UNIT 14 GREEN ACCOUNTING AND ENVIRONMENTAL COST BENEFIT ANALYSIS

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14.0 OBJECTIVES

After going through this unit, you will be able to:

- explain the system of national income accounts (SNA);
- state the limitations of the conventional system of national income accounts;
- discuss the methods of modifying the conventional national income accounts;
- outline the usefulness of environmental accounting;
- discuss the method of environmental cost benefit analysis (ECBA);
- describe the methods of valuation of environment; and
- enumerate the limitations of ECBA.

14.1 INTRODUCTION

National accounts provide a description of the state of the economy and a database useful for macroeconomic analysis. Measures such as gross domestic product (GDP) and gross fixed capital formation (GFCF) generated by the national accounts have for

long been used for economic progress evaluation and policy design and recommendations. However, for more than two decades now it has been recognised that conventional indicators of economic growth like GDP/GNP are incomplete as they have not been designed to account for environmental asset's contribution/depletion in the process of economic growth such as deteriorating quality of air and water, depletion/ degradation of natural resources (e.g. minerals, soil quality), etc. With increasing public demand for cleaner environment and policy focus on growth-environment trade-off, a need is felt to integrate the accurate supply and use of natural and environmental resources into the national accounts system. As already studied in Unit 2, environment is a source of both raw material, amenities and sink for wastes generated as a result of economic activities. Green accounting aims at incorporating the environmental service flow into the national income accounts by suitably quantifying the contribution of such assets into the income stream and augmenting the capital/asset account by including the addition or depletion of natural capital/asset. For green growth, investment projects having significant impacts on environmental resource should ideally be evaluated from social point of view for which the method of Environmental Cost-Benefit Analysis (ECBA) is useful. The present unit makes a brief review of the existing 'system of national accounts' (SNA) followed by an account of its major shortcomings. The methods by which the existing shortcomings can be rectified are also discussed.

14.2 SYSTEM OF NATIONAL ACCOUNTS: THEORY AND PRACTICE

"The System of National Accounts (SNA) is the internationally agreed standard set of recommendations on how to compile measures of economic activity. The broad objective of the SNA is to provide a comprehensive conceptual and accounting framework for compiling and reporting macroeconomic statistics for analyzing and evaluating the performance of an economy" (United Nations Statistics Division). The SNA lays down the accounting rules which are to be followed internationally for measurement of indicators like Gross Domestic Product (GDP), Net Domestic Product (NDP), Gross Fixed Capital Formation (GFCF), Gross Savings, etc. The SNA is periodically revised to incorporate latest methods and desired practices. For instance, beginning with the SNA 1947 (which reflected the Keynesian macroeconomic approach emphasising on major aggregates like consumption, savings, investment and government expenditures following the period of the Great Depression), the SNA has subsequently been revised in 1953, 1960, 1964 and 1968. More recently, the SNA was revised in 1993 and then in 2008. The SNA categorizes the national income accounts into three major heads of accounts viz. (i) current accounts, (ii) asset accounts (also called as accumulation accounts) and (iii) a balance sheet for different sectors (SNA 1993, 2008).

Current Accounts: Current accounts deal with the reporting of the production of goods and services including the generation, distribution and use of income. Under this, GDP is measured as the sum of the value added from all economic activities carried out within a country's territory plus 'net indirect taxes' (i.e. indirect taxes minus subsidies). It is thus a value added identity (to be summed up over all the sectors of economic activity) expressed as:

Gross Value Added = Output – Intermediate Consumption + Net Indirect Taxes

.....(14.1)

or Net Value Added = Gross Value Added – Consumption of Fixed Capital

.....(14.2)

The above approach, called as the production approach, is one of the three methods by which the GDP is measured. The other two approaches are what are known as the 'income approach' and the 'expenditure approach'. The GDP estimating identities of these two approaches are respectively expressed as:

GDP = Compensation of Employees + Gross Operating Surplus + Gross Mixed Income + Net Indirect Taxes .....(14.3)

GDP = Consumption + Government Spending + Gross Capital Formation + Net Exports

.....(14.4)

Asset Accounts and the Balance Sheet: 'Assets' in SNA are defined as 'entities owned by some unit, or units, from which economic benefits are derived by their owner(s) over a period of time' (SNA 2008). Assets may be synthetic (produced economic assets) or grown naturally (non-produced economic assets such as mineral deposits, land, etc). The definition of assets includes financial as well as fixed assets (e.g. machinery, equipments, structures, cultivated biological resources, etc). SNA 2008 categorizes five types of natural resources: (i) land, (ii) mineral and energy reserves (recoverable using current technologies), (iii) non-cultivated biological resources, (iv) water-resources and (v) other natural resources (e.g. radio spectra). All environmental assets having effective ownership rights (either private or government owned) such as land, fuel reserves, mineral deposits, orchards, timber tracts, livestock for breeding, private plantations, etc. are included in the SNA. On the other hand, economically un-exploitable minerals, resources having no proper ownership rights such as air and oceans, common property resources lacking effective control and undiscovered mineral deposits are not included in the SNA. One reason why these are kept outside the purview of SNA is that the contribution of such resources cannot be measured easily.

