Handbook of National Accounting

Integrated Environmental and Economic Accounting

An Operational Manual

United Nations

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Integrated Environmental and Economic Accounting

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PREFACE

Growing pressures on the environment and increasing environmental awareness have generated the need to account for the manifold interactions between all sectors of the economy and the environment. Conventional national accounts focus on the measurement of economic performance and growth as reflected in market activity. For a more comprehensive assessment of the sustainability of growth and development, the scope and coverage of economic accounting need to be broadened to include the use of non-marketed natural assets and losses in income-generation resulting from the depletion and degradation of natural capital. Conventional accounts do not apply the commonly used depreciation adjustment for human-made assets to natural assets. Since sustainable development includes economic and environmental dimensions, it is essential that national accounts reflect the use of natural assets in addition to produced capital consumption.

Following requests made in Agenda 21[1] of the 1992 United Nations Conference on Environment and Development (Earth Summit) in Rio de Janeiro, the United Nations Statistics Division (UNSD) published in 1993 a Handbook of National Accounting entitled *Integrated Environmental and Economic Accounting*.[2] The handbook was based on numerous approaches to environmental accounting, pioneered in a series of workshops by the United Nations Environment Programme (UNEP) in collaboration with the World Bank. However, the discussion of concepts and methods has not come to a final conclusion, and the United Nations handbook and its System of integrated Environmental and Economic Accounting (SEEA) were therefore issued as an interim version of work in progress.

The SEEA was tested in Canada, Colombia, Ghana, Indonesia, Japan, Mexico, Papua New Guinea, the Philippines, the Republic of Korea, Thailand and the United States of America. Only parts of the SEEA were actually compiled in these studies. The reasons are lack of data and the controversiality of certain valuations of nature services and their welfare effects. As a result, the country projects invariably excluded SEEA modules that extended the production boundary of the national accounts into household production and its environmental effects, and nature s production of services of waste disposal, provision of space and other physiological and recreational services. In addition, modules applying valuations of the damage to ecosystems and humans from losses of these services were also found difficult to implement, at least at the national level.

The objective of the present operational manual is thus to provide hands-on guidance for the implementation of the more practical SEEA modules, which are those SEEA versions that can be compiled within reasonable time and cost constraints, while ensuring maximum consistency with the worldwide adopted standards of the 1993 System of National Accounts (SNA).[3]

The manual is expected to be used as a reference document for the implementation of integrated environmental and economic accounting at the national level. It supplements the United Nations handbook and work undertaken by UNSD and other international and national organizations in this area. A sequence of "how-to" steps leads through the implementation process, supported by illustrative tabulations and corresponding software. The main target groups for the manual are the data producers, who may be either part of the official statistics system or research institutes charged with conducting pilot projects . Potential users, including policy makers, may find particularly useful the chapters discussing the use of the accounting results in planning and policy analysis; the purpose is to provide an incentive for implementing the SEEA in cooperation with data producers and users from diverse line ministries and institutions.

Similar methodologies for natural resource accounting were applied by the World Resources Institute in Costa Rica and Indonesia. Other accounting systems, focusing on physical (non-monetary) accounts, were designed by some European countries, including France, Norway and the Netherlands. Experiences with these approaches and with the use and usefulness of other SEEA modules could and should be further explored through research and experimentation. UNSD, in cooperation with the London Group on Environmental Accounting, a group of experts from national offices and international organizations, has now embarked on the revision of the SEEA under the guidance of the United Nations Statistical Commission.

This manual is the result of collaboration within the so-called Nairobi Group, established by UNEP to advance international work in the fields of environmental and natural resource accounting. The Nairobi Group agreed that the main objective of its work would be to prepare a manual on the implementation of the SEEA. Members of the Nairobi Group include internationally recognized experts from developed and developing countries, international organizations and non-governmental organizations. They are listed below, under Acknowledgements, with their affiliations.

Chapter I describes the uses of integrated environmental and economic accounting in policy- and decision-making. It explains why such accounting is important, what is to be gained by its implementation, what it entails and what it takes to carry it through. Chapter II provides an overview of the concepts used in the SEEA. It demonstrates the flexibility of a modular approach that permits selecting the more practical versions of the SEEA for elaboration (this is carried out in chap. III). Chapter III thus translates the generic concepts set out in the preceding chapter into a step-by-step implementation process. The different steps provide guidance and illustrative tabulations for the compilation of data on environmental protection expenditures, for the use of produced and non-produced assets in physical and monetary terms, and for the presentation and interpretation of environmentally adjusted aggregates. Fictitious, but realistic data are presented in the tabulations to facilitate understanding of the sequence of calculations. Chapter IV elaborates on sectoral accounts for forests, subsoil assets, fish, soil and air emissions. Chapter V discusses how information from integrated accounting can be applied in economic and environmental policies. Such information can be used to assess economic performance, to identify environmental problems and constraints, and to reform and evaluate policies. Chapter VI deals with the necessary institutional arrangements for implementing and maintaining the SEEA at the national level. It advocates implementation by those organizations that are responsible for compiling the national accounts in cooperation with other data producers and users.

The manual is accompanied by user-friendly software consisting of a sequence of worksheets linked through a set of automatic formulae and consistency checks. Annex VIII includes a detailed description of the software that is available on the United Nations Statistics Division, Environment Statistics Section (www.unsd.org/Depts/unsd/enviro/), and Fondazione ENI Enrico Mattei, (FEEM) (http://www.feem.it/gnee/seeahot.html/info.html) web sites. The software is password-protected.

Notes

1. *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992*, vol.I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrugendum), resolution 1, annex II.

1. Studies in Methods, No. 61 (United Nations publication, Sales No. E.93.XVII.12).

1. Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, Unitted Nations and World Bank, *System of National Accounts, 1993* (United Nations publication, Sales No. E.94.XVII.4).

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Acronyms

ABS	Australian Bureau of Statistics
BOD	biochemical oxygen demand
C final consumption	
CAP	capital stock
CAP I	capital stock including (economic) natural capital
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CC	capital consumption
CEPA	Classification of Environmental Protection Activities
CF	capital formation
CFCs	chlorofluorocarbons
CNFA	Classification of Non-Financial Assets
CO_2	carbon dioxide
COFOG	Classification of the Functions of Government
COICOP	Classification of Individual Consumption According to Purpose
COPNI	Classification of the Purposes of Non-Profit Institutions Serving Households
COPP	Classification of the Outlays of Producers According to Purpose
CPC	Central Product Classification
CPUE	catch per unit of effort
DENR	Department of Environment and Natural Resources (Philippines)
DSRF	driving force-state-response framework
ec	environmental capacity
EC	environmental cost
ECE	Economic Commission for Europe
ECF	environmentally adjusted net capital formation
ECLAC	Economic Commission for Latin America and the Caribbean
EDP	environmentally adjusted net domestic product
EDP I	environmentally adjusted net domestic product at market prices
EDP II	environmentally adjusted net domestic product at maintenance cost
EEZ	exclusive economic zone
EIA	environmental impact assessment
EIOT	extended input-output table
ENI	environmentally adjusted national income
EO	Executive Order (Philippines)
EP	environmental protection
EPE	environmental protection expenditures
ESCAP	Economic and Social Commission for Asia and the Pacific
EVA	Environmentally adjusted value added
EVA I	environmentally adjusted value added at market values
EVA II	environmentally adjusted value added at maintenance cost (or combined market value/maintenance cost
FAO	Food and Agriculture Organization of the United Nations
FDES	Framework for the Development of Environment Statistics
FEEM	Fondazione Eni Enrico Mattei
FISD	Framework for Indicators of Sustainable Development

GCFEP	gross capital formation for environmental protection
GDP	gross domestic product
GLASOD	Global Assessment of Soil Degradation
GNI	gross national income
GNP	gross national product
IC	intermediate consumption
ICEP	intermediate consumption for environmental protection
IEEA	integrated environmental and economic accounting
IPCC	Intergovernmental Panel on Climate Change
IPPC	integrated pollution prevention and control
ISIC	International Standard Industrial Classification of All Economic Activities
ITQ	individual transferable quota
ITSQ	individual transferable shared quota
ITTA	International Tropical Timber Agreement
IUCN	World Conservation Union
KIT	Royal Tropical Institute (Netherlands)
LTO	landing and take-off
M	imports
MEB	material energy balances
MFA	material flow accounts
NAMEA	National Accounting Matrix including Environmental Accounts (Netherlands)
NCF	net capital formation
NDP	net domestic product
NEDA	National Economic and Development Authority (Philippines)
NFI	national forestry inventories
NNI	net national income
NO_x	nitrogen oxides
NRA	natural resource accounts
NSCB	National Statistical Coordination Board
NVA	net value added
O	output
OECD	Organisation for Economic Cooperation and Development
PEENRA	Philippines Economic-Environmental and Natural Resources Accounting
PIOT	physical input-output table
PSNA	Philippines System of National Accounts
SAMEA	Social Accounting Matrix including Environmental Accounts
SEEA	System of integrated Environmental and Economic Accounting
SEEAF	System of integrated Environmental and Economic Accounting for Fisheries
SERIEE	European System for the Collection of Economic Information on the Environment
SERNAGEOMIN	Servicio Nacional de Geología y Minería (Chile)
SNA	System of National Accounts
SO_2	sulfur dioxide
TCE	tons of coal equivalent
TFAP	Tropical Forestry Action Plan
TSP	total suspended particulate matter

UNCHS	United Nations Centre for Human Settlements (Habitat)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSD	United Nations Statistics Division
USBEA	United States Bureau of Economic Analysis
VAC	volume actually commercialized
VOB	volume over bark
VPA	virtual population analysis
WORLD-SOTER	Global Soil and Terrain Database
WS	worksheet
WTO	World Tourism Organization
WWF	World Wide Fund for Nature
X	exports

CHAPTER I

THE NATURE AND USE OF INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING

A. Why include the environment in the national accounts?

1. The need to account for the environment and the economy in an integrated way arises because of the crucial functions of the environment in economic performance and in the generation of human welfare. These functions include the provision of natural resources to production and consumption activities, waste absorption by environmental media and environmental services of life support and other human amenities.

2. Conventional national accounts have only partly accounted for these functions, focusing on market transactions and indicators that reflect important factors in welfare generation, but they do not measure welfare itself. However, new scarcities of natural resources now threaten the sustained productivity of the economy, and economic production and consumption activities may impair environmental quality by overloading natural sinks with wastes and pollutants. By not accounting for the private and social costs of the use of natural resources and the degradation of the environment, conventional accounts may send wrong signals of progress to decision makers who may then set society on a non-sustainable development path.

1. Incorporating environmental assets in the national accounts

3. The System of National Accounts (SNA) (Commission of the European Communities and others, 1993), referred to hereinafter as the 1993 SNA, is an internationally agreed framework for the systematic compilation and presentation of economic data. It serves purposes of economic analysis, decision-taking and policy-making. The accounts can be compiled for successive time periods, providing information for the monitoring, analysis and evaluation of the performance of an economy over time (1993 SNA, para. 1.1). A country's system of national accounts includes two main categories: *flows* of goods and services and *stocks* of assets used in the production of goods and services. Another name for the stocks is *capital*. Both stocks and flows are measured in monetary terms. The objective of the national accounts is thus to measure not only the flows of goods and services resulting from production (gross domestic product (GDP) or net domestic product (NDP)) but also the capital stock itself, the country s economic wealth.

4. The production of goods and services requires inputs from, and has effects on, the natural environment. In particular, these effects are the depletion of resources and the production of wastes which are returned to the environment. Pollution occurs when these wastes disrupt or change natural systems, including those that are important for human well-being (for example, air and water). If the natural environment is conceptualized as a stock of natural capital, and if its uses for humans are regarded as the services that flow from this stock, then in principle the use of the natural environment for economic activity can be accounted for in the same way as the use of other kinds of capital (for example, manufactured capital, including machines, buildings and infrastructure) and the products to which they give rise.

