying defensive expenditure is discussed in Blades (1989). Blades (1989) sees three kinds of problems in separating defensive expenditure from other expenditures.

(a) The difficulty of establishing a base-line from which to measure the extent of pollution abatement activities i.e., whether one should cover both traditional and new methods of pollution control cost or only the new.

(b) The problem of joint cost involved in equipment and industrial processes which are good for business and also cause less pollution. In such cases it is not clear how much of the additional cost of the equipment or process should be treated as a pollution abatement expenditure.

(c) The respondent's awareness of anti-pollution costs. For example, if new legislation forbids open cast mining, the additional expense of shaft mining should be counted as an anti-pollution cost. According to Blades,(1989) the respondents may overlook this cost and may find it difficult to identify the additional amount.

Since the defensive expenditure approach is a controversial area, the present UNSO proposal suggests that this issue can be addressed in a separate "satellite account" without incorporating it into the existing income accounts. It also suggests that before going into the details of how to treat these expenditures, more research should be conducted in this area (UNSO, 1993).

DEPRECIATION OF NATURAL CAPITAL

The depreciation approach attempts to incorporate the monetary value of the depreciation of the natural capital into the income accounting system. The man-made capital and the natural capital are asymmetrically treated in the present SNA. In the case of man-made capital it is considered as productive asset and any depreciation of it is written-off against the value of the production. The NDP is derived by deducting the amount of depreciation of man-made capital but we can not consume even NDP year after year without ultimately impoverishing ourselves. As we have already seen the production of NDP requires supporting activities that are not bio-physically sustainable, and the measurement of NDP overestimates the maximum net product available for consumption (Daly, 1989). But natural resources - the supporting activities - are not even considered as assets and any loss to this asset is not valued and deducted from the GDP as depreciation. The present SNA treats the sale of the resources as current income or rent that is available for consumption, but no allowance is made for the depreciation which leads to the phenomenon in which the GDP is overstated by that amount of depletion.

This being the case, it is clear that the income presently estimated can not be sustained for a long period of time. So the income should be measured properly so as to reflect the sustainability of the resource. The income of a nation will be sustainable only if it produces the goods and services without reducing its productive capacity (Pearce, Markandya and Barbier 1989). This implies that reduction in the "productive capacity" will reduce the future income.

If the objective is to obtain a measure of sustainable income, it is necessary to make allowance for any depletion of the capital stock of a country-either man-made or natural. The major concern here is how to correct the GDP in relation to the depreciation of "natural capital". If a natural resource is extracted and the income is invested somewhere else in an economy, the national income will show a rise because of the income derived from the sale of the resource on the one hand and the investment made on the other. This is an overestimation of GDP because it fails to allow for the decline in one productive asset while allowing for the increase in another asset base over time (Pearce, Markandya and Barbier, 1989).

The depreciation approach to NRA can be broadly classified into two: Repetto's method (or, Net price method) and El Serafy's method, (or, user cost method).

Repetto et al (1989) attempted to account for the depreciation of natural capital in GDP for Indonesia. Repetto's method can be illustrated as follows: Suppose in the balance sheet the initial stock of forests

is 100 million cubic meters. This figure is increased through discoveries, revisions etc and reduced because of production, deforestation and degradation to finally arrive at a closing stock of 85 million cubic meters. In this example, it is assumed that the unit value (or net price or economic rent) of the timber(assuming the valuation is only for timber) is one rupee at the beginning of the period and three rupees at the end of the period. (The unit value is calculated by deducting the factor cost of extracting the resource and the cost of transportation to the sales point from the "export value" or f.o.b.price). On an average the unit value is 1.6 rupees over the whole period. According to Repetto's method, this average unit value is multiplied with the "net change" (85 - 100 = -15) of the resource base. The resulting figure is subtracted from GDP. If the net change is positive then it is added to GDP.

Repetto et al (1989) applied this simple methodology to Indonesian forests, petroleum and soil assets. In the case of forests, accounts were prepared only for timber resource and not for other items provided by the forest such as fuel wood, other minor forest products, etc. A physical account showing opening stock, additions (growth, reforestation), reductions (harvesting, deforestation, logging damage, fire damage), net change and closing stock was prepared. The economic value of the changes in the physical units was measured on the basis of the "stumpage value" of the standing trees prior to any processing. This stumpage value was estimated by the net price method i.e. deducting the cost of extraction and transportation (including a normal profit) to the port from the export value (f.o.b.price) of the timber.

For the oil resource, a slight modification was made in the physical accounts. In the case of additions, the discoveries and the upward revisions were taken to be the positive aspects, since there is no regeneration as in the case of forests. The subtraction of the resource was only due to extraction and the closing stock was arrived at by adjusting for both additions and subtractions. For valuing the net change (Closing stock - Opening stock), the economic rent (net price) was calculated and multiplied with the net change in the resource base.

In the case of soil, a soil erosion model was developed in which a "dose response" type analysis was made where the dose was the soil erosion and the response was the productivity lost. Three variables were considered to be the determinants of soil erosion namely, soil type and slope, rainfall erosivity and land use. The estimation of the annual soil erosion on the basis of soil type and land use pattern was prepared for four provinces in Java in terms of "per hectare erosion rate".

The economic valuation of the soil erosion was done by using dose-response type analysis where the dose is soil erosion and the response is the decline in the farm income (through declining productivity). Before going to the economic valuation, two kinds of classification was made. One was for the soil type and another was for food crops. In the case of soil type, some soils contained most of the nutrients in the top few centimeters. In the case of food crops, the study distinguished two groups of rain-fed food crops on the basis of the sensitiveness to the soil erosion (i.e., some crops are more sensitive to soil erosion than others). After making all these classifications, an economic valuation was done on the impact of soil erosion on yield. The study estimated the yield -erosion relationship for 25 soil types and two crop groups. For each cropping system, the declining income was estimated for one percent reduction in the yield. Using farm level data, the net present value method was adopted to estimate the total present value of the future losses of farm income. It was estimated that the capitalised losses of the future productivity were approximately 40 percent of the annual value of upland farm production. In other words, nearly 40 cents in future income would be sacrificed to obtain each dollar for current consumption.

As a result of this study, for all three resources, the adjusted GDP was higher than the actual GDP prior to 1974 and was lower thereafter, with the gap in 1984 being 17 percent (Repetto et al, 1989).

Repetto's method has led to the following criticisms :

(i) In the case of man-made capital, the depreciation allowance is made out of the value of the total output. But Repetto's method deduct the entire output as depreciation of natural capital. This is

methodologically misleading. A better course of action is to calculate the restoration cost of the resource and deduct it from the sales proceeds of the resource (Thamarajakshi,1992).

(ii) Repetto's method concentrates only on that amount of depletion of forest cover. But this does not tell anything about the increase in the economic wealth if the land under the deforested area is brought under cultivation.

(iii) Repetto's method does not define the desired level of the natural capital. The variation between two accounting years in the natural capital stock is valued and incorporated in the GDP. If the resource stock increases, it is treated as appreciation and if it decreases, it is treated as depreciation. But theoretically this is not always true. In some countries the existing level of natural capital stock is greater than the desired level (Figure 2).