The SNA classifies the assets or accumulation accounts under four heads viz. (i) the capital account, (ii) the financial account, (iii) changes in the volume of assets account (actually indicated by the SNA as '*other* changes in the volume of assets account') and (iv) the revaluation account. The products of economic assets are identified by the SNA under these four heads of accounts. Out of these, the first two accounts viz. the capital account and the financial account relate to changes in assets, liabilities and net worth due to savings and capital transfers. While the financial accounts record transactions in financial assets and liabilities, the capital account records the transactions in non-financial assets. The second group of accounts i.e. changes in volume of assets account and the revaluation account relates to changes in assets, liabilities and net worth due to other factors. In this, the 'changes in the volume of assets account' records the effect of exceptional events that cause the volume and value of assets and liabilities to change. The revaluation accounts records the changes in the value of assets due to changes in price level.

The 'changes in volume of assets account', besides serving the important function of recording the changes in assets due to catastrophic losses, also records the discoveries/ extractions and upward/downward reappraisals of subsoil resources like oil, coal and natural gas. It records the natural growth of uncultivated biological resources (e.g. fish stocks, natural forests) and the entry/exit of natural resources to and from the asset boundary. Taking the produced and the non-produced natural assets together, the 'balances' are identified in the SNA as:

Closing Stock = Opening Stock + Gross Capital Formation – Consumption of Fixed Capital + Other Changes in Volume of Assets + Holding Gains/Losses in Assets

..... (14.5)

In India, the national accounts and macroeconomic aggregates (such as GDP, NDP, GFCF, CFC, etc.) are published annually in the publication National Accounts Statistics (NAS). The publications of NAS are frequently revised to effect the change of base year (to a year of recent time point so as to reflect the changing price levels realistically) and include data on such new variables which have since become available. The NAS was revised in 2010 to incorporate the 1993 and 2008 SNA recommendations and change the base year to 2004. Subsequently, the base year has been upgraded to 2011-12. Many important environmental considerations are incorporated into the NAS in its current and accumulation accounts. For instance, GDP includes the output of dung manure, the value of natural growth of cultivated assets for certain crops, the value of fuel wood, timber and non-timber forest products extracted from forests depending on data availability on prices and outputs. Likewise data on Gross Capital Formation (GCF) is extended to include capital investment by households in wind energy systems and bio-gas plants, outlays on land improvements and development of plantations, mining sites and timber tracts and capital expenditures incurred on installation of wind energy installation systems. Many more variables which account for environmental considerations are yet to be accounted for in the NAS. For instance, in case of land, variables which are not included in the national accounts are depletion of land, impact of disasters, productivity of land, degradation of soil, etc. In case of forests, variables such as deforestation, mangrove cover, biodiversity, etc are not included. In case of minerals, pollutant loads from mining and depletion of minerals are not included. In case of atmospheric quality, SO_2, CO_2, Suspended Particulate Matter (SPM), carbon monoxide, nitrogen dioxide, fuel consumption, ozone depleting substances, among others, are yet to be accounted for. Surface and ground water quality, sedimentation in water ways and their treatment costs are few other variables which are as yet unaccounted in the national accounts.

14.3 GAPS IN CONVENTIONAL SYSTEM OF NATIONAL INCOME ACCOUNTS

The conventional system of national accounts basically reflects the Keynesian macroeconomic model which mainly focuses on measurement of consumption, investment in physical capital, savings and government expenditures. It thus largely ignores environmental/natural assets and flows there from. Since an economy cannot function without natural assets, natural resources must be explicitly accounted for in the national accounts so as to both reflect for their contribution and signal for their non-sustainable exploitation. In this context, measurement of natural resources is important for their effective management. While the requisite modifications in the SNA will be discussed in detail in section 14.4, the main shortcomings in the conventional system of national accounts are stated here.

1. According to classical economists, income is the return on land, labour and capital. In the standard neo-classical production function, there are only two primary factors of production – labour and capital. Neoclassical theory did not thus perceive land as distinct from capital. Hence, value addition is considered primarily through these inputs.

2. Economic activities use natural resources as inputs and produce outputs along with wastes/emissions as by-product. The conventional SNA standards do not recognize this role of environmental factors/natural resources as inputs in economic production as they are considered as intermediate inputs or are not exchanged through market with well defined property rights. For instance, waste disposal

services provided by nature are not recognized as inputs because they lack market value.

3. In the conventional SNA system, along with man-made capital assets, natural assets are not treated on same footing. For that reason, not only that GDP does not account for natural capital depreciation, but GDP can go up with increase in final output from depletion of soils, forests and minerals. For instance, the national accounts record the positive contribution of expenditures incurred in clearing forests for non-forest purposes, but the losses of forest inflicted on the society in the process is not recorded. Just as machineries depreciate, soils also depreciate due to loss in its fertility. Infertile soil has less future income potential. The NDP estimates in the conventional SNA adjusts for depreciation through Consumption of Fixed Capital (CFC) only for man-made assets. It does not account for depreciation or depletion of environmental assets as the CFC is not computed for non-produced assets like land and mineral deposits.