5. More precisely, to the extent that any product that is included in GDP has made use of natural capital as a resource or as a waste depository, any accounting system that does not account for natural capital will be incomplete and may be misleading. There has never been any dispute about the importance of the natural environment to economic activity. Clearly its role in providing resources, absorbing wastes and generally maintaining a habitable world is fundamental. Any system of economic accounting that omits the environment is omitting a dimension of crucial importance to the functioning of the economic system, and to the wider generation and maintenance of wealth.

6. Yet until very recently, practically all countries omitted the environment from their national accounts. There were good reasons for this omission. First, human activity, beyond producing effects that were local and reversible, was perceived as unlikely to affect the environment so as to jeopardize its contribution to the economy and to wider human welfare. Second, accounting for the environment's contribution to the economy and human welfare was considered extremely difficult, requiring the resolution of intractable methodological problems and the costly generation of a large amount of data. As a result, little or no action was taken to include the environment in the national accounts.

7. However, realities and perceptions change. It is now clear that human activities can profoundly affect, and are profoundly affected by, basic environmental systems and functions, with significant implications for national economies and humanity as a whole. It has also become evident that *all* countries at different stages of economic development have experienced environmental depletion and degradation. This manual addresses, therefore, the environmental accounting concerns of both industrialized and developing countries. (Unless otherwise stated, environmental accounting is the short form of integrated environmental and economic accounting.)

8. Yet without a systematic, quantitative, structured relationship between the environment and the economy, it is hard to know not only what are the various economic contributions to environmental damage, but also how the damage might be remedied. It is therefore not surprising that the inclusion of the environment in the SNA came to be regarded as a necessity. The difficulties of such inclusion became a problem to be solved rather than an insurmountable obstacle.

9. The revised SNA explicitly included, therefore, natural resources in its balance sheets and accumulation accounts, and introduced environmental accounting in a satellite accounting framework (1993 SNA, chaps. XII and XXI). Naturally occurring assets such as land, subsoil assets and uncultivated forests are included in the balance sheets provided that institutional units (households, government units, corporations and non-profit organizations) exercise effective ownership over these assets and draw economic benefits from them. The two criteria of enforced ownership and actual and potential benefits make them economic assets (1993 SNA, para. 10.2), qualifying these assets for inclusion in the balance sheets and asset accounts. The SNA also describes the links between the SNA and environmental accounting in a separate chapter on satellite accounting. The proposed environmental accounts include environmental assets, that is to say, ecosystems, as well as emission accounts in physical and monetary terms linked to the production accounts. Such linkage is a prerequisite of a meaningful comparison of conventional and environmentally adjusted accounting indicators.

10. In 1993, the United Nations Statistics Division (UNSD) elaborated a System of integrated Environmental and Economic Accounting (SEEA) in a handbook of national accounting (United Nations 1993a). For the first time, a United Nations publication set out a framework to systematically account

for the stocks and flows of environmental resources in a way that was consistent with the SNA. The SEEA is thus a product of the new SNA, drawing attention to the need for assessing the environmental sustainability of economic performance. The scope, coverage and accounting procedures for natural economic and environmental assets, as specified in this manual, are discussed in detail in chapters II and III below.

11. The SNA itself has left virtually unchanged the treatment of natural resources in the production accounts. The sale of natural resources is still partly counted as value added in the production and income accounts. The environmental cost adjustment is only to be carried out in satellite accounts . The satellite accounts of the SEEA, as presented here, should thus be seen as an attempt at integrating environmental change in the conventional measurements, without modifying the conventional accounts; they are to supplement the central accounts of the SNA with integrated accounts that expand the asset boundary of national accounts without changing their production boundary. In this manner, both stock and flow accounts are modified while maintaining consistency, notably, with the capital and production accounts of the SNA.[1]

12. It is important to note from the outset that the present manual does not present all versions or modules of the SEEA but describes only those that experience in pilot projects has shown, at least for now, to be feasible from a data availability and SNA compatibility point of view. Such compatibility refers in particular to the measurement of the production and consumption of goods and services in market prices or production costs rather than the measurement of their utility or human welfare through contingent and related valuations. As a consequence, and as further elaborated below in section C, welfare effects from environmental degradation, as valued, for instance, by the willingness to pay for the prevention of environmental damage, are not proposed for recurrent accounting in this practical manual; they are left to further research and experimentation, notably, in studies of environmental cost-benefit analysis.

13. The current SEEA will not be the last word on integrated environmental and economic accounting. It is a self-proclaimed interim version of a process not yet complete, and first initiatives of its revision are under way. However, it offers so far the most useful and generally accepted approach to environmental accounting. It is conceived as a multi-purpose system, intended to help in the compilation of relevant data for use in a variety of ways, some of which are elaborated in chapter V. The main purpose of this manual is to explain, in relatively simple terms, both the structure of the SEEA and how its more practical parts may be set up. The purpose of the present chapter is to explain in general terms what the SEEA is trying to achieve in order to provide information on the various policy-relevant uses to which it may be put.

2. The contribution of the environment to economic performance and welfare-generation

14. The purpose of production is to meet human wants and to ultimately increase human welfare. GDP is a measure of production, a significant contributor to welfare, but it is not a welfare measure itself. One reason is that the goods and services produced may affect human well-being in many ways that are not reflected in their market value. Also, many other factors such as natural disasters, scientific discoveries, freedom and security that may have positive and negative effects on human welfare are excluded from measures of economic performance such as GDP (1993 SNA, para. 1.69).

15. The environment is also an important contributor to both production and human welfare, through three broad sets of environmental functions:

(a) Resource functions: the provision of resources, including space for human activity;

(b) Waste absorption functions: the neutralization, dispersion or recycling of wastes from human activity;

(c) Environmental service functions: the maintenance of a habitable biosphere, including the stratospheric ozone layer, climate stability and genetic diversity; and the provision of services for human amenity, recreation and aesthetic appreciation.

These three sets of functions can each contribute to human well-being in a variety of ways, including:

(a) Indirectly, via the economic production system: economic activity generally requires environmental resource inputs and disposal of its wastes into the environment; and

(b) Directly, through the maintenance of human health, depending on clean air and clean water; the provision of wilderness, landscape and countryside for recreation, amenity and aesthetic appreciation; and the maintenance of stable, resilient ecosystems sustaining human and non-human life on earth.

16. Environmental problems arise when the use of the environment for one set of functions interferes with, or prevents, the operation of other functions. For example, using the atmosphere as a dumping ground for chlorofluorocarbons (CFCs) or carbon dioxide (CO_2) damages the ozone shield and reduces climate stability; damming a river to provide hydropower destroys riparian habitations and agriculture and, possibly, a whole range of associated cultural and recreational activities; and the quarrying of minerals or aggregates for construction destroys landscapes of historic, recreational or aesthetic value. It can be seen from these examples that environmental problems occur mainly when the use of the environment to supply resources to, or dispose of wastes from, economic activity reduces its ability to supply other environmental services. Of course, in addition, it may be that environmental problems have a negative impact on economic activity as well.

17. Natural resources are often sold in markets, and so to some extent are reflected in the conventional national accounts. However, the prices of resources may not always reflect the cost of renewing renewable resources, nor the true (full) costs of depletion of non-renewable resources. Natural assets and their services of resource supply, waste absorption and other amenities of the environment

often have no price at all, being treated as "free" goods, so that their use is not fully reflected in the national accounts. The result is that, in presenting the value of the actual monetary transactions in the economy, the national accounts systematically understate or omit the environmental costs incurred by those transactions, in terms of environmental depletion and degradation. GDP and related indicators thus contain a substantial element of consumption of natural capital, which is unaccounted for as a significant cost of production.

18. Of course, GDP also contains an element of consumption of manufactured capital. The national accounts therefore specifically deduct an estimate of its value to arrive at the figure of NDP, which is generally accepted as giving a better indication of the economically sustainable level of production. An important purpose of environmental adjustments to the national accounts is to account for the consumption of natural capital in much the same way as the consumption of manufactured capital.

19. Another question is to what extent measures of natural (non-produced) and produced capital consumption reflect the long-term sustainability of production and income-generation. The sustainability of future economic performance will depend on the different types of capital used and, more specifically, on the extent to which capital can be reproduced or substituted by other production factors. Weak sustainability, assuming the feasibility of full substitutability of produced and non-produced capital, can be distinguished from strong sustainability, allowing for complementarity of certain forms of capital. Weak sustainability would call for ensuring non-decline in the total value of capital, whereas strong sustainability would require the full conservation of non-substitutable capital goods. These questions are further explored below in section C.3 on the uses of the results of environmental accounting.

20. The environment contributes to production and welfare in all societies and economies at any stage of industrialization or development. Resource-dependent activities play a larger role in developing countries than in developed ones, and the policy focus of developing countries might thus be more on natural resource depletion. Industrialized countries, possibly relying on the provision of natural resources from developing countries, appear, on the other hand, more concerned with environmental degradation from pollution. However, industrialized and developing countries have experienced impacts of both resource depletion and degradation in their territories. As for global environmental phenomena, all countries should be concerned about their contributions to these phenomena, in accordance with what has been specified as their common but differentiated responsibilities .[2]

21. Environmental deterioration clearly has an adverse impact on human welfare. As indicated above in the context of GDP measurement, national accounts are not meant to measure welfare. However, they can give insights into welfare generation. For instance, accounting indicators of the depletion or deterioration of stocks of environmental assets, in physical or money terms, provide signals about possible losses of our long-term capability to maintain environmental functions and hence their welfare contributions. Also, the very same indicators may spur policy action, resulting in both the betterment of the environment and an increase in welfare. The emphasis under the SNA on extending asset boundaries to environmental resources reflects concern about the conservation of resource stocks and related national wealth. However, the primary objective of the national accounting system is the compilation of flow accounts, producing principally income and product and the various magnitudes that flow around and within these accounts. These magnitudes include GDP and national income, value added, consumption, savings and investment, exports and imports, the fiscal balance and the balance of payments. These indicators are vital inputs needed for macroeconomic analysis and policy.

22. The adjustment of these accounting aggregates for environmental cost within an integrated system of environmental and economic accounting provides a broadened insight into the workings and outcomes of the economy, focusing on both stocks and flows, and their sustainability (see chap. V). At the same time, these accounts provide sectoral information about the structure of the economy and the composition of environmental assets. Macroeconomic aggregates are thus detailed for different production, consumption and investment processes, permitting the assessment of environmental costs generated by these processes - a prerequisite of altering environmentally unsound production and consumption patterns.

B. Adjusting the national accounts

23. Many methods have been put forward for including environmental considerations in the framework of the national accounts. This manual does not seek to survey them but is mainly devoted to explaining the SEEA as the umbrella system developed by UNSD. As described in chapter II, the flexible, module-structured SEEA permits modification and expansion or contraction of the system according to different country conditions and priorities. In this manner, other frameworks such as input-output matrices or physical and monetary resource and emission accounts can be derived from the overall SEEA framework. It may be helpful, therefore, to first address the issue of environmental accounting in such general terms as would apply to all the systems that have been proposed.