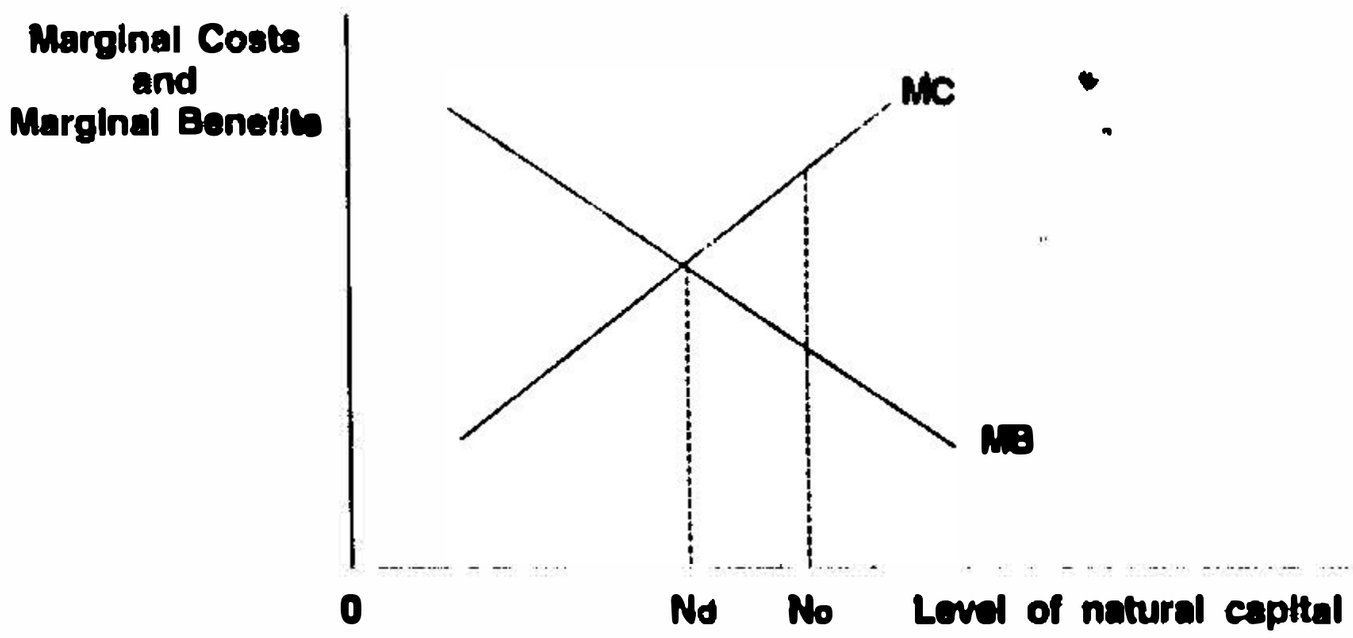


FIGURE - 2

The desired level of the capital stock (Nd) is determined at the point where the marginal benefit of maintaining the natural capital is equal to the marginal cost of it. In some countries, the existing level of capital stock (Ne) is above the desired level of capital stock where the marginal cost of maintaining the resource base is greater than the marginal benefit. In this case, allowing the resource stock to decline up to (Nd) will increase the welfare.

El Serafy (1989) argues that the depreciation approach in general still leaves the mineral extraction earnings in the GDP, provided that the value of the depletion is deducted from it for calculating the net income. This approach gives more importance to the adjustment and the exact valuation of natural capital appears to be of secondary importance. He argues that no harm can come from adding the depreciation of natural capital in GDP and "if an income correction is to be made, it should apply therefore to the gross product itself, and not to the net product level" (El Serafy 1989). That is, the correction for depreciation of mineral resource should be made at the level of GDP not at the NDP level.

El Serafy (1989) also finds a practical problem with Repetto's method in that it doesn't reflect the difference of the economic welfare of the countries with different levels of natural wealth. As El Serafy (1989) puts it "the countries with marketable natural resources, are evidently better-off than those without such resources, and they can enjoy a higher and sustainable standard of living than the latter by virtue of their resource endowment". This being the case, if one follows Repetto's method for a country like Saudi Arabia, where 100 percent of receipt is from petroleum extraction, it would give a GDP of 100 and a NDP of zero.

To overcome this practical problem associated with Repetto's method, El Serafy (1989) developed a new method called the "user cost method" to deal with the issue of treating the revenue of mineral sales in the GDP. According to El Serafy(1989), the net receipts (net of extraction costs) have two parts: income and capital element. The income content should be part of the GDP since it represents value added. The issue is how to convert the mineral asset into a perpetual income stream. From the annual earnings from sales, an income portion that can be spent on consumption should be identified; the remaining portion, a capital element, should be set aside year after year and invested to create a perpetual stream of income that would provide the same level of true income, both during the life of the resource as well as after the resource has been exhausted. The two constituent portions - income and capital - of the net receipts can be divided by using the following formula:

$$\frac{X}{R} = 1 - \left[\frac{1}{(1+r)^{n+1}}\right]$$

When X is true income, R the total receipts (net of extraction cost), r the rate of discount and n the number of periods during which the resource is to be liquidated. R-X would be the user cost or depletion factor that should be set aside as a capital investment and totally excluded from GDP. The ratio X/R depends on two values- the resource to extraction ratio and the discount rate. Implicitly, the method is trying to calculate sustainable income by valuing the resource through the income stream it will generate. But the effectiveness of this method is dependent on the future depletion, future price and future discoveries (Markandya & Perrings, 1991). Since this method is only at a theoretical level, empirical studies are needed to verify the validity of this approach.

But both Repetto and El Serafy methods do not tell anything about non-market environmental services. They are more concerned with the marketable environmental resources such as forest products or minerals and do not deal with non market environmental resources such as water, air etc,.and the problems of treating their depreciation in the national accounts.

Peskin's approach Peskin's (1989) approach basically deals with the non-market environmental activities and their treatment in the income accounts. It is a neo-classical approach in which the environmental resources are treated as *inputs* in the production process. The environment is viewed as providing services to both intermediate and final demand sectors. These services are regarded as benefits. On the other hand, there are *dis-benefits* due to externality problems associated with the consumption of these services. There are two sorts of disbenefit - direct damage imposed on the other parties and denial of the environmental asset for someone else to use. The latter dis-benefits occur if the asset is finite. These benefits and dis-benefits to competing parties can be measured in monetary terms by those techniques that are commonly used in benefit-cost analysis.

With the above mentioned basic aspects, Peskin(1989) has proposed an accounting framework in which the nature sector is added as an additional sector with the industry, government and household sectors. The relevant information is provided in a double entry book-keeping system. Under the industry, government and household sectors, the waste disposal service provided by the air, water and land is entered in the input side of the accounts. This service is entered with a negative sign because it is treated as a subsidy from nature. On the output side, the damages done to these resources by the sectors are accounted for with negative entry. The output to the final demand sector from the nature such as recreational activities are entered on the output side of the accounts. Finally, the net environmental benefits (sum of total environmental benefits less total dis-benefits) are entered on the input side so as to balance the entries.

In Peskin's approach, nature is shown as the primary source of all environmental services and generate substantial service to other aspects such as harbouring biological diversity etc and cause for most of the damages such as pollution generated by the nature itself. This being the case, nature requires a separate entry. All these accounts are consolidated into one account to arrive at an adjusted GDP for the environment. An important feature of Peskin's accounting framework is that it does not alter the existing structure of the traditional income accounts and can be used as a satellite account.

But, Peskin's approach has faced some criticisms. At the outset, it requires large scale information on the services and damages of the nature sector which is very difficult. If the users are large in number, identifying the competing users is a problematic one.