4. The non-monetised and non-marketed goods and services are underestimated in the conventional GDP. For instance, in forestry, while timber and non-timber forest products contribute to GDP, other forest services like flood control, carbon sequestration, protection from soil erosion, amenity values, etc. are not included as such services cannot be easily monetized/exchanged through market. In other words, primarily, the focus in conventional GDP is on marketed goods and services and non-marketed goods and services are ignored.

5. Due to the above factors, GDP will actually increase with decline in forest cover even though forests based timber output positively contributes to GDP as GDP includes the marketed value of timber. Another example is air pollution. When pollution rises, air pollution has negative impact on health. But with increased demand for medical services, consumption expenditure on health rises which tends to increase GDP.

6. Changes in environmental/natural assets also have distributional implications which are ignored by conventional GDP. For instance, regions dependent on natural resources may become poorer with increase in resource depletion. This may widen the gap between the developed and under-developed regions. Disappearing forests and wildlife and severely polluted air do not affect measured income in the present national accounts. Even low-income countries dependent on natural resources use national accounting system which ignores their natural assets. Such an accounting system implicitly assumes that natural resources are available in plenty. Natural assets, strictly speaking, are assets which effectively contribute to economic productivity in multiple ways, irrespective of whether they are directly reflected in the market exchange or not. Conventional system of national accounts conveys a false impression that income is rising even when our natural wealth is degrading. Such measures of income are inadequate for measuring the true welfare as they fail to indicate whether the growth process is environmentally sustainable. Persistent usage of an 'incorrect yardstick' of sustainable economic growth will have damaging consequences for the economy and the environment. Environmental accounting is therefore a rightfully required step in the recognition of growth-environment linkages and is also crucial for incorporating in policy decisions.

Check Your Progress 1 (answer the questions in about 100 words within the space given)

1. What are the three major heads of accounts in which the SNA is categorized? To which of these accounts the production value of goods and services accounted?

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2. What are the three methods by which national income is measured? Specify the equations for estimating the GDP under each of these methods.

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3. How are 'assets' defined in SNA? Specify its types and components.

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4. Which type of environmental assets are normally included under the SNA classification? Which ones are not included and why?

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5. State the four heads of accounts into which the products of economic assets are classified in the SNA.

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6. What function does the 'changes in volume of assets account' serve? In this, taking into account both the produced and the non-produced natural assets, write the equation by which the balance of capital stock is estimated in the NAS?

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7. Why does the conventional SNA not account for depreciation of environmental assets?

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8. Why are the forest services like flood control and carbon sequestration not accounted for in the conventional SNA?

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14.4 REQUISITE MODIFICATIONS IN THE CONVENTIONAL NATIONAL INCOME ACCOUNTS

To overcome the shortcomings of the conventional national income accounting represented through the SNA framework, two types of adjustments are required. The first one requires defining and valuing non-marketed environmental goods and services. The second area is in respect of measuring and valuing the changes in the stock of natural resources. For instance, in the area of forests, one should extend the traditional NDP by accounting for the non-marketed benefits associated with forests. In addition, it should also be adjusted for the value of change in forest as asset . While the consensus for greening the traditional SNA is widely accepted, the approaches suggested vary ranging from 'conserving the stock of environmental assets' to 'taking into account the effect of environmental change on welfare'. The various approaches could be broadly grouped into four major categories viz. (i) physical accounting, (ii) pollution expenditure accounting, (iii) development of green indicators, and (iv) extension of the SNA type systems in terms of two main approaches viz. system of integrated environmental and economic accounting (SEEA) and environmental and natural resource accounting framework (ENRAP).

14.4.1 Physical Accounting

According to this approach, physical information on status of environment should be used to supplement the conventional national accounts. For instance, in case of forests, data on physical indicators such as volume of timber stock, area under dense forests, open forests, etc. can be taken into account. In case of air quality, data on emissions of CO_2, SO_2, SPM, carbon monoxide, etc. can be considered. In case of water quality, data on physical indicators such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), dissolved oxygen, pH factor, etc. can be considered. Such information can be integrated with conventional input-output matrices. For instance, EUROSTAT has developed a tool called NAMEA (National Accounting Matrix with Environmental Accounts). Such a tool is useful for analyzing the economy-environment linkages. It can trace which economic activity is responsible for a particular type of emission.

While physical indicators such as CO_2 emissions per capita or wastes per capita are preferred by few environmental economists, there are some limitations to this approach. Physical indictors do not indicate the monetized value of environmental costs and benefits. Another shortcoming of this approach can be illustrated with the help of an example on forests. Forests can be measured by volume of timber, area under forests, number of species of flora and fauna, etc. But the units of measurement are varied as volume is measured in cubic meters, area in hectares and species in numbers. Incomparability of units of measurement makes this approach less suitable for use in policy making. The choice of appropriate measurement unit depends on the precise policy objective. For instance, forests can be used for preserving biodiversity or management of timber resources. Moreover, this approach fails to give a condensed description due to the use of dissimilar units. Hence, it fails to indicate how severe is the environmental problem. This approach also requires the establishment of huge data sets as different indicators are to be constructed for air, water, forests, etc. Hence, it does not help to draw conclusions on economic and environmental significance of assets.