24. Environmental accounting seeks to track environmental resource use, including both resource depletion and environmental degradation over a given period of time, the reporting period, which is usually a year. Figure I illustrates how environmental capacity (ec) may develop over this period, as a result of human activity. The level of environmental capacity is the ability of the environment to perform the environmental functions described above. It is measured by the quantity of resources (as affected by depletion) and their quality (as affected by pollution and other degradation) at the beginning of the period, (as represented by point X). Figure I is stylized and, of course, no aggregate measure of environmental capacity, encompassing depletion and pollution of all kinds, exists or could be meaningfully constructed. However, the concept can be used to illustrate various environmental accounting procedures and their associated methods of valuation. In particular, the figure attempts to pinpoint those concepts and methods that have been found to be readily applicable in field studies of SEEA implementation, which are fully elaborated in chapter III. Also, section C below makes use of this presentation to give a first impression of how the adjusted accounts might be used.

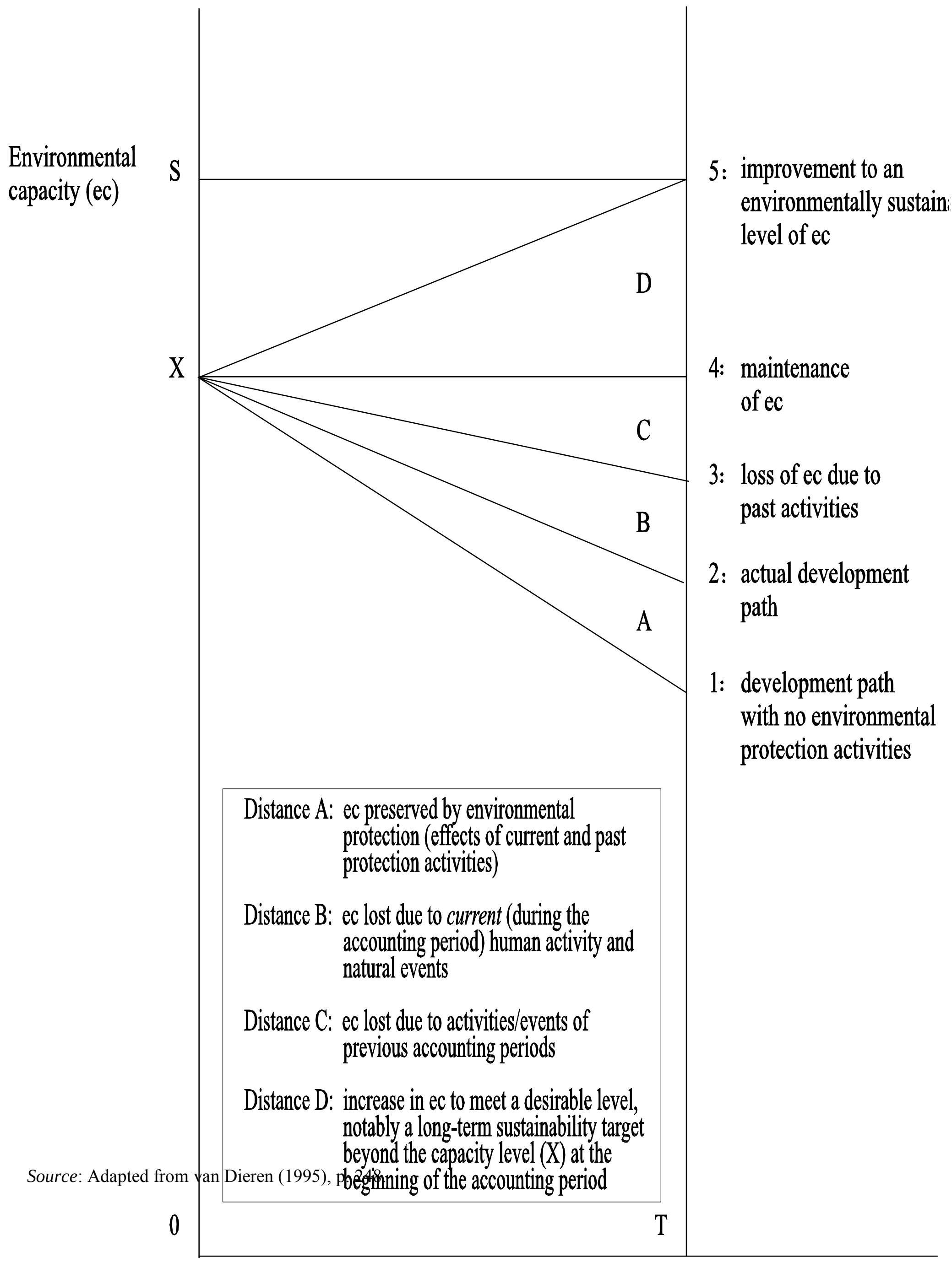
25. In Figure I, the lowest line (to point 1) indicates the hypothetical environmental capacity that would have been achieved had there been no attempts at environmental protection during the accounting period. However, there are likely to have been such attempts, from government, consumers and firms. Point 2 indicates the actual achieved environmental capacity, resulting from these expenditures, with distance A up the axis (between points 1 and 2) being the environmental difference made by the expenditures. Figure I shows that (as is likely) the current environment protection efforts did not succeed in totally protecting the environment, so that some deterioration from X due to activities in the current and past reporting periods took place.

26. Point 3 indicates the level of environmental capacity that would have been achieved if all *current* economic activities, including environmental protection, had resulted in no consumption or deterioration of natural capital. In reality, however, such deterioration from current activities, resulting in depletion and degradation in the current and future accounting periods, can be assumed to have taken place. Part of this loss, in other words, the depletion and degradation from current activities that occurred during the current accounting period (excluding capacity losses in future periods), is indicated by distance B (between points 2 and 3). This distance represents the current impacts of those production and consumption activities that took place during the current accounting period. These activities are measured for the current accounting period in both the SEEA and the SNA.

27. If the environment has indeed been affected by past activities, then it may deteriorate even if current activities do not damage it further. For example, emissions of past accounting periods may take time to accumulate in various environmental media (land, water, air) before they singly or together modify the natural systems. Of course, exposure of human beings to accumulated ambient concentrations in environmental media may occur still later, with health effects to become apparent thereafter. Distance C indicates environmental (capacity) deterioration, over the current period, due only to a legacy of past environmental impacts.

28. Finally, it is possible that the period began from a position of environmental unsustainability, in the sense that the initial environmental capacity X was below some environmentally sustainable level S. In that case, if point 5, at S, represents a sustainability target, then investment in the appropriate environmental capacity corresponding to D may be required for achieving environmental sustainability. The cost of restoring environmental quality to sustainability standards has been referred to as an "environmental debt" incurred by past and present and borne by present and future generations. This concept could be further explored in debt accounting but is not dealt with in this manual, which focuses on non-financial accounts of tangible assets, to the exclusion of liabilities.

Figure I. Development of environmental capacity during the accounting period



Source: Adapted from van Dieren (1995), p. 248.

29. The environmental effects represented by the distances up the vertical axis of figure I are conceived in physical units. However, to integrate these effects fully into the national accounts, it is necessary to ascribe a monetary value to them. There are several possible methods of valuation, as indicated in table 1. The table presents data categories related to the distances/capacities of figure I, distinguishing between physical measurement and monetary valuation. It should be noted that prior physical measurements of pollution (or emissions) and depletion (or natural resource uses) are always required in order to derive a monetary measurement of the costs associated with them. Such physical measurements also serve effectively in environmental management whether or not they are subsequently used to adjust the national accounts. The table also presents different methods of valuation and highlights those that are recommended for application in this manual.

Table 1. Environmental distances and methods of valuation

Environ-mental distance	Description	Units		Method of valuation			
		Physical measurement	Monetary valuation	Damage valuation	Avoidance/ prevention	Restoration	Market (price-based) valuation
A	Actual environmental expenditures	n.a.	+	n.a.	+	+	+
B	Depletion and degradation (emissions) from current activities	+	+	(+)	+	+	+
C	Depletion and degradation (emissions) from past activities	(+)	(+)	(+)	n.a.	(+)	n.a.
D	Restoration to reach sustainability targets	(+)	(+)	n.a.	n.a.	(+)	(+)

Explanations: + signifies that the relevant unit or method of valuation may be calculated for this environmental quantity; n.a. signifies that the relevant unit or method of valuation is not appropriate for this environmental quantity; (+) means that this valuation and/or distance measurement is/are not recommended in the present manual. The highlighted box shows the market and maintenance cost valuations used more frequently in recurrent integrated accounting.

30. The different valuation techniques are described in detail in chapters II and III. Table 1 provides a generic overview of different valuation and cost categories that have been discussed in the literature for monetizing environmental impacts. As already indicated, *damage valuation* using controversial methods such as contingent valuation, travel costs or hedonic valuation, notably in cost-benefit analyses of programmes and projects, is not recommended for application in nation-level accounting. It could be applied in experimental studies, possibly at local levels or for selected sectors, assessing the damage caused by current (distance B) or past (distance C) activities.

31. *Avoidance or prevention costing* is the valuation method recommended for capturing environmental pollution (emissions) in the SEEA s maintenance costing approach. Maintenance costs are those costs that could have been incurred in order to avoid emission of residuals and other degrading impacts of activities carried out during the accounting period. They refer to the portion of distance B, namely, environmental capacity loss (of waste absorption), caused by current economic production and consumption activities (excluding effects from natural disasters which are not costed in accordance with SNA accounting principles). Apart from encompassing these *hypothetical* costs, which could be considered the expense that should have been incurred by those responsible for environmental degradation so as to meet, for example, stricter environmental regulations, avoidance/prevention costs are also part of *actual* environmental protection expenditures (distance A).

32. *Restoration costs* can in principle be applied to all environmental distances. As indicated in table 1, the present manual recommends their use for measuring actual environmental protection (distance A) and the mitigation of environmental impacts resulting from current activities (distance B) if they represent a least-cost solution (lower than avoidance/prevention costs) to the impacts of current activities. The restoration of past impacts or impacts from past activities (distances C and D) are, as already mentioned, inconsistent with current activity costing in national accounts; they are not further discussed here, but could be assessed in special studies of environmental debt.[3]

33. It should be noted that, in the absence of markets for environmental services of waste absorption, the monetary value of actual environmental damage, however calculated, may differ considerably from actual or hypothetical avoidance or prevention costs. This also applies to restoration costs which, in fact, may be infinite if no technical solutions exist to mitigate actual damage or to restore the quality of the environment to desirable levels. Again, hypothetical maintenance (avoidance/prevention) costing is probably the furthest environmental accounting systems can go in providing aggregated (weighted in money terms) information on environmental impacts from economic activities.

34. *Market* (-price-based) *valuation* is the principal valuation of national accounts. Extending the valuation to environmental accounts, using actual or imputed market prices, exhibits the greatest consistency with conventional accounts. Actual environmental expenditures (distance A) can have the character of avoidance/prevention or restoration activities whose purpose is to prevent or reduce pollution, or to reduce the net depletion of renewable resources (for example, planting trees, restocking rivers with fish, plugging leaks in water distribution systems) or of non-renewable resources (for example, investing in recycling, developing substitutes, such as renewable energy to replace fossil fuels). They are accounted as production cost if incurred as intermediate consumption of goods and services or as depreciation of capital goods of environmental protection. As final demand categories, they are outlays by households for final consumption, by enterprises for capital formation, and by the government for both. In all these cases, they are valued at the market price at which these goods and services are acquired.

35. For the measurement of environmental costs of current economic activities (distance B), market valuation is applied in the SEEA to the depletion of natural resources. Depletion of both renewable and non-renewable resources may thus be valued according to all or part of the economic rent of the depleted resource. Techniques proposed for the valuation of the natural resource depletion include the present value (of net returns), net price and user cost methods (see chap. III, box 5). While maintenance costing is the generally applied method for measuring the cost of pollution (emissions) from current activities

(distance B), the market price of pollution permits might become an instrument of market valuation of pollution, once such economic instruments of pollution control are widely applied.