The U.S.Environmental Protection Agency has conducted a study of natural resource accounting by using Peskin's framework (Grambsch et al, 1993). This study was conducted for Chesapeake Bay which is one of the ecologically important areas of U.S. First, the Chesapeake regional output was dis-aggregated from the national output for the years 1982 and 1985. After making entries for the inputs and outputs of the Chesapeake region in a double entry book-keeping system, the emphasis was on the associated environmental services and damages of the economic activities in that region.

Only two resources, air and water, were taken for the study. On the input side of the Income account, the waste disposal services of air and water were measured and entered with negative entry as if they were subsidies to the productive activities. These disposal services were measured in terms of the pollution control costs. On the output side of the account, the value of the actual damage done to the air and water (with negative sign) and the value of the final consumption especially non-market activities such as beach use, recreational fishing, hiking, etc, are indicated. Later In the input side, the net environmental benefits- sum of the waste disposal services and final consumption less environmental damage- are entered. It was found that the damage cost exceeds the disposal service. It means that if the waste disposal service is eliminated by taking pollution control measures, the damage cost could be reduced. For instance, in 1985 the value of the disposal services was $ 193.9 million and the damage was $ 456.3 million. If the disposal service is eliminated by incurring $ 193 million, the net environmental benefit would be $ 262.4 million. Since the waste disposal service is entered as subsidy with negative sign, any pollution control expenditure in future will automatically be netted out. In the case of nature sector, output represents some of the waste disposal service and final demand service to other sectors and input represent the sum of the environmental damages absorbed from other sectors and net environmental benefits. The Information is obtained by rearranging the data in the consolidated accounts In such a way that all the inputs will become output and all the output will become input to the nature sector.

The environmental assets in Chesapeake were defined in terms of the services generated. Four kinds of services were identified namely:

(i) the Bay as a generator of direct final demand service,

(ii) the Bay as a generator of waste disposal service,

(iii) the Bay as a generator of both direct final demand and disposal service,

(iv) the Bay as a generator of net environmental benefits.

The perceived reduction in these services was treated as depreciation, because this study treats the *services* as assets not the resource base as such.

But this study covers only limited benefits and dis-benefits. The actual benefits and dis-benefits of the nature sector are very large and covering of which will give a different picture. This study does not address the issue of the defensive expenditures actually incurred in the past.

CONCLUSION

From the review of the available literature on NRA, the following conclusions emerge;

- ✩ NRA is done at two levels; (i) on a satellite basis and (ii) on an integrated basis within the conventional income accounts itself. The satellite accounts are mostly in the form of physical accounts In which the resources are measured only in terms of physical units.

- ✩ Among the two broad approaches namely - physical and monetary approach, the physical accounting approach has been used extensively by most countries.

- ✩ The developing countries,as far as the existing literature is concemed, are not concemed about the defensive expenditures, because the total defensive expenditures Incurred on environmental protection measures is a negligible percentage of their GDP. With regard to the monetary approach, it should be noted that the developed countries are more concerned with the defensive expenditure approach, whereas the developing countries are concentrating on the depreciation approach.

- ✩ As far as the depreciation approach is concerned, Repetto's method has been most widely used in developing countries. However, there are concerns that it may not be methodologically sound.

- ✩ El Serafy's method, though still theoretical in nature, can be extended to those countries which are mainly dependent on their mineral resources for their development. Empirical studies can test the validity of this method.

- ✩ The Peskin's method is relevant for the developing countries since it deals with non-market services provided by the nature sector.

So far the discussion has concentrated on how the natural resource accounts have been set up in various other countries. Let us now discuss the relevance of these approaches to the Indian context.

NATURAL RESOURCE ACCOUNTING IN INDIA

The concept of Natural Resource Accounting was introduced in India only very recently. Though there are well documented reports about the State of India's Environment (CSE, 1982, 1985), no effort has been made to integrate the environmental issues with the National Accounts Statistics. But during 1992, in collaboration with UNDP, Ministry of Environment and Forests, Government of India proposed to undertake an NRA study and asked Indira Gandhi Institute of Development Research (IGIDR), Bombay to develop a suitable NRA framework for India. While IGIDR has developed a framework for NRA, empirical NRA studies have been attempted by Tata Energy Research Institute(TERI), Delhi with support from International Development Research Centre, Canada.

Before going Into the details of these two studies, it would be interesting to mention the Ideas of some of the authors on natural resource accounting in the Indian context.

Ghosh (1991) discusses how an attempt can be made, along the line of the CSO classification of "national income by industrial origin", to quantify the cost of environmental degradation in estimating Indian GDP. In this discussion, the author has explained the possible ways of estimating the environmental degradation costs In various industries for the reason that no attempt has been made so far to deduct any definite quantitative estimates of these cost from GDP.

In the agricultural sector, increased fertiliser use, waterlogging, desertification, salinity, soil erosion due to deforestation impose environmental costs which can be quantified in broad terms. Though Ghosh has not made any attempt to explain how to measure the environmental costs of fertiliser and pesticides use, reference has been made to quantification of the cost of other environmental problems mentioned above.

According to Ghosh, the cost of deforestation can be quantified by estimating the amount of defensive expenditures required for afforestation. In the case of desertification, the cost of restoration of the desertified land can be estimated from the past attempts for reclamation of the saline land but care should be taken to avoid the double counting if the desertification of the land is due to deforestation. For the water logging problem, the restoration cost of the water logged area can easily be estimated by using the figures on investment required for suitable drainage channel and treatment of salinity.

For mining and quarrying industry, the author points out that though the Planning Commission has proposed to include the full cost of rehabilitation in the estimation of cost of each project in future, the cost imposed on the people displaced in the past will have to be estimated. The open cast mining operations impose environmental cost in terms of land degradation. For this, the special cess of Rs. five per tonne of coal (as recommended by the Bureau of Industrial Costs and Prices) raised at present for the restoration of the area despoiled by coal mining can be treated as the surrogate. In addition, mining operation involves emergence of "tailings' for which the restoration cost undertaken by some mining companies in the past can be used as a surrogate which can be extended for a majority of the companies not undertaking restoration at present. In the case of cost imposed by the atmospheric pollution of quarrying activities on workers the defensive expenditure should be estimated by conducting research studies.

The environmental degradation of manufacturing industry involves various forms of pollution and in energy sector, environmental problems are created by thermal power stations, nuclear plants, large dams for electricity generation. In all these cases, the cost can be estimated by using the defensive expenditures required for avoiding problems. Measurement of cost through defensive expenditure is difficult in transportation sector because "it would be extremely difficult to frame any estimate of the capital costs involved in converting all vehicle manufacturing units". But a possible solution, though not satisfactory, is to estimate the overhauling cost of the engine of the vehicles after a particular life time so as to meet the standards laid down by the authorities. Finally Ghosh (1991) suggests that though the household sector creates environmental problems in many ways, no adjustment needs to be attempted for these problems at least at present.

Thamarajakshi (1992) argues that for the resources like forests, fisheries and agricultural soil, the restoration cost can be calculated and this cost can be accounted for as capital consumption and charged against gross returns from proceeds of sales of these resources.

Nadkami (1994) discusses the importance of natural resource accounting for the forest resources of India and argues that more emphasis should be given to the contribution of forests to the local economy.

The IGIDR Framework The IGIDR has released a report which discusses the general framework for NRA and the methodology on how to prepare it in the Indian context. The IGIDR framework basically tries to focus on the impact of both market and non market economic activities(NMS) on the environment and ultimately relates this impact to the quality of life. The non-market economic activities are given importance in this study because linkage between the environment and the non-market activities is of three types; (i) environmental impacts created by the NMS (such as air, water and noise pollution), (ii) NMS themselves get affected by environmental damage(polluted water and air affecting the quality of output of the NMS) and (iii) environment oriented employment opportunities created by the NMS(waste collection and processing).