14.4.2 Pollution Expenditure Accounting

This approach basically involves development of data series on environmental expenditures such as pollution abatement. U.S. and OECD countries have maintained such data series. Such an approach helps to indicate the effect of environmental policies on productivity. However, it is also subject to some limitations. Such expenditures should not be taken as additions to traditional national accounts because they are already incurred expenditures reclassified as environmental expenditures. Moreover, such expenditures have a tendency to exaggerate the actual opportunity costs as they include material costs which are already included in the value added of the sectors which produce these materials. They, thus, increase the chances of double counting.

14.4.3 Development of Green Indicators

Many indicators to incorporate environmental and unpaid services have been developed over the years. For instance, a measure brought out by Nordhaus and Tobin called 'Measure of Economic Welfare' (MEW) in 1972 adjusts GDP for unpaid work, value of leisure time, industrialization externalities and environmental damages. Another measure is *Environmentally Adjusted NDP* or *EDP*. Resource extraction leads to both environmental degradation and depreciation of natural capital assets. Since improvement in the quality of environment may also increase the value of natural capital, EDP is obtained by adjusting NDP for 'net annual change in value of natural capital'. EDP deducts depreciation of man-made capital and natural capital from GDP ensuring consistency in treatment of both man-made and natural assets. However, this approach requires that natural capital depreciation should be estimated in monetary terms. Further, it may hide the real value of resource depletion expressed in physical terms. For instance, decline in volume of timber resources may go unnoticed if there is an increase in the value of timber resources due to rise in market prices.

The concept of '*comprehensive wealth*' as a measure of sustainable growth has also been attempted. Comprehensive wealth is defined as the shadow value (i.e. true opportunity cost) of all capital assets in the economy. Capital assets are defined in a broader sense to include physical capital, human capital, natural capital and social capital. While human capital is basically the knowledge, skills and health embodied in humans, social capital refers to institutions like efficient judicial system, well-defined property rights, etc. World Bank (2006 and 2011) has generated comprehensive wealth estimates for various countries. The International Human Dimensions Programme on Global Environment Change (by United Nations University) releases an Inclusive Wealth Report

(IWR) every two years providing the 'Inclusive Wealth Index' for various countries. In India, an Expert Group set up to suggest a system of 'Green National Accounting' has pointed out that 'Green GDP is a misnomer' and it is the 'wealth' of a nation which should be ideally measured. Work on deriving wealth estimates for India is in progress.

Adjusted Net Savings (or 'Genuine Savings') is another indicator of sustainable growth published by the World Bank. It is obtained by deducting the value of natural resource depletion and value of damages from pollutants from the traditional net national savings. Additionally, expenditure on education is added to the net national saving since it enhances human capital. The adjusted national accounting (or green accounting) is preferred over qualitative indices such as the Environmental Sustainability Index (ESI). The ESI is constructed using 21 indicators of 5 types viz. state of environmental systems, human vulnerability, stewardship, level of risks and social/institutional capacity. In contrast to a green accounting exercise, ESI cannot answer whether economic growth is environmentally sustainable. Few other such indices are Ecological Footprint, Biocapacity and Ecological Debt, Human Well-Being Index, etc.

14.4.4 Extensions of SNA-Type Systems

Building upon the existing SNA, covering all the sectors that interact with the environment rather than just one element such as depreciation or pollution abatement expenditure, has been another direction in which work has gone on towards green accounting. Under this, two approaches viz. the 'system of environmental and economic accounting' (SEEA) and the 'environmental and natural resource accounting framework' (ENRAP), both requiring sector-specific information, are discussed here.

System of Environmental and Economic Accounting (SEEA): There are three parts to the SEEA approach viz. the 'central framework', the 'experimental ecosystems accounts' (EAA) and the 'extensions and applications'. The 'central framework' integrates environmental information measured in physical terms with economic information measured in monetary terms. The EAA describes ecosystem measurement in physical terms and ecosystem valuation with market valuation rules. SEEA's 'extensions and applications' presents various monitoring and analytical approaches that can be adopted using SEEA data and describes how SEEA can be utilized for policy purposes.

The SEEA 'central framework' covers measurement in three important areas viz. (i) physical flow of energy/materials, (ii) stocks and flows associated with environmental assets and (iii) economic activity and transactions related to the environment. The 'physical flow of energy materials' includes: (a) flows of natural inputs from the environment to the economy such as water, minerals, timber, etc.; (b) flows of residuals from the economy to the environment such as emissions, solid waste, etc.; and (c) product flows within the economy. The 'stocks and flows associated with environmental assets' focuses on material benefits derived directly from using environmental assets (e.g. natural inputs) and ignores non-material benefits derived indirectly from using environmental assets (e.g. water purification, carbon storage and other benefits flowing from ecosystems). Individual elements embodied in individual assets are not considered separately. For instance, various nutrients present in the soil are not taken as individual assets. The 'economic activity and transactions related to the environment' area covers those economic activities which reduce environmental pressures (like pollution abatement and sustainable resource management). Other environmental transactions such as taxes, subsidies, grants and rents are also recorded here. A separate account viz. the 'environmental protection expenditure account' (EPEA) in the SEEA central framework provides information on the output of environmental protection specific services produced across the economy and the expenditure of resident units incurred for environmental protection purposes.