36. Table 1 thus shows which environmental distance categories and corresponding physical and monetary aggregates are discussed in the implementation of those SEEA modules that field experience has shown to be practicable in recurrent integrated accounting. The key valuations of maintenance (avoidance/prevention, restoration) costing and market valuation, as applied to environmental protection and environmental impacts from current economic activities, are shown in the highlighted box of table 1.

37. To summarize, this manual presents the measurement of environmental depletion and degradation as caused by economic activities that took place during the accounting period, in consistency with conventional accounting. It does not attempt to assess the environmental damage from activities carried out in current or past accounting periods or outside national boundaries because of the controversiality of damage valuation and the difficulty of tracing current damage to causal activities. Maintenance costing for pollution and market valuation for depletion of natural resources measure the environmental costs of impacts generated by economic activities during the accounting period. The environmental costs thus measured reflect a loss of environmental capacity and can therefore be considered an extension of the (produced) capital consumption concept into the consumption (or loss) of natural capital. Both types of capital consumption affect the long-term sustainability of production and consumption and are therefore netted out in the calculation of environmentally adjusted aggregates.

38. In figure I, the distances up the vertical axes are conceived in physical units. As discussed in chapter VI, the availability of current, reliable physical data about the environment is essential for effective environmental policy and management, whether or not adjustment of the national accounts is considered. This does not mean that comprehensive data about all aspects of the environment must be generated before the environment can be related to economic activity as described in the national accounts. Indeed, Norway, with a highly developed system of natural resource accounts, which are used regularly and effectively in both economic and environmental analysis, has specifically rejected a comprehensive approach to data collection, preferring to concentrate on those areas that are most important for environmental and economic policy. This is a sensible approach for those countries with small statistical offices just starting out on environmental accounting. However, comprehensive macroeconomic aggregates could not be compiled with such a selective approach.

39. The core of the production (supply and use) accounts in the SNA and SEEA is an input-output structure organized according to a standard industrial classification. For policy purposes, it is necessary to relate the environmental data, whether in physical or monetary units, and whether on resources (an input into industries) or pollution (an output from industries and final demand), to the economic activities causing environmental impacts of depletion and pollution. Such disaggregation of the environmental accounts can be considered even more important, for integrative environmental-economic policies and environmental management, than the calculation of a green GDP.

C. Using the results of integrated environmental and economic accounting

40. The environmental data are the raw material for environmental accounting; they are also an essential foundation for environmental policy generally. When structured as they are in the SEEA and subjected to appropriate valuation techniques, they can be used to supplement the national accounts. The national accounts have become the principal information system for macroeconomic management and policy appraisal. The SEEA, as a satellite system of the 1993 SNA, provides a framework, in which to identify the contribution of the environment to the economy and to indicate whether the environment is being used sustainably, that is to say, in such a way as will enable it to maintain its contribution into the future. To elaborate the policy-relevance of environmental and resource accounting, the various extensions to the conventional accounts, introduced in the previous section, will be further discussed with an indication as to how adjusted indicators are, or might be, used.

1. **Environmental expenditures** (related to environmental distance A in figure I)

41. Many industrialized countries collect data on environmental expenditures, commonly regarded as indicators of environmental commitment. However, a high or increasing level of environmental expenditures would have to be seen in the context of the particular environmental conditions in a country and its effectiveness in tackling these conditions. In most countries, the government, industries and, to a lesser degree, households have been prompted more and more to respond directly to the environmental impacts they cause, according to the polluter-pays principle. It is relatively easy to assess the cost of direct environmental action. However, with the focus increasingly switching from end-of-pipe environmental controls to integrated clean technologies, which are introduced for a range of commercial as well as environmental reasons, it has become increasingly difficult to separate out environmental expenditures as such.

42. Notwithstanding this development, much environmental expenditure can still be clearly identified. The SEEA proposes, therefore, to segregate environmental protection activities and related expenditures in an activity classification developed to this end (see Classification of Environmental Protection Activities (CEPA) contained in annex II). To collect such information from firms, households and government seems important for two reasons, namely:

(a) To remain aware of the *costs* imposed by environmental protection expenditures in different sectors, with their implications for competitiveness and economic performance. These costs show the expenses borne by industries responding to environmental regulations. Environmental policy and management systems seek to reduce these costs by changing the techniques and patterns of economic activity;

(b) To remain aware of the *opportunities*, as well as the costs, of environmental protection: one sector's costs is another's revenue, and the environmental protection sector is widely forecast to be one of the fastest-growing business sectors in the coming years. Information on environmental protection expenditures enables policy makers to see to what extent domestic business is benefiting from this business growth, and to what extent the business is going to foreign competitors.

2. **Accounting for loss of environmental capacity** (environmental distances B and C in figure I)

(a) Depletion of natural resources

43. Those countries whose economies are heavily dependent on the contributions made by natural resources, such as timber, fish, agricultural products, minerals and touristic attractions, have particularly good reasons for accounting for them carefully. To treat the income from natural resources without accounting for the permanent loss of their income-generating capacity and of other amenities derived from their use is to commit a fundamental error of economic analysis with potentially far-reaching implications for future wealth and prosperity. In fact, accounting for the consumption of produced wealth (capital) is already common practice in national and business accounting and thus needs to be extended to "natural capital". A good number of studies have now been carried out, especially in developing countries, indicating the extent to which unadjusted national accounts differ in their assessment of a country's economic performance. A selected list of studies on integrated environmental and economic accounting can be found on the following web site: www.panda.org/resources/publications/sustainability/mpo/accounting/studiesindex.htm.
For sound economic management, the depletion of natural resources must come to be regarded as capital consumption rather than as added value.

44. The 1993 SNA (chap. XII) already accounts for the use and depletion of "economic" natural capital, albeit outside the production accounts, in its (tangible) asset accounts. As elaborated in chapter II of this manual, however, the SEEA regards such depletion as production costs and moves these costs into the production and income-generation accounts. In this manner, that is to say, by making an allowance for the consumption of natural economic capital, a broader notion of cost and capital maintenance, beyond replacement of produced or fixed capital, is introduced in the SEEA for a better assessment of the economic sustainability of production.

(b) Pollution, environmental degradation (emissions)

45. As has been seen, the costs of pollution and other environmental degradation are not as easy to calculate as the costs of depletion, because they tend to be non-market, unpriced effects of economic activity. The felt impacts of these negative effects on human health and welfare are none the smaller for their being market externalities, and it is important for policy makers to obtain at least an indication of the extent of the underlying physical impacts and their economic significance (in terms of corresponding maintenance cost) and to connect them with the economic activities that give rise to them. As with natural resources, it is desirable for the costs associated with pollution and environmental degradation (emissions) to be allocated in the accounting structure to the economic sectors which are responsible for them, according to the accounts' input-output framework.

46. The estimates obtained for the B and C environmental capacity changes for both natural resource depletion and pollution can alert policy makers to the changes in environmental capacities that are of high policy-making significance. The valuation of these estimates enables them to be further used in assessing environmental costs and adjusting the national accounting aggregates, modelling environmental policy and improving project appraisal. These uses will be discussed in turn.

3. Adjusted accounting aggregates

47. The level of a country's GDP relative to other countries, its breakdown by economic sector, and its rate of growth over time are still regarded as the most important indicators of national economic performance and structural change. Yet, as has been seen, where these indicators omit the environmental impacts of economic activity, they can overstate that performance and provide a distorted picture of production and consumption patterns.

48. Gross income or product, as conventionally measured, does not indicate an economically sustainable level until it has been pruned for capital consumption. The widespread use of GDP for estimating economic growth and for cross-country comparisons is justified, however, on various grounds, including the fact that depreciation of produced assets is of a limited, and frequently non-ascertained, magnitude. Overlooking this, it is thought, does not affect the growth rates or meaningful international income comparisons. Environmental deterioration, which may be viewed as a charge against gross income, however, may vary considerably from country to country and from year to year and cannot be presumed to be of a standard size for either temporal or geographical comparisons. Regarding the costs of depletion and pollution as consumption of natural capital suggests that they may be subtracted, along with the consumption of produced capital, from GDP and gross national income (GNI) to arrive at environmentally adjusted net domestic product (EDP) and national income (ENI) figures.

49. Such adjustments will give a more realistic indication of wealth creation and consumption of goods and services, and, of course, where environmental costs are growing faster than GDP, EDP growth rates will be below those of GDP. Accounting for the costs of consumption of natural capital yields not only an EDP but also an aggregate of environmentally adjusted (net) capital formation (ECF). Calculations have also been made of the counterpart of ECF, namely, "genuine" or net saving (World Bank, 1995).[4] Positive net capital formation is essential for the maintenance of the current level of production, or economic sustainability. In situations where loss of environmental capacity has occurred, ECF, rather than unadjusted net capital formation, is the appropriate indicator for showing whether such sustainability has been achieved.

50. However, the characterization of sustainability in this way may assume full substitutability between natural capital and manufactured capital, something which should not be taken for granted.[5] A cautious interpretation of measures of genuine saving or ECF would be that, where they are negative, they are certainly indicative of economic unsustainability, representing dissaving or disinvestment; where they are positive, they show only that calculated environmental losses are less than net saving/investment. Whether this implies economic sustainability or not depends, as already noted, on whether the natural capital lost is fully substitutable with the investment in manufactured capital, or whether its loss may constrain production or welfare in the future. Current lack of understanding about the details of ecosystem functions means that unless substitutability in any particular case can be convincingly demonstrated, it would be prudent, and in general consistent with the precautionary principle, not to assume it. This means that the value of genuine savings or ECF lies more in its being able to convincingly demonstrate unsustainability than in its acting as proof of sustainable development.

51. Another point that should be noted is that monetary figures for depletion depend on two quantities: the physical quantity of resource use, and the resource's market price. Market prices for resources, like any price in a far-from-perfect competition situation, can change markedly from year to year for reasons unrelated to their physical scarcity. Therefore, it is quite possible, when the physical use of a resource has gone up but its price has gone down, for the costs of depletion to be shown as

decreasing despite the fact that more of the resource has been extracted. In order to ensure that perceptions of depletion are not misled by such seemingly perverse results, physical depletion figures should always be quoted as well as their monetary value. Measurements in constant prices and revaluation (capturing holding gains and losses from price changes: see chap. III) aim at presenting volume rather than value changes in produced and non-produced (natural) assets.

52. The compilation of flow accounts of natural resource use and depletion and the corresponding adjustment to income estimates will be the greatest boon for the developing countries, which rely on the exploitation of their minerals, soil, water, fisheries and forestry stocks for the generation of a substantial proportion of their income. Where asset sales are entered wrongly in the production accounts, production is overestimated, and economic policies are guided by wrong estimates. On the other hand, the valuation of pollution remains controversial. Thus some countries, mainly industrialized, have compiled physical indicators of residuals linked to polluting economic activities, without attempting their valuation. This is the approach of the Netherlands National Accounting Matrix including Environmental Accounts (NAMEA), propagated in particular by the Statistical Office of the European Communities (Eurostat). As a result, monetary accounting aggregates are not adjusted for environmental costs in this approach.