It is proposed to prepare an exhaustive list of natural resources of India for this study. The proposed study would cover the soil, forest, virgin forest, water, air and bio-diversity in the case of renewable resources and oil, gas, coal, other minerals and ores under non- renewable resource category. The accounts for these resources will be mostly in terms of physical units but more attention would be paid on monetary aspects of the changes brought about by the economic activities. For the monetary valuation of the damage Imposed on society, dose-response type valuation technique is proposed especially for renewable resources.

In the case of soil, a dose- response relationship (similar to Repetto's method) will be established between the soil quality parameters(soil type,soil colour, soil depth, salinity, drainage characteristics and

rate of percolation) and decline in the farm income due to productivity decline. Using the changes in the soil quality parameters, the discounted value of the annual output loss would be calculated and would be shown as the cost of soil quality deterioration.

In the case of air and water, pollution data would be collected both in terms of quality as well as quantity and the economic measurement would be in terms of cost of damage imposed on human beings, animals, properties etc. The damage cost would be measured in terms of medical expenditures, imputed value to human life, changes in the property value, etc.

As far as the non-renewable resources are concerned, it is proposed to apply both Repetto's and El Serafy's methodology to value the depreciation.

The IGIDR approach has the following limitations:

(i) At the outset, this framework does not spell out whether these accounts would be prepared as satellite accounts or if the monetary changes would be incorporated in the National Accounts Statistics (NAS). This framework tries to cover almost all the resources without looking into whether these resources or the value of their services\ damages are already treated in the NAS. For instance, in the NAS, some of the forest products such as timber and other minor forest produces are valued and included.

(ii) There is another possibility for double-counting on the damage side. The damage costs due to pollution, soil degradation, deforestation etc, might have been already incorporated in the NAS in the form of increased medical expenses, the cost of additional fertiliser use, etc. So it would be desirable if the accounting procedure could try to identify and separately show them in a satellite account

(iii) The valuation approach used for valuing the changes brought about by the economic activities is only partially relevant for accounting purpose, because this approach tries to measure only the damages. But the damages are caused by the utilisation of services provided by the natural resources. For an accounting purpose both the services provided by environmental sectors and the resulting damages received by it have to be measured and the difference between these two will have to be shown as *net environmental benefit/damage* (Peskin,1989).

(iv) Another major problem with the IGIDR framework is that it gives much more weight to the *secondary effects* of resource degradation such as health damage, loss in property values etc. But the major Issues to be addressed in the NRA are the two important *primary* effects namely, the depletion(quantitative) and the degradation(qualitative)of the resource base.

(iv) This approach tries to extend the input-output model for measuring the quantities of pollution released from various market and non-market activities. But the existing input-output tables are very weak in displaying the flow of environmental services and damages and any conclusion based on the information provided by these tables will be misleading.

TERI study

Natural Resource Accounting studies were undertaken by Tata Energy Resource Institute (TERI, 1994), using the Repetto's method to three resources: soil, coal and forest.

In the case of soil, a classification of the land resource regions on the basis of the soil type was made. The study estimated the amount of top soil lost for each region. But economic valuation was done only for a small area of the black soil region which experienced the highest erosion rate.

The TERI study used the "replacement cost approach" (or restoration cost) for the economic measurement of the soil erosion. First, the nutrient content (per tonne) of the black soil was calculated.

In the next step, the total top soil lost in the No. 7 area of the black soil region was estimated. The nutrient loss was expressed in terms of three nutrients namely, Nitrogen(N), Phosphorous(P) and Potassium(K). The study used the 1991-92 price of NPK fertilisers and multiplied this price with the total amount of nutrient loss in the study area. It was found that the average annual cost of soil erosion in area no.7 of the black soil region was Rs.40.49 billion from 1980-81 to 1990-91. This average annual figure was expressed in terms of percentage of GDP for each year which shows a continuously declining trend from 1980-81 to 1990-91.

In addition to the cost of top soil loss, the TERI study also estimated the cost of sedimentation of rivers treating this as the other component of the cost of soil erosion. The cost of sedimentation was calculated in terms of the cost of de-silting the amount of soil deposited in rivers. It was estimated that the cost of de-silting 2936.59 million tonnes of silt was Rs. 42 billion. But this cost was not expressed in any way in relation to GDP as the cost of nutrient loss was expressed in terms of percentage of GDP.

Though the study was mainly intended to extend the Repetto's methodology to the valuation of soil resource, the methodology used by TERI study is different from Repetto's. Repetto et al used the dose-response method in which the dose was soil erosion and the response was loss of productivity. In the case of TERI methodology, the replacement cost approach was used. The basis difference between Repetto's methodology and the TERI's methodology is that the former is trying to estimate the cost of soil erosion closer to the actual cost(using types of soil, land use pattern, crops cultivated, annual productivity loss of each crop, etc) whereas the latter gives more hypothetical results.

In the case of coal, the study covers all coal resources of India except lignite. The accounts were constructed for seven major coal producing states. Physical accounts were prepared for opening stock, additions, subtractions and closing stock. Having constructed the physical accounts, the net price method of Repetto et al(1989) was used for the changes in the coal resource. Unlike Repetto's approach, valuation was done at four levels.

Valuation(i) is the total change in the resource stock (which includes the additions) multiplied by the net price. Net price here refers to the c.i.f. price minus cost of processing and transportation.

Valuation(ii) is the net depletion(only subtraction without including the additions) multiplied by the net price. Net price = c.i.f price minus cost of processing and transportation.

Valuation(iii) is the total change in the stock(which includes the additions) multiplied by the net price. Here net price refers to the pithead price minus cost of processing and transportation.

Valuation(iv) is the net depletion(only subtraction without including the additions) multiplied by the net price. Net price = pithead price minus cost of processing and transportation.

Adjustment was made for these four values in GDP from 1983-84 to 1991-92. It was found that for the values (i) and (iii), the adjusted GDP was greater than the actual GDP. For the values, (ii) and (iv) the adjusted GDP was less than the actual GDP. This is because of the obvious reason that the values(ii) and (iv) include the additions which are greater than the depletion during the accounting years. It was also found that the values (iii) and (iv) are relatively smaller than the values (i) and (ii), because values (i) and (ii) were based on the c.i.f. price which was greater than the pithead price.

In the case of forest, this study extended Repetto's methodology to fuel wood in addition to timber. Accounts were prepared only for three states; Uttar Pradesh, West Bengal and Haryana. The depreciation of forest resources was expressed in terms of timber output in physical terms and the value of the depreciation was measured by estimating the stumpage value which is equal to supply price minus cost of milling, transportation with a profit margin. This stumpage value was taken to multiply the net change(additions minus reductions) of the forest cover on year to year basis. The value of the depreciation was expressed

both in terms of current and constant prices(1991-92 price). When adjusted, the average annual value of the depreciation was approximately Rs 0.32 billion at current prices.

Limitations of the TERI study.

- ☆ A general criticism of this study is that it has used Repetto's methodology to coal and forest resource, without taking into account the major criticisms of this methodology. As we have already discussed, Repetto's method treats the entire income derived from the resource base as depreciation. It does not tell anything about the desired level of capital stock above which a reduction in the stock is actually an improved welfare to the society.