The SEEA 'central framework' uses a series of tables and accounts to provide information on stocks/flows related to the economy and environment. These are: (i) supply and use tables in physical and monetary terms showing the flows of natural inputs, products and residuals; (ii) asset accounts for individual environmental assets in physical and monetary terms showing the stock of environmental assets at the beginning and at the end of each accounting period and the changes in the stock; (iii) a sequence of economic accounts highlighting depletion-adjusted economic aggregates; and (iv) functional accounts recording transactions and other information about economic activities undertaken for environmental purposes. The SEEA 'central framework' is broadly consistent with the SNA. Both the SEEA 'central framework' and the SNA use the same market price valuation principles for valuing environmental assets. However, there are few differences between them. For instance, the SEEA 'central framework' recommends recording all intra-enterprise flows (i.e. production and use of goods and services on own account within enterprises) depending on the analytical scope of the account being compiled. The SEEA 'central framework' also encourages recording of household own account production. In contrast, SNA only records production of goods for own final use and intra-enterprise flows related to ancillary activities. Both SNA and SEEA 'central framework' recognize the value of natural resource depletion. But, natural resource depletion is placed in 'other changes in the volume of assets' account in the SNA. Hence, SNA does not recognize resource extraction as a cost against earned income whereas the SEEA 'central framework' does recognize resource extraction as a cost against income by giving 'depletion adjusted balancing aggregates'. Broadly, however, the asset boundaries of SEEA central framework and SNA are the same in monetary terms i.e. only assets having economic value as per SNA valuation principles are included in the SEEA central framework. In physical terms, however, the asset boundary of SEEA central framework is broader as it includes all natural resources and areas of land of an economic territory that may provide resources and space for use in economic activity. In physical terms, SEEA Central Framework is not restricted to only 'assets having economic value'. Likewise, while SNA includes land under the broad category of natural resources, the SEEA central framework recognizes land's distinct role in provision of space and treats it separately from other natural resources.

In totality, the asset boundary of SEEA is much broader as compared to SNA as it relaxes the criteria that assets must have ownership rights and also includes assets which do not provide direct economic benefit like the ecosystems. The distinction between SNA and SEEA asset boundary is illustrated in Figure 14.1.

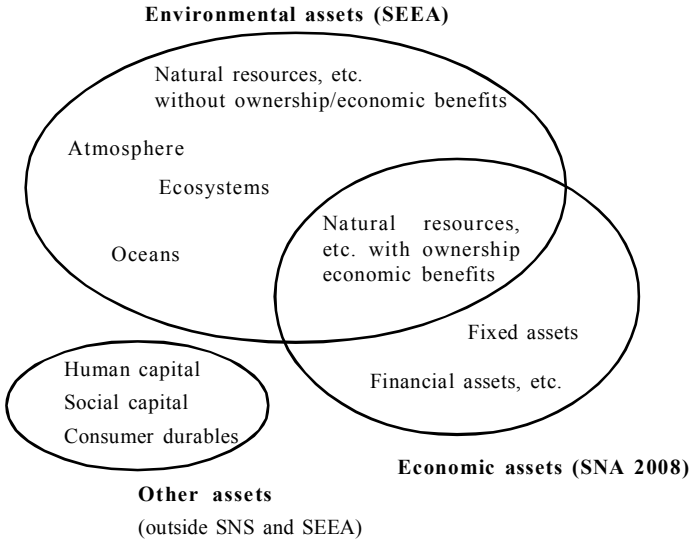

Figure 14.1: Assets in SNA and SEEA

Environmental and Natural Resource Accounting Project (ENRAP): The ENRAP (also known as Peskin framework) starts from the conventional national accounts but is more consistent with economic theory than with SNA. SEEA adheres more to SNA principles rather than economic theory. The basic idea of ENRAP is that an economic account should include all economic inputs and outputs that comprise an economic system for which the inputs and outputs need not necessarily have market prices in order to be classified as 'economic'. Rather, they must be scarce enough so that, if they are marketed, they have a non-zero price. The natural environment is a major source of non-marketed input which is economically scarce. ENRAP therefore expands traditional accounts to incorporate the input/output service of non-marketed but yet scarce environmental capital. Essentially, three categories of non-marketed natural goods and services are excluded from traditional accounts even though they are economic. These are: (i) input services (e.g. waste disposal services), (ii) output or environmental quality services (e.g. recreation services) and (iii) negative outputs (e.g. pollution). The ENRAP approach appends these non-marketed services to the marketed services which are already considered in the national accounts. Shadow prices are used to estimate the monetary value of such non-marketed services.

Check Your Progress 2 (answer the questions in about 100 words within the space given)

1. What are the two areas in which adjustment is required in order to remove the shortcomings of the conventional SNA system? Give illustrations.

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2. In which two directions the work on greening the conventional SNA framework has taken place? What are the four groups into which they can be classified?

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3. What does the method 'physical accounting' approach basically entail? What are its limitations?

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4. What are the limitations of the 'pollution expenditure accounting' approach in using it for improving the conventional SNA for environmental accounting?

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5. How is the Environmentally Adjusted NDP or EDP estimated? What problems are encountered in considering EDP for green accounting?

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6. State the major differences between SEEA and the SNA.

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7. What is the basic idea behind ENRAP? In what respects does ENRAP differ from SEEA?