53. The treatment of environmental degradation and depletion as consumption of natural capital has implications for other accounting aggregates apart from GDP and net investment/saving. Perhaps the most important of these other aggregates is a country's international balance of payments. Income (value added) derived from the production of exports is, of course, part of GDP, while the difference between exports and imports is a major component of the international balance of payments or "current external balance". Whether this balance is positive or negative has important implications for a country's exchange rate, international creditworthiness and whole international financial profile. Under current accounting conventions, which count all net revenues from the liquidation of natural capital as income, a country that was reliant on the export of natural resources would be giving a very misleading picture of its economic health and prospects. It is therefore important to identify in the external accounts for goods and services those exports of natural resources that are based on non-sustainable extraction. This would give a very different signal to the international financial community, indicating the need for the country to add more value to its natural resources, and extract and use them with greater environmental efficiency.[6]

54. Reducing GDP by the amount of natural capital consumption would also affect those ratios that commonly have GDP as a denominator to such numerators as domestic or foreign debt, debt-service obligations, the balance-of-payments deficit, the fiscal deficit, savings and investment, public expenditures, and the money supply. It would also suggest a different approach in the design, for example, of structural adjustment programmes. Those programmes would come to place a greater emphasis on maintaining and enhancing the natural capital stock, as well as increasing the value added to such extraction as did occur.

55. The capability of environmentally modified accounts to provide adjusted indicators in a detailed breakdown by economic sectors (and not only at the macroeconomic level) should not be overlooked. Structural distortions in the economy from underpriced use of environmental resources at meso- and microeconomic levels can be addressed by full-cost pricing, that is to say, environmental cost internalization in the budgets of households and enterprises. Given the inefficiencies of command-and-control measures in environmental protection and natural resource conservation, the application of market

instruments has been generally advocated. Economic instruments of cost internalization include effluent charges, user taxes, tradable pollution permits, deposit-refund systems and so forth. They are usually applied to those who can be held responsible for natural resource depletion and environmental degradation, according to the user-/polluter-pays principle. Environmentally modified accounts can help to define those instruments and measure the appropriate level of fiscal incentives (subsidies) or disincentives (effluent charges and so forth). Such information on the level of cost to be internalized can be considered as the initial data input into models assessing the ultimate effects of cost internalization.

56. Accounting for wealth and its distribution provides measures of the availability of productive and financial capacities, and of the concentration of economic power within and among nations. When natural assets are included in the accounts, it can also give insights into issues of environmental distribution between current and future generations. The focus of economic concern seems to have shifted in the past between stock (wealth) and flow (income) analysis. The explicit inclusion of stock/asset accounts in the (1993) revision of the SNA seems to have been prompted by increased attention to aspects of non-produced human wealth, notably natural and human capital.

57. Several avenues of analytical and policy use of natural wealth indicators can be identified (Bartelmus, 1996):

(a) Ownership and property rights: generation of individual property rights, or clearly defined common-property rights, for open-access natural assets is intended to facilitate greater care and more efficient use by the owners;

(b) Distribution and equity of ownership: equity aspects of ownership allocation include not only intra-national but also international aspects (for example, for global commons or internationally shared resources), as well as inter-generational ones, that is to say, wealth to be shared with future generations;

(c) Wealth and production: the analysis of the role of natural capital in economic production and growth would have to consider short-, medium- and long-term productivity effects of capital availability and substitution (notably of natural capital with produced and human capital);

(d) Financial aspects of wealth accounting: the notion of environmental debt and debt servicing for restoring the environment to levels owed to future generations might be usefully explored in expanding the financial accounts and balance sheets of the 1993 SNA. In addition, portfolio management of financial and tangible, including natural, wealth has been proposed as a source of development finance (World Bank, 1997).

58. These adjustments - to GDP and associated ratios, investment and net savings, and the current external balance - indicate how macroeconomic perceptions may change with a correct treatment of natural resources in the national accounts. The implications of such changes in the accounting system may be profound. They are changes that will enable policy to be far more sensitive to the underlying realities of wealth creation and loss than it is at present.

4. Modelling of environmental and economic policies

59. Modelling of policy proposals in any field requires that the initial situation on which the policy is to act be understood in terms of cause and effect. The modelling of the policy can be an important means of estimating the impacts of the policies, in terms both of the desired outcomes and of side effects.

60. The discussion and implementation of environmental policy are increasing in profile and importance in practically all countries. Of major interest in connection with such policy are its effects on the economy. Equally important is the measurement of the impacts of economic policy on the environment. Both effects are further discussed in chapter V. An integrated environmental and economic accounting system is of fundamental importance in predicting these impacts and repercussions. Such an accounting system, detailing the material and energy inputs into the economy, and the various ways they emerge as wastes from the economy, provides the essential framework for modelling the effect of any environmental policy on the whole economy.

61. It has already been noted that the basic framework of the supply and use accounts of the SNA is an input-output structure in which the outputs of industries are divided between inputs into other industries (as intermediate goods and services) and final demand. Such an accounting format yields important insights into the actual structure of the economy. When used for modelling, it enables the full effects of the policies to be estimated, because changes in any one sector can feed back through the input-output structure to affect the economy as a whole, as they do in real life.

62. This characteristic of input-output systems, namely that changes in the whole system can be derived from changes to any part of it, is essential to understanding the effects of environmental and economic policy on the environment and the economy. For instance, a particular environmental policy may be directed at particular economic sectors that are the sources of pollution and depletion, or that are expected to be the sources of environmental improvement. The first-round effect of the policy on the relevant sectors will be only part of the total effect of the policy, and may not even be the most important part, once the policy has fed through to the economy as a whole. Furthermore, different effects will be felt in different time periods and may have repercussions beyond a country's borders. Of course, and as indicated above, input-output analysis can also be usefully applied to assessing policy responses that change exports and other final demand categories such as consumption and investment.

63. These considerations argue very strongly for the satellite environmental accounting system that is linked to the national accounts having the same input-output structure and, as far as possible, the same concepts and definitions of its aggregates. New rows can be added for the use of non-produced environmental goods, such as air, water, soil and oil reserves, that feed into primary economic sectors, and new columns can be added to indicate the emissions of matter and energy to air, water and land from these and other sectors. These material inputs and outputs can be in physical and/or monetary units. In a complete accounting system, there would be a mass/energy balance between the material/energy inputs and outputs, just as there is an identity between income, expenditure and value added in the current national accounts. The modelling of environmental and economic policies in such a system would then reveal the impacts of these policies both on environmental quantities and on economic output and input, by sector and for the economy as a whole. The links between input-output tabulations and environmental accounts, referring in particular to extended accounting matrices such as the Netherlands NAMEA implemented by various European countries, are elaborated in chapter II, section C.

64. The construction of a complete environmental input-output system to enable modelling of the whole-economy effects of a wide range of environmental and economic policies is a daunting task, but it does not have to be achieved all at once. It makes sense for a country to start with the depletion, pollution and environmental degradation that are of most importance to it in its current situation. If it is a major producer of oil or other minerals, then their depletion should be an initial focus. If timber or fish production is important, then the size of the stock, the sustainable yield and current harvests in relation to this should be of concern. If emissions to air (for example, CO_2), to water (by industrial discharges) or to land (by hazardous waste or improper agricultural practices) are causing serious impacts on human health and the environment, then these should be tackled. Priority-setting may not be easy but it is essential, especially if resources are limited. Areas need to be tackled methodically and systematically, that is to say, the information should be generated in such a way as to render it compatible with the input-output structure of the national accounts.

5. Improved data collection and project appraisal

65. A commitment to supplement the national accounts with environmental data, backed by political will and the allocation of adequate, but not necessarily substantial, resources, would set in train a major process of data generation with regard to the natural resources and environments of interest. This would in turn increase national understanding of these environments and of their relationship to economic activities. This would in turn develop skills of environmental appraisal which are in increasing demand for the planning and assessment of projects or programmes likely to have environmental impacts.

66. Environmental impact assessment as a technique is now mandatory in many countries and is being increasingly practised in most. Its purpose, of course, is to maximize the benefits of projects by ensuring that *all* their impacts, positive and negative, are both understood and factored into the decision-making process. Of course, the costs of depletion and pollution from a project should be accounted as costs, rather than counted as value added (in the case of depletion) or ignored (in the case of pollution), as is usually the practice.

67. Several of the skills (notably for valuation of environmental impacts) required for generating environmental data for the national accounts, are also appropriate for use in environmental impact assessment and vice versa. Of course, impact assessments are more in the nature of prediction modelling, assessing the potential environmental cost of a project, than presenting an ex post description of depletion and degradation that has actually occured. Also, as already discussed, some of the more controversial valuations, notably of environmental damage or benefits, may be usefully applied in the narrow project context but are hardly applicable in the *national* accounts system.

68. By showing commitment to the extension of the national accounts to environmental accounts and developing those skills and data-collection capacities, a country will send positive messages to the international investor and aid communities: first, that the country is determined to give substance to its commitments to sustainable development, and second, that the country is prepared to invest in the human capital that is necessary for environmental appraisal.

D. Conclusions

69. The concept of sustainable development has played an important organizing role for environmental policy following the 1992 Rio Summit. It remains to be seen if it can also provide a framework for environmentally sound and socially acceptable economic policy. Much of the success of this new paradigm will depend on the extent to which it can be made operational. Operationality will depend on developing an information system that both identifies the important environmental determinants of sustainability and relates them systematically to the economic activities that are affecting them. Chapter V will explore how integrated environmental and economic accounting can assist in formulating and evaluating environmental and economic policies aiming at sustainable development.

70. Of course, merely extending the national accounts to include the environment is not a panacea for the problems of the environment or sustainable development, but it is an essential first step towards the systematic assessment and resolution of those problems. It will not be possible for economic activity to be made compatible with, and supportive of, a sustainable natural environment until the economic and

natural systems are linked by a structure of information that enhances the understanding of both. Such an information structure would then enable the impact of policies in any sector of either system to be assessed with regard to their implications for the whole. That is the underlying driving purpose of the extension of the national accounts to include the environment and, in particular, of the SEEA, which is the subject of most of the remainder of this manual.

Notes

1. Other more controversial versions or modules of the SEEA do expand the production boundary for the incorporation of environmental services as outputs of nature and for the production of household (domestic) services. They are not further discussed in the present manual (see chap. II, sect. B).

2. Principle 7 of the Rio Declaration on Environment and Development (United Nations, 1993b, resolution 1, annex I) adopted at the Earth Summit, states that ... In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

3. Accumulated (restoration) costs may assess how far a nation has drifted away from a sustainable development (Hueting, 1989, p. 37). The concept of environmental debt has been discussed by the National Institute of Economic Research and Statistics Sweden (1994), p. 40.

4. The difference between environmentally adjusted (net) capital formation (ECF) and genuine saving is that the latter excludes possibilities of financing capital formation through capital transfers from abroad. However, both indicators are, in principle, modified by the same amount of environmental cost. It is another question whether estimates of human capital formation, for example, in the form of expenses for education, should be added to genuine saving and thus de facto deducted from public and private consumption, as suggested by the World Bank (1997). The complex topic of human capital includes much more than just education and is not discussed here further; it is a topic of further research by national accountants in UNSD.

5. Note that different valuations may imply different sustainability concepts. Maintenance costing of the preservation of natural assets assumes a strong sustainability concept that does not allow for substitution. On the other hand, valuations that aim at income maintenance, such as the user cost allowance, are used to indicate overall sustainability of the total value of different kinds of assets (even of financial assets), reflecting a weak sustainability concept (Bartelmus, 1998). For economic assets, the different categories of sustainability are significant for ex ante analysis of future economic growth. In national accounting of past economic performance, and in the absence of replacement values of natural assets depleted or degraded, the future (discounted) loss in income-generation capacity is the allowance to be costed as capital consumption - irrespective of whether this allowance is reinvested or not, and where.

6. The present description of the SEEA also includes cross-boundary pollution as "transfers" from and to the "rest of the world" (see figure VII, below). Those transfers would affect the current external balance (but not the external balance of goods and services) and thus national (disposable) income (but not gross domestic product/environmentally adjusted net domestic product (GDP/EDP)).