- ☆ In the case of cost of soil erosion, the study estimated the total cost of soil erosion in terms of the amount of top soil lost and the point of measurement is one year. The total cost (measured in one year) is then projected back to various years so that the average annual cost is constant for various years. Since the average annual cost is constant and the annual GDP is increasing constantly from year to year, the cost of soil erosion expressed in terms of percentage of GDP gives a declining trend of the cost of soil erosion. If one follows this kind of procedure, then it will lead to the conclusion that if we wait for some more years the cost of soil erosion in terms of GDP will become zero.

- ☆ In addition to the direct soil erosion cost this study also attempted to measure the cost of sedimentation of the rivers due to soil erosion. This will lead to the problem of double counting. The simple logic is that if the primary effect (soil erosion) is controlled then there will be no secondary effect (sedimentation of rivers). It should also be noted that the story does not end only with sedimentation but also reduction in the electricity output, reduction in fish output and so on. Even if we accept the argument that siltation is a cost of soil erosion, a part of the cost might have been accounted for in the GDP already as the government expenditure. In this case the problem is identification of that amount of siltation cost and deduct it by treating it as intermediate cost. This study also assumed that all the top soil eroded is deposited in rivers which may not be true. If a part of it is deposited on the off-site lands, then the productivity will actually go up which will actually increase the GDP. This study has completely neglected another aspect of cost of soil quality deterioration due to pollution which may occur even in the absence of top soil erosion.

- ☆ For the coal sector, the study has used four kinds of valuation techniques which give four different results. So the suggestion is that if any adjustment is to be made, it should be done only at the net depletion level and instead of using the pithead price the c.i.f. price may be a desirable one to reflect the true opportunity cost of coal.

Conclusion

In this paper, we have discussed about the nature of the NRA and various approaches developed and adopted both out side and inside India. Each approach has its own merits and demerits. A main concern for the developing countries is to modify these approaches in such a way as to suit their own problems. Thamarajakshi(1992) points out that developing countries are charecterised by poverty, unemployment and low productivity resulting mainly from the degradation of the resource base and the major issue in these countries is to keep the natural resource base intact. A proper natural resource accounting frame-work can take into account this particular aspect by giving more attention to physical accounting. In India, the Central Statistical Organisation (CSO) is involved in collecting data related to natural resources so as to incorporate them in the National Accounts Statistics(NAS). The economic valuation of the stocks and the flows of the natural resources is an important aspect of natural resource accounting in developing countries. The techniques that are used in the developed countries can be modified and applied to address the local level resource issues.

SELECTED BIBLIOGRAPHY

BOOKS

Ahmed, Yusuf J., Salah El Serafy and Ernst Lutz, **Environmental Accounting for Sustainable Development**, The World Bank, Washington D.C., 1989.

Blades, D. W. **Non- Monetary (Subsistence) Activities in the National Accounte of Developing Countries;** OECD, Paris, 1975.

Barbier, E. **Economics, Natural Resource Scarcity and Development: Conventional and Alternative Views,** Earthscan, London, 1989.

Barnett, H.J. and C. Morse, **Scarcity and Economic Growth: The Economics of Natural Resource Availability,** Jhons Hopkins Press, Baltimore, 1963.

Daly, H. E. and J.B. Cobb **For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future,** Beacon Press, Boston.: 1991.

Dension, Edward F. **Accounting for Slower Economic Growth,** The Brookings Institution, Washington D.C, 1979.

Hicks, J. R. **Value and Capital,** Oxford University Press, London 1946.

Hueting, R. **New Scarcity and Economic Growth; More Welfare Through Less Production?,** North-Holland Publishing Company, Amsterdam, 1980.

Hueting, R. and C. Leipert, **Economic Growth, National Income end the Blocked Choices for the Environment,** Internaionales Institut fur Umwelt und Gesellschaft, Bertin, 1987.

Leipert, C. **The Role of Defensive Expenditures in a System of Integrated Economic-Ecological Accounting,** Internationales Institut fur Umwelt und Geselischaft. Berlin,1991.

Leontief, et al.**The Future of the World Economy,** Oxford University Press, New York, 1977.

Lutz E. (ed) **Toward Improved Accounting for the Environment** A UNSTAT - World Bank Symposium, The World Bank, Washington D.C: 1993.

Magrath, William S., and P.Arens, **The Costs of Soil Erosion on Java - A Natural Resource Accounting Approach,** World Resources Institute, Washington D.C., 1987, Processed.

OECD, **Information and Natural Resources,** OECD, Paris, 1986.

Pearce, David. W. **The Economics of Natural Resource Management,** Projects Policy Department, World Bank, Washington D.C.,1986.

Pearce, David. W, A. Markandya and E. Barbier, **Blue Print for a Green Economy,** Earthscan, London, 1989.

Pearce, David. W, E. Barbier and A. Markandya **Sustainable Development: Economics and the Third World,** Earthscan, London, 1990.

Pearce, David. W,and R. K. Turner, **Economics of Natural Resource and the Environment,** Harvester Wheatsheet, Hertfordshire, 1990.

Peskin, Henry M., **National Accounting and the Development Process; illustration with Tanzania,** Resource for the Future, Washington D.C., 1984.

Peskin, Henry M., **National Accounting and the Environment,** Resources for the Future, Washington D.C., 1987, Processed.

Repetto, Robert, Economic Policy Reform for **Natural Resource Conservation**, World Resource Institute, Washington D.C. 1986.

Repetto, Robert, et.al, **Natural Resource Accounting for Indonesia**, World Resource Institute, Washington D.C., 1987, Processed.

Repetto, Robert, et.al, **Wasting Assets; Natural Resources in the National Income Accounts**, World Resource Institute, Washington D.C., 1989.

Solorzano, R. et al. **Accounts Overdue: Natural Resource Depreciation in Costa rica**, San Jose, Costa Rica. Tropical science Center and World Resources Institute, World Resource Institute, Washington, D.C., 1991.

United Nations, **Hand Book of Natural Accounting: Integrated Environmental and Economic Accounting**, Dept.of Economic and Social Development Statistical Division, United Nations, 1992.

World Commission on Environment and Development, **Our Common Future**, Oxford University Press, New Delhi,1987.

ARTICLES IN JOURNALS AND EDITED BOOKS

Blades, D. W.**Measuring Pollution within the Framework of the National Accounts**, In Y. J. Ahmed, S. El Serafy and E. Lutz (eds) 1989.

Bartelmus, P., **Beyond GDP: New Approaches to Applied Statistics**, *Review of Income and Wealth*, Vol.33(4), December 1987, pp.347- 358.

Bartelmus P., **Environmental Accounting and Statistics**, *Natural Resource Forum*, Vol.16(1), 1992,pp.77-84.

Bartelmus, P et.al, **SNA Framework for Integrated Environmental and Economic Accounting**, *Review of Income and Wealth*, (Vol.No. - Not known) 1989.

Blades, D. W., **Subsistence Activities in the National Accounts of Developing Countries with Special Reference to Latin America**, *Review of Income and Wealth*, Vol.21(4), December 1975, pp.391-410.

Corniere P., **Natural Resource Accounts in France- An Example: Inland Water**, *(IN) OECD Information and Natural Resources*, Paris, 1986.

Cremeans, J.E., **Conceptual and Statistical Issues in Developing Environmental Measures: Recent US Experience**, *Review of Income and Wealth*, Vol.23, 1977,pp.97-115.