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14.5 USEFULNESS OF ENVIRONMENTAL ACCOUNTING

Green Accounting has important policy implications especially for developing economies which are dependent on natural resource based activities such as agriculture, fishing, forestry, etc. In these economies, one gets inflated national income estimates if depletion of natural capital goes unaccounted. Green accounting provides a framework which facilitates designing of policies that encourage sustainable economic growth without exerting excessive pressure on natural capital or helps in identifying areas of investment in natural capital maintenance or improvement. Towards this, 'environmentally adjusted NDP' or EDP which assigns a monetary value to depreciation of natural capital assets is helpful in encouraging the formulation of policies for better environmental protection. Revenue from extraction of resources, if used to finance investment in physical and human capital besides encouraging adoption of pollution reducing practices, would contribute to balancing the ill-effects of economic growth as reflected in the unadjusted conventional GDP. In this context, indicators such as *comprehensive wealth* and *inclusive wealth index* reflect whether the *wealth* of the nation is increasing or decreasing over time. Such indicators can therefore be used for cross-national comparisons i.e. to indicate which economies are growing sustainably and which ones need to implement stricter environmental standards for sustainable growth.

An example will illustrate the usefulness of green accounting. Consider a hypothetical economy which exploits its natural resources for financing development expenditures.

GDP growth rate is given to be 8 percent per annum. Let the depreciation estimates include both physical capital and resource depletion in selected sectors like timber, petroleum and soil. Discounting for these, the NDP growth rate is only 4 percent per annum. This example illustrates how GDP paints a disguised picture of growth ignoring the erosion of the capital asset base of the economy i.e. capital inclusive of natural capital. With green accounting, policy makers would not be under the false impression that the economy is doing well and the policy focus would be on sustainable growth.

14.6 ENVIRONMENTAL COST BENEFIT ANALYSIS

Environmental Cost Benefit Analysis (ECBA) refers to social evaluation of investment projects and policies that involve significant environmental impacts. Environmental protection agencies frequently use ECBA to analyze the environmental impacts of economic projects such as highway construction. Environmental regulations and policies are also subject to cost-benefit analysis to judge their implications. Basically, Cost Benefit Analysis refers to social appraisal of projects taking into account their consequences over time. ECBA extends this notion to incorporate the environmental impacts of the projects. Environmental impacts are generally positive or negative externalities emanating from the environment. In ECBA, the environmental impacts are assigned a monetary value for weighing costs and benefits. Since environmental goods and services (like clean air) do not have observable market price, economic valuation or measurement of the environment is crucial for its management.

In a typical Cost Benefit Analysis, increases in well-being or utility of individuals are classified as 'benefits' and decreases in well-being or utility of individuals are classified as 'costs'. A project is allowed to go ahead if 'social benefits' are found to be higher than 'social costs'. Benefits are aggregated across various social groups by adding up the 'willingness to pay' for benefits or 'willingness to accept' as compensation for losses. Although a standard cost benefit analysis does not account for distributional concerns, sometimes, low income groups' benefits or costs are assigned higher weights to account for social concerns. Since CBA involves aggregation over a period of time, future benefits and costs are discounted to derive the present values. Inflation is taken care of by considering constant price estimates. An example will illustrate the central idea of ECBA. Consider the development of a wilderness area. Let the present value of development benefits be denoted by BN, that of development costs by CO and the discount rate by 'r'. When we ignore environmental impacts, the Net Present Value 'NPV' of the project is given by:

$$NPV = \sum_{t=0}^{t-T} \frac{(BN_t - CO_t)}{(1+r)^t} - \sum_{0}^{T} \frac{BN_t}{(1+r)^t} - \sum_{0}^{T} \frac{CO_t}{(1+r)^t} = \text{BN} - \text{CO} \quad \text{.....(14.6)}$$

After accounting for environmental impacts, the NPV is given by:

$$NPV = BN - CO - EC \quad \text{.....(14.7)}$$

where, EC represents environmental cost. It is taken as the present value of the stream of the net value of the environmental impact of the project over its lifetime. The project should be allowed to go ahead if the NPV is positive. That is, if:

$$\text{BN} - \text{CO} > \text{EC} \quad \text{.....(14.8)}$$

14.6.1 Application of ECBA

Two types of environmental 'cost benefit analysis' (CBA) can be distinguished on the basis of the timing of conducting analysis: *Ex-ante* CBA is undertaken prior to the implementation of the project to find out an optimal alternative and *Ex-post* CBA undertaken after the project has been implemented to examine the net benefits realized from the project. Ideally, a cost benefit analysis should be conducted ex-ante because many a times, environmental damages cannot be repaired.

There are various stages of ECBA. These are: (i) defining the problem (e.g. identification of beneficiaries and losers, defining the time horizon); (ii) identifying the project's physical impacts; (iii) valuing the impacts; (iv) discounting the cost-benefit flows (with an appropriate discount rate selected); (v) selecting the project to be implemented on the basis of a net present value criterion; and (vi) sensitivity analysis (e.g. checking how NPV changes with the choice of various discount rates). Policy makers typically conduct the first stage, whereas experts in geology, ecology and other sciences conduct the second stage. Economists are primarily involved in stages three to six. Essentially, the success and reliability of ECBA depends on the monetary evaluation of the impact on the environment. The distributional implication of the project is another area which requires policy attention.