CHAPTER II

THE SYSTEM OF INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING (SEEA): OVERVIEW

A. Objectives and structure of the SEEA

71. Conventional accounts address the role of the environment in economic performance in part only. The SEEA supplements the SNA by separately identifying expenditures related to environmental issues and by incorporating environmental assets and changes therein in the supply, use and asset accounts of the SNA. This is illustrated in figure II where environmental extensions of the conventional accounts are presented as shaded blocks. The figure shows how the horizontal supply and use accounts overlap with the vertical asset accounts, where supply and use constitute part of the changes in stocks of the assets.

72. In the conventional accounts, these overlapping flows and stocks consist of:

(a) Capital formation , that is to say, the acquisition less disposal of fixed assets and changes in inventories;

(b) The wear and tear of fixed assets in production, in other words, consumption of fixed capital .

73. As illustrated in figure II and further elaborated in chapter III, the SEEA incorporates environmental concerns mainly by:

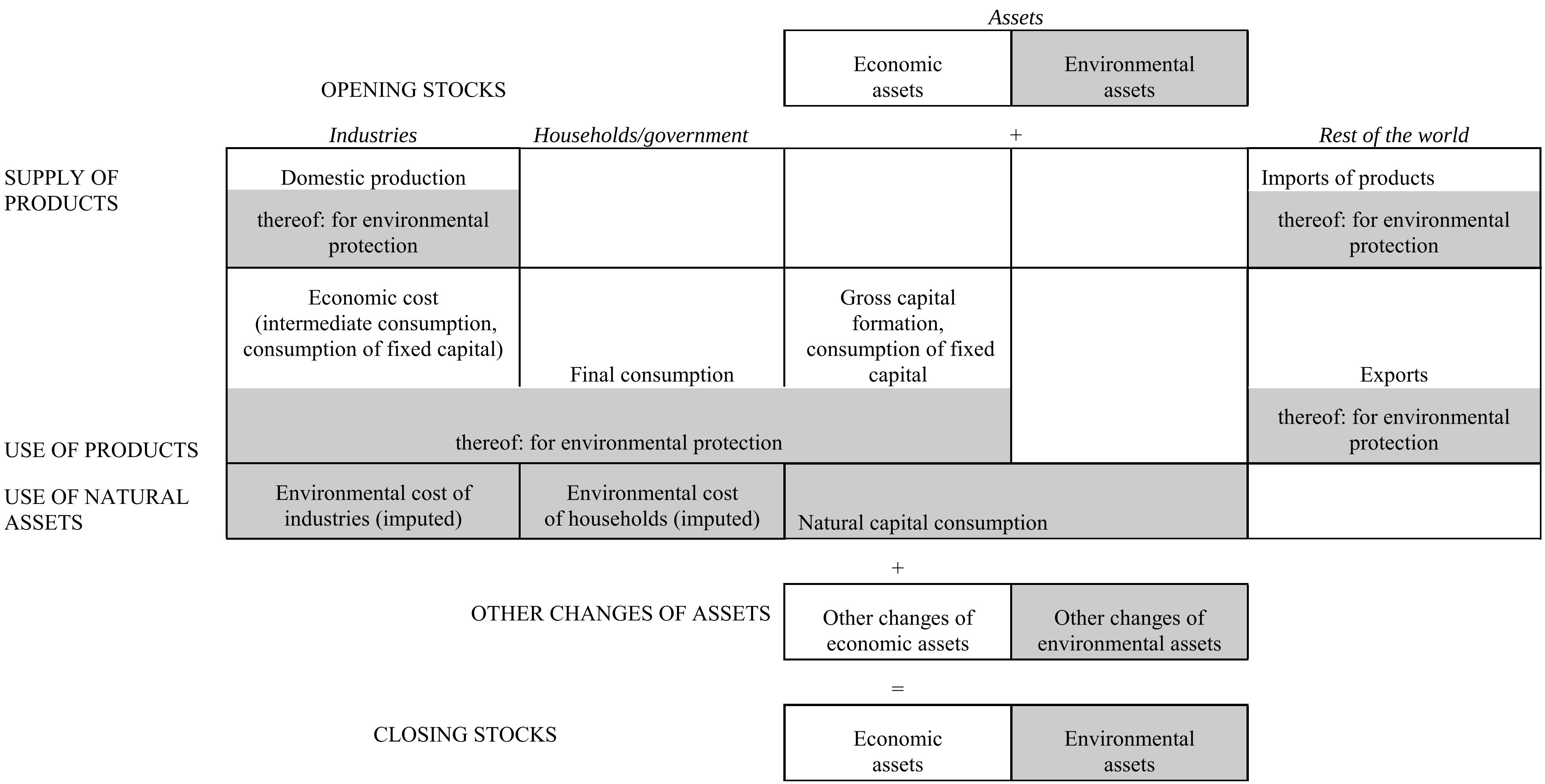
(a) Segregating and elaborating all environment-related flows and stocks that are already included in the conventional accounts. The objective is to present separately environmental protection expenditures;

(b) Expanding the asset accounts beyond economic assets to include environmental assets and changes therein;

(c) Introducing impacts on natural (economic and environmental) assets, caused by production and consumption activities of industries, households and government, as environmental costs incurred by these activities.

74. Environmental protection expenditures have been regarded as part of the costs necessary to compensate for the negative impacts of economic growth, in other words, as "defensive expenditures" (Leipert, 1989). These expenditures correspond to, but do not directly measure, the environmental capacity attained through actual environmental protection measures during the accounting period, as represented by distance A in figure I; they do not measure the actual effects of these measures on the environment. Further expenditures to avoid or mitigate effects on human health and well-being from environmental deterioration can also be considered defensive . Owing to problems of definition and measurement, these expenditures are not assessed in the SEEA.

Figure II. SEEA: flow and stock accounts with environmental assets



75. The distinction between economic and additional environmental natural assets is at the heart of environmental accounting. Box 1 discusses in some detail the SNA definition of economic assets and the (implicit) SEEA definition of non-economic environmental assets. Economic assets supply the economy with natural resources or raw materials for use in production and consumption processes. Environmental assets provide environmental services such as waste absorption, habitat, flood and climate control and nutrient flows. Environmental asset accounts include the physical accounts of ecosystems. The monetary valuation of stocks or inventories of ecosystems and their components is not recommended in this manual because of the controversial valuation techniques required for determining option or existence values for these environmental assets. Physical and monetary emission accounts by media (land, air and water) are calculated and linked to the production accounts.

76. The SEEA considers the depletion and degradation of natural assets as costs to be accounted for in the production accounts. This constitutes a major deviation from the conventional accounts where the depletion and degradation of (economic, non-produced) natural assets are recorded as other changes in volume in the asset accounts. These impacts and corresponding costs, together with the degradation of environmental assets, are therefore shown in shaded boxes in figure II.

Box 1. Economic and environmental assets: definition and classification

The *economic asset* definition of the 1993 SNA already includes all natural assets (a) over which ownership rights are enforced by institutional units, individually or collectively, and (b) from which economic benefits may be derived (1993 SNA, para. 10.2). These natural assets can be produced, for example, agricultural products or non-produced, for example, land, mineral deposits and fish in lakes or the ocean. Changes in the availability of economic, non-produced assets, resulting from depletion or degradation, are accounted in the SNA as other changes in volume . In the SEEA, they are shifted as cost into the production and income-generation accounts.

Implicitly, *environmental assets* are all those non-produced natural assets that function as providers not of natural resource inputs into production but of environmental services of waste absorption, ecological functions such as habitat and flood and climate control, or other non-economic amenities such as health and aesthetic values. Since natural assets can exhibit economic and environmental functions simultaneously, both economic and environmental assets are contained, but not separately distinguished, in the SEEA classification of non-financial assets (CNFA) (see annex III).

77. One should note that these environmental costs are imputed in the sense that they are not actually incurred by industries and households. They are, at least in part, so-called social costs that were *caused* by economic agents but were not *borne* by the same agents. Even where those costs were actually accounted for by individual enterprises, as may be the case for the owners of run-down mineral deposits, they would still not be accounted as cost in the conventional national accounts, thus inflating their aggregates of value added, income and production. The SEEA corrects this by fully costing environmental depletion and degradation (emissions) and incorporating their value as a change in value of environmental assets in the asset accounts, an approach analogous to the treatment of capital consumption of economic assets.

78. Also in consistency with the conventional accounts, changes in environmental assets that cannot be attributed to production and consumption, such as impacts of natural disasters and natural growth, are

recorded as other changes in volume of assets . In this manner, only the asset boundary of the SNA is changed, while the production and consumption boundaries are generally maintained (except for some alternative versions of the SEEA).[1] This is to ensure, as much as possible, comparability of the results of environmental and conventional accounting.

79. As a result of the above-described incorporation of environmental costs, and natural assets and asset changes, the following objectives can be met through integrated accounting by the SEEA:

(a) Assessment of environmental costs: the SEEA expands and complements the SNA with regard to costing:

(i) The use (depletion) of natural resources in production and final consumption;

(ii) The impacts on environmental quality (emissions) resulting from pollution by production and consumption activities.

These costs correspond to environmental capacity distance B (environmental capacity lost from current activities, described in figure I and table 1 of chap. I), except for the cost of natural disasters recorded as other volume changes according to SNA conventions;

(b) Linkage of physical accounts with monetary environmental accounts and balance sheets: physical natural resource accounts cover the total stock or reserves of natural resources and changes therein, even if these resources are not (yet) affected by the economic system. Natural resource accounts provide the physical counterpart of the SEEA's monetary stock and flow accounts;

(c) Accounting for the maintenance of tangible wealth: the SEEA extends the concept of capital to cover not only human-made capital but also non-produced natural capital. Natural non-produced capital includes renewable resources such as marine resources or tropical forests, non-renewable resources of land, soil and subsoil assets (mineral deposits), and cyclic resources of air and water. Capital formation is correspondingly changed into a broader concept of capital accumulation ;[2]

(d) Elaboration and measurement of environmentally adjusted aggregates: the consideration of the costs of depletion of natural resources and environmental degradation from emissions allows the calculation of modified macroeconomic aggregates in different SEEA versions. Indicators thus compiled include, besides the above-mentioned capital accumulation, environmentally adjusted net value added and domestic product (see sect. E below).

B. Building-block approach: SEEA versions

80. The SEEA has been designed with a high degree of flexibility without compromising on comprehensiveness and consistency. The purpose is to facilitate choices from a broad range of theoretical approaches for the adaptation of the system to national priorities, environmental concerns and statistical capabilities. This is achieved by means of "versions" or modules dealing with the above-described objectives of the SEEA through a logical sequence of implementation activities. As shown in figure III, the SEEA thus consists of five major versions that expand increasingly the SNA concepts and system boundaries.

81. Version I is the basic national accounting framework of the SEEA, obtained through reformatting the SNA s supply, use and asset accounts. These accounts are modified to present in detail environmentally relevant economic activities. Other activities that do not affect or are not affected by the environment would be shown at an aggregate level only.

82. Version II describes those flows and stocks that are already part of the conventional accounts but not separately identified in those accounts. It sets out from the supply and use tables and non-financial asset accounts of version I. Environmental protection activities that prevent and mitigate environmental deterioration are shown in a classification specifically developed for these accounts, the Classification of Environmental Protection Activities (CEPA) (see annex II).

83. Version III combines concepts of material/energy balances and natural resource accounting to present the physical counterpart of the monetary SEEA, version IV. It indicates also possible extensions of this counterpart presentation by fully developing materials/energy balances and natural resource accounting, as described in section C below.