Daly, H.E. **Toward a Measure of Sustainable Social Net National Product**, In Y. J. Ahmed, S. El Serafy and E. Lutz (eds), 1989.

Dasgupta, P and K. G. Maler, **The Environment and Emerging Development Issues** *Proceedins of the World Bank Conference on Development Economics*, World bank, Washington D.C.: 1990.

Dixon, J. A. **Valuation of Protected Areas in Developing Countries** In J. R. Vincent, E. W. Crawford and J.P. Hoehn (eds) *Valuing Environmental Benefits in Developing Economies*, Proceedings of a seminar series,East Lansing, Michigan State University,1991.

Eisner,R. **Extended Accounts for National Income and Product** *Journal of Economic Literature*, Vol. 26, December, 1988, pp 1611-1684.

El Serafy, S.and E. Lutz, **Environmental and Natural Resource Accounting**, (in) Gunter Schramm and Warford J.J (eds) *Environmental Management and Economic Development*, World Bank, JHU Press, Baltimore, 1989.

El Serafy. S and E. Lutz **Environmental Accounting: An Overview** In Y. J. Ahmed, S. El Serafy and E. Lutz (eds), 1989.

Friend,A. **Review of International Experience in Natural Resource Accounting**, UNEO/W.G:85? UNF.3, 1983.

Friend, A, **Conceptual Frameworks for Natural Resource Information Systems**, *(IN) D.Eade and J.Hodgson (eds) Information Systems in Public Administration*, North Holland Publishing Company, Amsterdam, 1981.

Garnasjrdet P.A and Viggo Saebo, **A System of Natural Resource Accounts In Norway**, *(IN) OECD Information and Natural Resources*, Paris, 1986.

Ghosh, A.K., **Ecological and Environmental Degradation and Their Accounting for GDP Estimation**, *The Journal of Income and Wealth*, Vol.13,(4), July 1991, pp.132-147.

Grambsch, A. E., G. Michaels with H. M. Peskin **Taking Stock of Nature: Environmental Accounting for Chesapeake Bay**, In E. Lutz (ed), 1993.

Harisson, A. **Introducing Natural Capital In the SNA**, In Y.J. Ahmed, S. El Serafy and E. Lutz (eds), 1989.

Harisson, A., **Environmental Issues and the SNA**, *Review of Income and Wealth*, Series 35(4), December 1989, pp.377-388.

Harisson, A, **Major Changes Proposed for the Next SNA; An Overview**, *Review of Income and Wealth*, Series 36(4), December 1990, pp.335- 351.

Hartwick, J. M. **Natural Resource, National Accounting and Economic Depreciation**, *Journal of Publuic Economics*, Vol. 43, 1990, PP. 291- 304

Hartwick, J.M. **Degradation of Environmental Capital and National Accounting Procedures**, *European Economic Review*, 35, 1991,Pp.641- 649.

Hartwick, J. M.(forthcoming),**Notes on Economic Depreciation of Natural Resource Stocke and National Accounting** In A. Franz and C. Stahmer (eds).

Hueting,R. **Economic Aspects of Environmental Accounting**, *Journal of Interdisciplinary Economics*, Vol.2, 1987,pp.55-71.

Isard, W. **Some Notes on the Linkage** of Socio- **Economic and Ecololcal systems** *Regional Science Association Papers*, Vol.22, 1969, PP.79- 100.

Johansson,P., **Valuing Environmental Damage**, *Oxford Review of Economic Policy*, Vol:(6), No.(1),1989.

Juster, F.T., P.N. Courant and G. K. Dow, **A Thoeretical Framework for the Measurement of Well-Being**, *Review of Income and wealth*, Series.27 (1), PP.1-32.

Landefeld, J.S. and J. R. Hines, **National Accounting for Non - Renewable Natural Resources In the Mining Industries**, *Review of Income and wealth*, Series 31 (1), 1985,PP.1-20.

Langanier, J, **The Possible Impact of National Accounts and Balances on the Development of Frameworks for Environmental Statistics**, *Statistical Journal of the UN, ECE 2*, 1984, pp.43-61.

Leipert, C. **Social Costs of Economic Growth**, *Journal of economic Issues*, Vol. 20 (1), 1986.

Leipert, C. **A Critical Appraisal of Gross National Product: The Measurement of Net National Welfare and Economic Accounting**, *Journal of Ecnomic Issues*, Vol.21 (1), 1987,PP. 357-373.

Leipert, C.**National Income and Economic Growth : The Conceptual Side of Defensive Expenditures,** *Journal of Economic Issues*, Vol. 23 (3), 1989, PP. 843-856.

Leipert, C, **What the GNP Does not Account for?**, *Development; Seeds of Change*, 3, 1986, pp.58-65.

Leipert, C.and U. E.Simonis, **Environmental Protection Expenditures : The German Example,** *International Review of Economics and Business*, March, Vol.36(3),1989.

Lemaire, M. **Satellite Accounts : A Solution for Analysis in Social Fields,** *Review of Income and wealth,* Series 33 (3) 1987, PP.305-325.

Leontief, Wassily, **Environmental Repercussions and the Economic Structure : An Input-Output Approach,** *Review of Economics and Statistics*, Vol.52(3), August 1970, pp.262-271.

Levin, J. **The Economy and the Environment : Revising the National Accounts,** *IMF survey*, vol.19, 1990, PP.161,168- 169.

Marin, A. **National Income, Welfare and the Environment,** *Review of income and Wealth,* series. 24 (4), 1978, PP.415-428.

Mishan, E.J., **GNP: Measurement or Mirage?**, *National Westminster Bank Quarterly Review*, November, 1984, pp.2-13.

Nadkami, M.V., **Foresta In the Economy of India** *Indian Journal of Social Sciences* vol.7 (1), 1994, pp.33-45.

Nordhaus, W.D,and J. **Tobin, Measures of Economic Welfare** In R. Dorfman and N. S. Dorfman (eds) *Economics of the Environment: Selected Readings,* W. W. Norton, New York, 1977.

Norgaard, R.B. **The Dilemmas of Environmental accounting,** *Ecological Economics*, 1989 (1), PP. 303-314.

Oslon, M. **The Treatment of Externalities in National Income Statistics,** In L. Wingo and A. Evans (eds), *Public Economics and the Quality of Life,* Maryland: Johns Hopkins University press.

Opschoor, J.B.and L. Reijnders **Towards Sustainable Development Indicators,**In O.Kuik and H. Verbruggen (eds), *In Search of Indicators of Sustainable development,* Dordrecht, Boston and London, 1991, PP. 7-27.

Parikh, K.S., **Towards a Natural Resource Accounting System** (In) Anil Agarwal (ed), *The Price of Forests*, Centre for Science and Environment, New Delhi, 1992, pp-28-31.

Perrings, C. **Sustainable Livelyhood and Environmentally Sound Technology** *International Labour Review* Vol.133 (3), 1994.

Peskin, H. M., **National Income Accounts and the Environment**, *Natural Resources Journal*, 21 (July), 1981, pp.511-537.

Peskin, H. M.and J. Peskin, **The Valuation of Nonmarket Activities In Income Accounting**, *Review of Income and Wealth*, Vol.24(1), March 1978, pp.71-91.

Schramm, G., **Practical Approaches for Estimating Resource Depletion Costs**, *(IN) E. Miles et.al (eds), Natural Resources and Economic Policy Approach*, Seatle; University of Washinton Press, 1986.