14.6.2 Valuation of Environment

If there is significant damage to environmental assets, the 'cost' component in ECBA should include the 'Total Economic Value' (TEV) of the depreciated environmental asset. Correspondingly, if a project improves environmental quality, the 'benefit' component in ECBA should record the rise in TEV of the environmental asset. Basically, TEV encompasses both the use value and the non-use value of the environment. Use value is the benefit which is derived from using the environment. Some natural resources have direct use value (e.g. crude oil, timber from forests, medicinal herbs). Recreational fishing, hunting, swimming, and other such activities also provide use values. Use values may be indirect as in case of individuals watching television shows on wildlife for recreation. Some ecosystem services such as waste assimilation, water purification, etc. also provide indirect use values. Forests, for example, directly provide timber but there are indirect use values of forests arising from prevention of soil erosion, carbon storage, etc.

Non-use value is obtained by aggregating option value, bequest value and existence value. Environmental goods and services are valued for their future benefits given the uncertainty of future supply. Option value may be conceived as insurance premium which the individuals are willing to pay in order to ensure availability of some environmental goods and services in future. There is a lack of consensus on whether option value should be placed in 'use value' or 'non-use value' category. Bequest value is the value of satisfaction derived from preserving the natural environment for successive generations. For instance, we may be willing to pay to reduce green house gas emissions so that future generations do not suffer from adverse consequences of global warming. Existence value is the satisfaction derived from the simple knowledge that a particular environmental good exists. For instance, an individual may derive satisfaction from knowing that endangered species exist and their protection from extinction is necessary even though he may never have an opportunity to see that species or derive any benefit from it.

Three standard environmental valuation methods are discussed in literature: Stated Preference Method, Revealed Preference Method and Benefit Transfer Method. Under

the Stated Preference Method, people are directly asked to place a monetary value on the environmental good or service. The Revealed Preference Method follows an indirect approach as individuals' willingness to pay is inferred from their observed behaviour rather than direct questioning. Revealed Preference Method can be either market-based or surrogate market based. Market based method is based on directly observed market values. For instance, the value of fertile soil which is a natural asset cannot be observed directly. But using a production function approach, one can calculate the loss in output due to decline in soil fertility, by considering soil as an input in production. This procedure helps to deduce the value of fertile soil in terms of output loss. In some cases, non-market environmental goods and services have surrogate markets i.e. markets for a related good or service. Such markets can reveal the individuals' indirect preference for a non-market environmental good. Travel Cost Method and Hedonic Pricing Method are two methods which use surrogate markets for valuation of some environmental goods or services. For instance, in the Travel Cost Method, household expenditure and time spent in travelling to a recreational park is taken as a measure of willingness to pay for the recreational benefit derived from the park. Likewise, in the Hedonic Pricing Method, value of clean air is deduced from the extra premium that people are willing to pay to stay in a house located in greener areas free from pollution. All else being equal, property prices will be higher in cleaner and greener localities.

Sometimes using market based or surrogate market based methods may not be possible. In such cases, Stated Preference Method is employed which uses non-market based methods. For instance, individuals may be directly asked to reveal their willingness to pay for preserving a particular species. Such a method is known as *Contingent Valuation Method* (CVM). This is a widely used stated preference technique. In CVM, the respondents are directly asked how much they are willing to pay for environmental goods. Assuming a hypothetical situation, the compensation they are willing to accept for losses in environmental quality is ascertained by direct enquiry. While other techniques capture only the use values (direct and indirect), CVM captures both the use and the non-use values of the environment, at least, in principle. However, CVM may be subject to deficiencies such as improper questionnaire design and respondents' bias. Another Stated Preference Method is *Choice Modelling* wherein respondents are required to choose the most preferred alternative from a set containing a minimum of two options. At least one option in the set should be the current situation. Respondents are required to rank the various options. Such a method permits the respondents to analyze the tradeoffs between various alternatives.

Another method used to value environment is the Benefit Transfer Method. This method uses the already existing estimates from completed studies on some other issue or location. It then assigns values for similar environmental changes. Such a method is generally undertaken due to time and resource constraints on fresh evaluation. Since additional assumptions have to be made in applying the results of past studies, this approach is considered subjective.

The valuation techniques discussed above are all applicable and widely used in ECBA. However, they are subject to a few limitations. While the Stated Preference Method is subjective, the Revealed Preference Method is though more objective, its scope for valuing environment is limited as it is applicable to situations where individuals are already making payments for environmental goods one way or the other. The Revealed Preference Method cannot be used for evaluation of non-use values of the environment (e.g. preservation of endangered species). Typically, the Stated Preference Method has been used more in ECBA. The CVM can be used to estimate the use values as well as the option, bequest and the existence values. However, this method is also criticized

as it generates hypothetical price estimates not reflecting the true willingness to pay. But due to lack of alternative methods, CVM and other Stated Preference Methods are widely used in ECBA.