84. The fourth version of the SEEA introduces different approaches for estimating the value of natural assets and the imputed costs of their uses. Three different valuation methods (further discussed in sect. D) are presented as different modules of version IV:

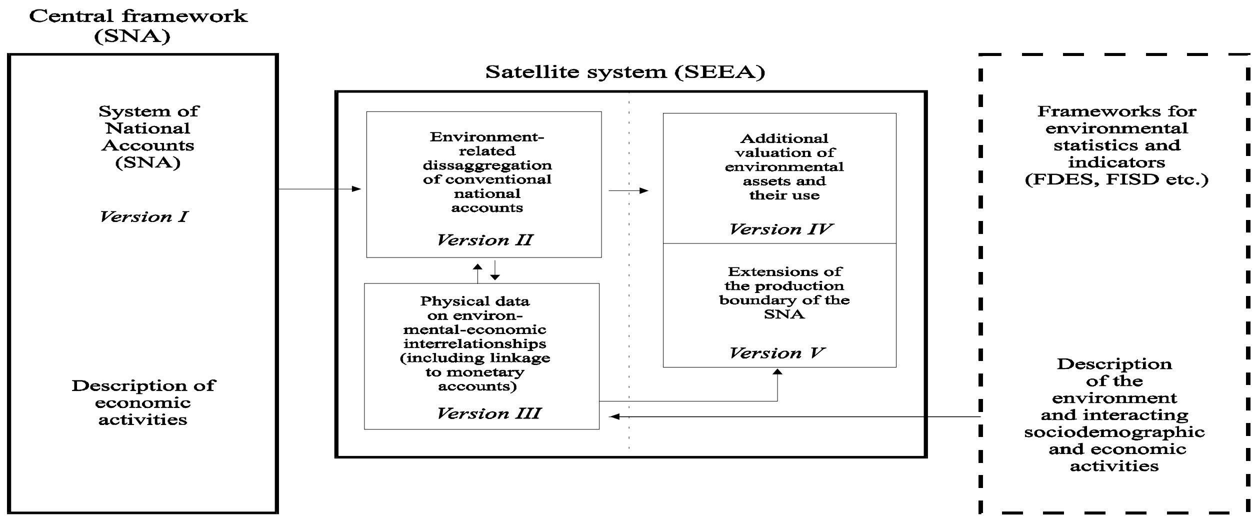
(a) Market valuation according to the principles of non-financial asset accounting in the SNA (version IV.1);

(b) Maintenance valuation which estimates the cost necessary to sustain at least the present (or a feasible standard) level of natural assets (version IV.2);

(c) Contingent and related demand-side valuations for estimating the (damage) value of the loss of consumptive services of the environment, that is to say, the damage borne by individuals (version IV.3).

As a result of these valuations, environmentally adjusted indicators can be compiled as discussed in section E. Version IV.3 is difficult to implement in practice, as the valuation method suggested

Figure III. SEEA versions and links to the 1993 SNA



Source: United Nations (1993a), figure II.

is highly controversial. Moreover, the damage caused exclusively during the accounting period is hardly identifiable from the total damage borne during this period.

85. The modules contained in version V represent further extensions of the production boundary of the SNA. They refer to the analysis of household production and its impacts on the environment and human welfare, applying the three basic valuation methods, mentioned in the previous paragraph, to develop versions V.1, V.2 and V.3. A further expansion of this boundary is achieved by introducing the production of spatial and related services of land (version V.4) and of consumer services related to physiologic, recreational and other environmental amenities (version V.5). A last version (V.6) externalizes internal (ancillary) environmental protection activities in a broader concept of output and production, based on version II.

86. Version V and its modules have not been applied, except for the externalization of ancillary services for environmental protection, in country programmes of SEEA application. The reason is the existence of methodological and data problems; version V is therefore not further described here. The present manual thus deals only with versions I, II, III, IV.1 and IV.2 in its core chapter III.

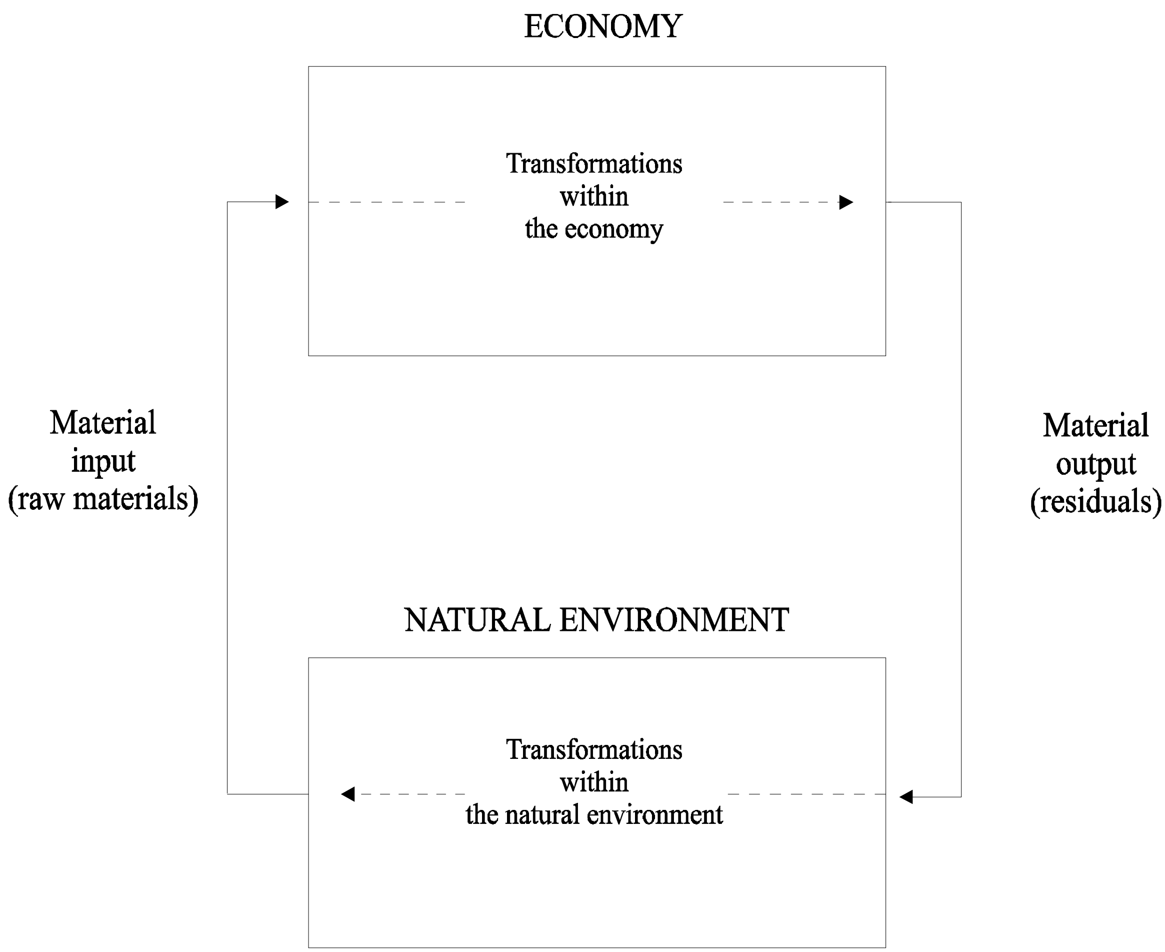
C. Integrating physical and monetary accounts

87. Underlying the monetary stocks and flows of the economy are physical assets and commodities. Environmental statistics and environmental and sustainable development indicators attempt to capture the interaction between the economy and the environment in mostly physical terms.[3] Figure III above illustrates the role of environmental statistics and indicators as producers of the basic data for integrated environmental and economic accounting.

88. Figure IV shows the environment-economy interactions in a simplified format as physical flows of natural raw materials and residuals (pollutants) between the economy and the environment. The figure also indicates intra-economy and intra-environment processes, or "transformations", which are assessed by material/energy flow accounts and ecological statistics. The SEEA devotes a separate module (version III) to describing the linkages between physical databases and the national accounts framework. Linkage is achieved by molding the databases into a physical counterpart of the SEEA.[4]

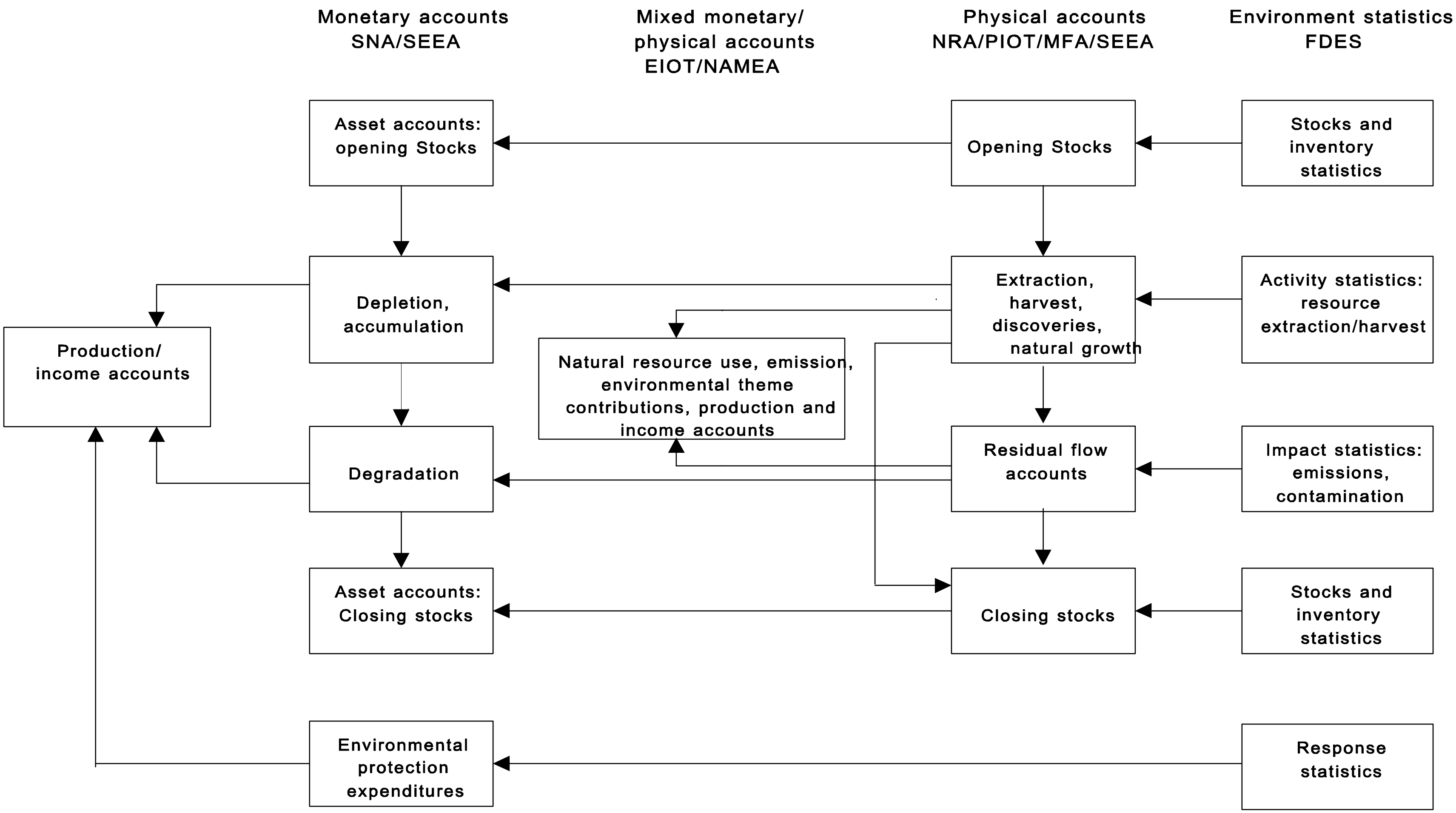
89. Figure V describes the links between environment statistics, physical, mixed physical-monetary, and monetary accounts. Environment statistics provide the basic data mostly to physical accounts which in turn are the basis for valuation in monetary accounting. An exception is (monetary) environmental protection statistics which feed directly into the monetary accounts. The figure also distinguishes between physical and mixed physical-monetary accounts. This is in recognition of the increasing interest in linking physical flows of residuals to the causing economic activities, for instance, in the Netherlands NAMEA, as well as in purely physical material flow accounts (MFA) providing an indication of environmental pressures from the economy.