Solberg, B. **Natural Resource Accounting: Experiences from Norway**, (In) Anil Agarwal (ed) *The Price of Forest*, Centre for Science and Environment, New Delhi, 1992.

Solow,R. M. **The Economics of Resources or the Resources of Economics,** In R. Dorfman and N.S. Dorfman, *Economics of the Environment; Selected Readings*, New York: W.W. Norton,1977.

Steer, A. and E. Lutz, **Measuring Environmentally Sustainable Development,** *Finance and Development*, December, 1993.

Stone, R. **The Evaluation of Pollution : Balancing Gains and Losses,** *Minerva*,Vol. 10 (3), 1972, PP.412-425.

Teillet, P. **A Concept of Satellite Accounts in the Revised System of National Accounts,** In U. P. Reich et al. *Saellitensysteme zu den Volkswirtschaftlichen gesamtrechnungen*, Stuttgart and Mainz, Germany, 1988,PP. 29-59.

Thamarajakshi, R. **Some Aspects of Environmental Accounting** *Economic and Political Weekly* vol.27 (47), 1992, pp. 2533-2534.

Theys, J. **Environmental Accounting in Development Policy : The French Experience,** In Y.J. Ahmed, S. El Serafy and E. Lutz (eds), 1989.

Turner, R.K **Sustainability : Principles and Practice** In Turner, R. K. *Sustainable Environmental Economics and Management: Principle and Practice*, Belhaven **Press,** London, 1993.

United Nations, **Survey of Environment Statistics : Framework, Approaches, and Statistical Publications,** *Statistical Papers*, Series M.No.73, New York, 1982.

Weher J.L, **The French Natural Patrimony Accounts,** *Statistical Journal of the United Nations Economic Commission for Europe 1*, 1983, pp.419-44.

REPORTS AND WORKING PAPERS

Alfsen, Knut H., Torstein Bye & Lorents Lorensten, **Natural Resource Accounting and Analyeia: The Norwegian Experience, 1978-1986"** *Central Bureau of Statistical of Norway*, Oslo, Norway, 1987.

Bartelmus, Peter, **Accounting for Sustainable Development,** *Working Paper 8*, Dept. of International Economic and Social Affairs, United Nations, New York, 1987.

Bartelmus, Peter & Jan Van Tongeren, **SNA Framework for Environmental Satellite Accounting,** *United Nations Statistical Office*, Newyork, 1988, Processed.

Blades, Derek W., **Environmental Statistics and the National Accounts,** *Paper at UNEP/World Bank Workshop*, Washington D.C., 1986.

CSE, **The State of India's Environment; A Citizen's Report** *Centre for Science and Environment* New Delhi, 1982.

CSE, **The State of India'a Environment: The Second Citizen's Report** *Centre for Science and Environment* New Delhi, 1984-85.

Daly, Herman E., **A Modest Proposal for a Modest Start in Modestly Relating Environmental and Economic Accounts,** *Paper at UNEP/World Bank Workshop*, Paris, 1985.

French Delegation to OECD, **Natural Resoure Accounts:- French Experience and the Case of Water Resources,** *Paper prepared for OECD Environmental Committee*, October 22, 1980.

Friend, Anthony, **Natural Resource Accounting: International Experience,** *Paper at UNEP Meet*, Geneva, 1983.

Friend, Anthony, **Natural Resource Accounting: A Canadian Perspective,** *Paper at UNEP/World Bank Workshop*, Washinton D.C., 1986.

Friend, Anthony M., **Natural Reaource Accounting .and its Relationahip with Economic and Environmental Accounting,** *Discussion Paper*, Statistics Canada, 1986.

Garnasjordet, Per Arild, **Reaource Accounts of Norway**, *Paper prepared for the Symposium: Basis of Accounts for Norway's Natural Resources*, The Norwegian Academy of Science and Letters, Oslo, (April 26-28), 1982.

Gamasjordet P.A, **Resource Accounts: The Norwegian Experience**, *Paper at UNEP/World Bank Workshop*, Geneva, February, 1983.

Garnasjordet, P. A. and P.Longva, **Outline of a System of Resource Accounts: The Norwegian Experience**, Paper prepared for the Environmental Directorate of the OECD, Paris (March), 1980.

Gilbert A.J., **Natural Resource Accounting: Some Experiences**, *Institute for Environmental Studies*, Free University, Amsterdam, Mimeo, 1990.

Gilbert, A.J. **Natural Resource Accounts: Theory, Logistics and Application to Botswana**, *Paper at ISEE Conference*, Washinton D.C., May 1990.

Gilbert, A.J. and David James, **Natural Resource Accouting - A Review of Current Activity and its Application to Australia**, *Paper presented at the Workshop on N.R.A.*, Caneberra, (November 26), 1986.

Gilbert, A.J. and W.Hutkamp, **Natural Resource Accounting in a Multi-Objective Context**, *Paper at UNEP/World Bank Workshop*, Paris, 1986.

Gilbert.A.J., O.Kuik and J. Arntzen **Natural Resource Accounting: Issues Related to Clasalfication and Valuation of Environmental Assets**, *Unpublished Paper Prepared for the United Nations Environmental Programme*, Amsterdam, February 1990.

Harisson, A. **Natural Assets and National Income**, *World bank Environment Department Divisional Working Paper*, Washington, D. C.: World Bank, 1992.

Hueting, Roefie, **Environmental Deterioration, Economic Growth and National Income**, *paper presented at the Fourteenth General Conference of the International Association for Research in Income and Wealth, Finland* (Aulanko), Finland, August 18-23, 1975.

Hueting, Roefie, **The Use of Environmental Data in the Economic Declalon-Making Process**, *Paper presented for the Ad Hoc Expert Committee Meeting on Environmental and its use in Development Policy and Planning*, UNEP, Geneva, February 23-25, 1983.

Hueting, Roefie, **A Note on the Construction on Environmental Indicator in Monetary Terms as a Supplement to National Income with the Aid of Baalc Environmental Statlatics**, *Paper at UNEP/ World Bank Workshop*, Paris, 1986.

Hueting, Roefie, **Possibilities for Incorporating Changes in the Environment, Including Natural Resources in the National Income**, *Paper at UNEP/World Bank Workshop*, Washington D.C., 1986.

Hueting, R., P. Bosch and B. de Boer **Methodology for Calculation of Sustainable National Income.** *Unpublished Paper* Voorburg, Netherlands:Central Central Bureau of Statistics, 1991.

Leipert, Christian, and Udo E.Simonis, **Environmental Damage- Environmental Expenditures: Statistical Evidence on the Federal Republic of Germany**, *Paper FS II*, 90-403, Berlin: Wissenschaftszentrum, 1990.

Loikkanen, T. **Environmental Accounting Developments in Finland**, *Paper at UNEP/World Bank Workshop*, Paris, 1986.

Lone, O. **Natural Resource Accounting: the Norwegian Experience**, OECD Environment Committee, Group on the State of the Environment, Paris, 1988.

Longva, P. **A System of Natural Resource Accounts**, *Rapporter 81.9*, Statistisk Sentralbyra, Norway, 1981.

Lutz, Emst, **Agricultural Trade Liberalisation, Price Changes, and Environmental Effects**, *Draft Papers*, Environmental Policy and Research Division, World Bank, November 1990.

Lutz, Ernst, Mohan Munasinghe & Ramesh Chander, **A Developing Country Perapective on Environmental Accounting**, *ENVPR Divisional Working Paper No.1990-12*, World Bank, August 1990.