14.6.3 Limitations of ECBA

Sometimes environmental degradation can be far beyond repair. Many ecosystem services (like the ozone layer) simply cannot be substituted by physical capital. Degradation of such critical natural capital poses a threat to survival of mankind. ECBA ignores these critical and non-substitutable natural capital assets. Thus, utility losses reported by a typical ECBA may not be substantial enough to stop a project which poses a threat to human survival. Such projects should be analyzed separately outside the confines of a cost benefit analysis. The choice of the discount rate is very subjective. Sometimes, discounting transforms future benefits and costs into very small present values which may not appear to be very significant countering the very idea of intergenerational equity. The discount rate must therefore be chosen judiciously.

Some environmental economists contend that there is a lot of ambiguity and uncertainty in the valuation of the environment, especially the ecosystem services as the value of environment cannot be perfectly quantified and measured by the yardstick of money. It is possible that many ecological connections get missed out while conducting such valuation exercises. Nevertheless, attaching no value is as good as attaching a value of 'zero'. Knowing that our environment is priceless, it is inappropriate to attach a 'zero' value for it. Evaluating the costs and benefits of a project from a societal as well environmental perspective is therefore crucial for achieving greener growth.

Check Your Progress 3 (answer the questions in about 100 words within the space given)

1. Why is it particularly important for developing countries to adopt environmentally accountable SNA? In this context, how is EDP helpful?

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2. What is ECBA? Illustrate the central idea behind ECBA by means of an example.

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3. State the different stages of ECBA. Distinguish between Ex-ante CBA and Ex-post CBA.

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4. Distinguish between direct use-value and indirect use-value of a natural resource? Illustrate by the help of an example.

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5. What are 'surrogate markets'? Which two methods use the concept of surrogate markets to estimate the value of certain environmental goods/services?

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14.7 LET US SUM UP

There is a popular saying: 'what can't be measured, can't be managed'. This maxim applies very well in case of environmental resources. In the context of environmental challenges such as global warming and depletion of natural capital, we need a suitable measure of 'environmentally sustainable growth'. Green accounting provides such a measure. Although implementation of green accounting is challenging and subject to data limitations, it is not impossible. Against this background, the unit has discussed the existing or conventional system of national accounting, identifying its shortcomings and the requisite modifications in order to make it environmentally accountable. Two methods that have been evolved for this viz. SEEA and ENRAP are explained. The usefulness of environmental accounting and the method of ECBA to forestall and compensate environmental impact are discussed.

14.8 KEY WORDS

Carbon Sequestration — Is the process of capturing CO_2 from the atmosphere and putting it into long term storage. The goal is to reduce the effects of global warming and climate change.

Ecological Footprint — Measures human impact on the environment. It is the sum of cropland, forest, grazing land and fishing grounds required for production of food, fiber and timber, etc. for human consumption and absorption of wastes.

Natural Capital — Refers to stock of natural assets like air, soil, water, forest, biodiversity, etc.

Non-Cultivated Biological Resources — Consist of animals, birds, fish and plants that yield both once-only and repeat products over which ownership rights are enforced but for which natural growth or regeneration is not under the direct control, responsibility and management of institutional units.

Pollution Taxes	Are taxes on amount of pollution or on goods whose usage increases amount of pollution.
Stewardship	Are ethics encouraging resource management in a responsible manner.
Shadow Price	In the absence of market value of undesirable products such as pollution/environmental degradation, shadow price can be calculated. Shadow price refers to net change in social welfare due to a unit change in the supply of a good. For instance, shadow price of wilderness is the change in social welfare caused by one (measurement) unit change in wilderness.

14.9 SUGGESTED REFERENCES FOR FURTHER READING

1) Bartelmus, P (2013), '*Measuring Sustainable Economic Growth and Development*,' http://www.eoearth.org/view/article/154541.

2) Harris, J. M. and B. Roach (2014), 'Environmental and Natural Resource Economics: A Contemporary Approach,' 3rd Edition, Chapter 8 - *National Income and Environmental Accounting*, Routledge.

3) OECD (2006), 'Cost-Benefit Analysis and the Environment: Recent Developments,' Executive Summary, ISBN 92-64-01004-1, OECD.

4) Peskin, H. M. and M. S. Angeles (2001), 'Accounting for Environmental Services: Contrasting the SEEA and the ENRAP Approaches,' *Review of Income and Wealth*, Series 47, Number 2.

5) World Bank (2006), '*Where is the Wealth of Nations*?', Washington, DC: World Bank.

6) World Bank (2011), '*The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium*,' Washington.

14.10 ANSWERS/HINTS TO CYP EXERCISES

Check Your Progress 1

1) See 14.2 and answer.

2) See 14.2 and answer.

3) See 14.2 and answer.

4) See 14.2 and answer

5) See 14.2 and answer.

6) See 14.2 and answer.

7) See 14.3 and answer.

8) See 14.3 and answer.

Check Your Progress 2

1) See 14.4 and answer.
2) See 14.4 and answer.
3) See 14.4.1 and answer.
4) See 14.4.2 and answer.
5) See 14.4.3 and answer.
6) See 14.4.4 and answer.
7) See 14.4.4 and answer.

Check Your Progress 3

1) See 14.5 and answer.
2) See 14.6 and answer.
3) See 14.6.1 and answer.
4) See 14.6.2 and answer.
5) See 14.6.2 and answer.