Lutz, Ernst and Salah El Serafy, **Environmental and Resource Accounting: An Overview,** *Environment Department Working Paper No.6*, Environment Department, World Bank, June 1988.

MacNeill, J. **Sustainable Development, Economics and the Growth Imperative** *Paper presented at the Workshopon the Economics of Sustainable Development,* Washington D. C. 23- 26 January, 1990.

Maler, K. G. **Theoretical Foundation for the Concept of Sustainable Development,**OECD Economics and Statistics Department\ Environment Directorate, Joint Seminar on the Economics of Environmental Issues, 2-3 October 1989. Paper No.1.

Markandya, Anil and Charles Perrings, **Resource Accounting for Sustainable Development : A Review of Basic Concepts, Recent Debate and Future Needs,** *A Report prepared for FAO*, December, 1991.

NIBR, **A Basis for Resource Accounts,** *Report No.40*, Norwegian Institute for Urban and Regional Planning, Oslo, Mimeo, 1975.

Norway, Ministry of the Environment, **Resource Accounts and Resource Budget,** Oslo, Norway, 1986.

OECD, **Treatment of Mining Activities in the System of National Accounts,** *Restricted Draft*, DES/ N1/85.4, Paris, 1985, Processed.

OECD, **Natural Resource Accounts: Pilot Study Inland Water,** *Discussion Paper ENV/SE./88.21*, OECD Environment Committee, Paris, 1988.

OECD, **Environment and Growth in National Accounts** *Working Document,* DES\NI (70). 3 (rev.) 22 April, 1971, Paris: OECD.

Opschoor, J. B.**Towards Sustainable Development: Environmental Change and Macro Indicators,** OECD Economics and Statistics Department/ Environment Directorate, Joint Seminar on The Economics of Environmental Issues, 2-3 October, Paper No. 4 (Rev.1).

Perrings C.A., et al, **Natural Resource Accounts for Botawana : Environmental Accounting for a Natural Resource-Based Economy,** *LEEC Discussion paper 89-11*, IIED, London,1989.

Peskin, Henry, **The Collection of Pollution Control Expenditure in the Future,** Washington D.C., 1978.

Peskin, Henry M.,**Natlonal Income Accounts and the Environment,** ***Paper at UNEP/World Bank Workshop***, Geneva, Feb. 1983.

Peskin, Henry M., **Accounting for Natural Resource Depletion and Degradation in Developing Countries,** *Environment Department Work. Paper No: 13*, World Bank, 1989.

Peskin, Henry M., **Accounting for Natural Resource Degradation in Developing Countries** ***(In) Valuing Environmental Benefits in Developing Economies***, Special Report 29, Michigan State University, September 1991, pp.33-66.

Peskin, Henry and Ernst Lutz, **A survey of Resource and Environmental Accounting in Industrial Countries,** *Environment Department Working Paper No:37*, Envt. Dept., World Bank, August 1990.

Peskin, Henry. M., W. Floor and D.F. Barnes, **Accounting for Traditional Fuel Production: The Household Energy Sector and its Implications for the Development process,** World Bank, Industry and Energy Department Working Paper, Energy Series Paper, No.49. Washington, D.C.: World Bank, 1992.

Pezzy, J. Economic Analysis of Sustainable Growth and Sustainable Development. *Environment Department Working Paper, No.15.* Washington, D. C. : World Bank, 1989.

Poitier, Michel.,**Natural Resource Accoun*s: OECD,** ***Paper at UNEP/World Bank Workshoop***, Geneva, February 1983.

Rapport, David and Anthony Friend, **Toward a Comprehensive Framework for Environmental Statistics: A Stress Response Approach**, ***Statistics Canada***, Ottawa, 1979.

Repetto, Robert., **Natural Resource Accounting for Countries with Natural Resource Based Economies** *Paper for UNEP/World Bank workshop*, World Bank, Washington D.C., 1986.

Repetto, Robert., **Report on Natural Resource Accounting,** *Paper prepared for the Australian Envt. Council*, March, 1988.

Repetto, Robert.,**Resources and Economic Accounts,** *OECD Environmental Committee*, Group of the State of Environment; Paris , 1988.

Repetto, Robert., **Economic Policy Reform for Natural Resource Conservation,** *Envt. Dept. Workg. pap. No. 4*, World Bank, May 1988.

Schafer, D. and C. Stahmer, **Input-Output Model for Analysis of Environmental Protection Activities,** *Economic Systems Research,* Vol. 1 (2), 1989, PP. 203-228.

Schafer, D. **Conceptual Considerations on Satellite System,** *Review of Income and Wealth,* Series.36, No.2, 1990, PP.167-176.

Simonis, U.E. **Beyond Growth : Elements of Sustainable Development** Berlin: Internationales Institut fur Umwelt and Gesellschaft, 1990.

Theys, J. **Environmental Accounting and Ita Use In Development Policy,** ***Policy Draft (January)***, The World Bank, Washington D.C., 1984.

Theys, J. **Environmental Accounting and Its Use in Development Policy: Proposals baaed on the French Experience**, UNEP, 1984.

Theys, J. **Environmental Accounts and Development Planning: Proposals for a Programme of Action,** ***Paper at UNEP/World Bank Workshop***, **Paris,** 1985.

Uno, Kimio, **Economic Growth and Environmental Change In Japan: Net National Welfare and Beyond,** *Paper presented at International Conference on Environment and Development*, Milan, Italy, March 1988.

United Nations, **A Framework for the Development of Environment Statistics,** *Statistical papers*, Series M.No.78, New York, 1984.

Ward, Michael, **Accounting for the Depletion of Natural Resources In the National Accounts of Developing Economies,** *Development Centre Publication CD/R(82)3010*, OECD Paris, 1982.

Willer, Edward, **The Use of Environmental Accounting for Devlopment Planning,** *Report to UNEP*, New York, 1983.

Wright J.C., **Natural Resource Accounting: A Technique for Improving Planning in Newzealand?,** *Information Paper No.12*, Centre for Resource Management, Lincoln College and University of Canterbury, Newzealand, 1989.

Yoshikawa, Atsushi, **Macroeconomic Accounting for the Environment and the Quality of Life,** *Paper at UNEP/World Bank Workshop*, Geneva, February 1983.

ABBREVIATIONS

GDP	–	Gross Domestic Product
NDP	–	Net Domestic Product
NRA	–	Natural Resource Accounting
SNA	–	United Nations System of National Accounts
NNP	–	Net National Product
SSNNP	–	Sustainable Social Net National Product
CSO	–	Central Statistical Organisation
NAS	–	National Accounts Statistics
UNDP	–	United Nations Development Program
IGIDR	–	Indira Gandhi Institute of Development Research
TERI	–	Tata Energy Research Institute
NMS	–	Non-Market Economic Activities
UNSO	–	United Nations Statistical Office
OECD	–	Organisation for Economic Co-operation and Development

GLOSSARY

Gross Domestic Product	–	The value of goods and services produced in an economy during an accounting vear.
Net Domestic Product	–	GDP minus depreciation of man-made capital.
User Cost	–	The sacrifice of expected future benefits due to using the capital today rather than in future.
Depreciation	–	Decline in the value of a fixed asset, such as plant or equipment, due to wear and tear, destruction or obsolescence resulting from the development of new and better techniques.
Net Price	–	the difference between the international market price of a resource and the cost of processing and transporting it to the export point.
Option value	–	a premium that the people would be willing to pay for using a resource in future.
Existence value	–	people's willingness to pay for the mere existence of the resource.