Figure IV. Interrelationships between the economy and the natural environment



Source: United Nations (1993a), figure V.

Figure V. Linking statistics and environmental accounts



Source based on Bartelmus (1997, p. 116)

Explanations:

ECF:	Environmentally-adjusted net Capital Formation
EDP:	Environmentally-adjusted net Domestic Product
EIOT:	Extended Input-Output Table
EVA:	Environmentally-adjusted Value Added
FDES:	Framework for the Development of Environment Statistics
MFA:	Material Flow Accounts
NRA:	Natural Resources Accounts
PIOT:	Physical Input-Output Table
SEEA:	System of integrated Environmental and Economic Accounting
SNA:	System of National Accounts

90. The three main approaches that have been advanced in physical accounting may be described as follows:

(a) Natural resource accounts (NRA) describe the stocks and use of different natural resources during the accounting period in a fairly aggregate fashion. They were pioneered by Norway (Alfsen, Bye and Lorentsen, 1987) and further developed by France as natural patrimony accounts (Theys, 1989). NRA are measured in different units (weight, volume, energy equivalent, area) and are largely consistent with the SNA asset accounts. They can be expressed in monetary units, too, and have thus been developed as an integral part of the SEEA;

(b) Physical input-output tables (PIOT) can be extended to include material flows from, and back into, the environment, presenting these flows in great sectoral detail (Stahmer, Kuhn and Braun, 1998). Providing a balance of total material inputs and outputs, these tabulations can also be interpreted as material/energy balances (MEB);

(c) Material flow accounts (MFA) attempt to measure the material throughput through the economy as a measure of the sustainability of economic activity in non-monetary terms (usually weight). MFA describe the extraction, production, transformation, consumption and accumulation of chemical elements, raw materials or products (Steurer, 1997). They may include ecological rucksacks of hidden material flows that are not physically incorporated in a particular output but are required for the production of goods, their use, and the recycling and disposal of wastes (Spangenberg and others, 1999).

The present manual of SEEA implementation does not further discuss PIOT and MFA because of their considerable additional data requirements, and focuses instead on NRA as a major component of the SEEA in physical and monetary terms (see chap. III, below).

91. Mixed monetary and physical accounts have been propagated in particular through the Netherlands NAMEA. Linking physical environmental indicators with monetary aggregates of production and consumption in a detailed breakdown by industries and final consumption is considered the furthest environmental accounting can go in terms of monetary valuation (Keuning and De Haan, 1998). Depending on the more or less detailed breakdown of the industry sector, NAMEA can be seen either as an extended input-output table (EIOT) or as part of an SNA-based environmental accounting scheme that is, in fact, largely consistent with the SEEA. As such, it does not require further elaboration in this manual but could be implemented as a halfway elaboration of the SEEA, linking emissions in physical terms to the causing activities (see worksheet 7 in chap. III).[5]

92. Physical data are necessary for describing environment-economy relationships. However, they are not sufficient for assessing the relative significance of economic and environmental flows. Large sets of physical indicators suffer typically from arbitrary indicator selection and do not convey the nutshell information preferred by policy makers. Compound indices built up from individual indicators, on the other hand, usually apply questionable weights as, for instance, through the calculation of simple averages.

93. Chapter I has already made a plea for developing integrated or at least comparable information for integrated policies of sustainable development. Physical accounts can achieve some degree of integration by using conversion factors to express different physical units of measurement in "equivalents". For instance, the energy content of different (re)sources can be converted into coal or oil equivalents, or contributions to global warming can be attributed to greenhouse gases in terms of CO_2 equivalents. For individual resources or groups of similar resources, vertical linkages from opening to closing stocks are thus indicated in the physical accounts column of figure V. Note, however, that pollutants are more difficult to present in the asset accounts format and to combine with quantitative changes of these assets.

94. Full data integration can be achieved only by applying an appropriate numeraire to the physical indicators. This is done in the SEEA by costing environmental depletion and degradation in the production accounts and adding or subtracting these values from the opening stocks in asset accounts. As a result, aggregates of environmentally adjusted value added (EVA), its sum total environmentally adjusted net domestic product (EDP) and environmentally adjusted net capital formation (ECF) are obtained. Valuation is thus a key issue of environmental accounting for sustainable development. The following sections discuss briefly the main valuation approaches included in the SEEA and the resulting adjustments to conventional economic aggregates.

D. Valuation of natural resources and environmental impacts

95. As indicated in box 1 above, natural assets are valued in monetary terms in the SNA only if they are under the controlled ownership of economic agents and provide actual or potential economic benefits to their owners. These "economic" assets are accounted for with a positive monetary value in the balance sheets of the SNA. All other natural assets obtain a zero value and are thus not recorded in monetary balance sheets; they could be and they have been presented in physical asset accounts outside the SNA.

96. The SEEA introduces some of the SNA s other changes in volume in economic assets as depletion cost in the production accounts. However, the limitation of this approach, which deals with economic assets only, is that it excludes by definition all other environmental assets (see box 1). Chapter I (sect. B) has described how the degradation and destruction of land, water, air, forests and other biota in the wilderness affect economic performance and human welfare. These effects, which are not accounted for in private budgets, have been categorized as social costs of economic growth and development. The SEEA attempts to put a monetary value on these effects by applying three alternative valuations.

97. The different valuations are presented as different modules of SEEA, version IV. The first module (IV.1) applies a market valuation approach that does no more than rearrange environmental changes already contained in the asset accounts of the SNA. A second module (IV.2) uses a maintenance valuation that estimates the costs that would have been required to keep the natural environment intact during the accounting period. The third module (IV.3) combines the market valuation of the first module with contingent valuation and related damage valuations in order to assess the environmental costs borne by industries together with those borne by households; it attempts to measure welfare losses, rather than the environmental (maintenance) cost caused by economic activity. As discussed below, the three modules answer different questions and reflect, to an increasing degree, problems of consistency of valuations with the principles of market transaction and valuation of the SNA. This manual will describe in detail the implementation of the first two valuation methods.

1. Market valuation of natural resources

98. The market valuation based module of the SEEA, which measures the depletion of natural resources, in other words, of the economic assets of the SNA, is the closest to conventional accounting. It identifies changes in the values of natural assets that are already accounted for in conventional asset accounts as other changes in volume . These changes in volume include the depletion of natural resources, as well as their degradation from pollution and other degrading activities, to the extent that the underlying environmental impacts are reflected in changed market values of those assets. The SEEA shifts the value of the depletion and degradation of economic natural assets as environmental cost from other volume changes in the asset accounts to the production accounts. As further discussed in chapter III, depletion and degradation are defined as the permanent loss in quantity or quality of parts or all of a natural asset, beyond natural regeneration or replenishment. The reason is that natural regeneration would offset any resource reduction, reflecting a sustainable use of the resource without generating any scarcity and thus economic value.

99. Stocks of non-produced tangible assets that are marketed, such as land, can be valued by applying the market prices observed in statistical surveys of market transactions. However, the stocks of many depletable natural assets, like subsoil assets or wild biota, may not have a market price, since they are rarely sold or bought in total. A number of methods to estimate the market value of the stocks of scarce (depletable) natural resources and, by implication, changes in the value of stock have been proposed and applied in practice.[6]

(a) Net present value of natural resources

100. The basic principle of market valuation of economic assets for which a price cannot be directly observed in the market rests on using the prices of the goods extracted from, or services provided by, these assets for estimating the future sales value, reduced by the exploitation costs. If the exploitation is spread over a lengthy period, the flow of future net returns has to be discounted (1993 SNA, para. 13.34). In some cases, the reserves of depletable natural assets and exploitation rights are marketed. The market prices will then reflect to a high degree the current value of the expected net returns, since investors would base their decision of buying an asset on relative present values of future net income streams. This

assumption will not hold, however, in those countries where concessions to extract the resource are fixed by the government, and frequently done so below market value.

101. It is also difficult to estimate future returns and costs of natural resource exploitation by industry (agriculture, forestry, mining, construction and so forth) or type of natural resource used by different industries. Those estimates would require information on the availability of future stocks (reserves), prices, and extraction or harvest costs that are usually available, if at all, only at the microeconomic, rather than the sectoral, level. In addition, the choice of the discount rate is controversial, with proposed (real) rates ranging between 0 and 17 per cent (Born, 1992).[7] In practice, two main valuations are therefore applied, which can be seen as simplifications of the basic principle of present-value calculation. They are the net price method and the user cost allowance.

(b) Net price method

102. The net price valuation neglects future (discounted) losses of net returns from resource depletion. The assumption underlying this simplification is that in long-term equilibrium the net price of the marginal unit extracted will rise at the discount rate, neutralizing the discount factor. The net price has been applied in various studies (for example, Repetto and others, 1989) and country applications of the SEEA.[8] It is defined as the actual market price of the raw material minus its marginal exploitation costs including a "normal" rate of return of the invested produced capital. The value of a natural resource is then calculated as the product of the quantity of the natural resource stock and the net price. In the case of non-renewable (mineral) resources, this stock comprises only "proven reserves" which are exploitable under present economic conditions and therefore have a positive net price. The net price method could also be applied to wild biota and water as long as these natural assets are considered economically exploitable assets.

103. This estimation of stock values can of course also be applied for valuing all *changes* of natural assets during the accounting period. In principle, the net price effective at the time of the resource use should be applied. In practice, the cost of depletion is calculated by multiplying the depleted quantities of the natural assets by the *average* net price between the beginning and end of the accounting period.

(c) User cost allowance

104. Another method that approximates the net present value for the depletion of natural resources is the user cost valuation. The idea is to convert a time-bound stream of (net) revenues from the sales of an exhaustible natural resource into a permanent income stream by investing a part of the revenues, namely, the "user cost allowance", over the lifetime of the resource; only the remaining amount of the revenues should be considered "true income" (El Serafy, 1989). Given a particular net revenue for an accounting period, the calculation of the user cost allowance is straightforward, requiring only two additional parameters, the discount rate and the lifespan of the resource at the current extraction rate (see chap. III, box 5, below).

105. The net price and user cost methods differ in their respective objectives of natural capital and income maintenance. The net price method tends to overstate capital consumption, thus representing an upper limit of environmental cost estimates, whereas the user cost allowance assumes full substitutability of natural capital by other production factors; it can thus be considered a lower limit. Both valuation methods have been applied in SEEA case studies to assess a range of cost estimates.

2. Maintenance valuation of environmental assets

106. The market value approach covers only natural assets that have an economic value (in the SNA sense). They are those assets that are connected with actual or potential market transactions. Market valuation does not cover environmental assets of air, land in the wilderness, waters and species that provide environmental services (see box 1), nor can market valuation capture environmental functions of "economic" assets, which are not reflected in their market price. In order to obtain a more comprehensive picture of environmental costs, beyond natural resource depletion, a maintenance cost valuation is introduced in the SEEA as an alternative or addition to market valuation.

107. Maintenance costs are defined as the costs which one would have had to incur during the accounting period in order to avoid current and future environmental deterioration from the impacts caused during the accounting period (United Nations, 1993a, paras. 50 and 298). This valuation, in addressing the cost that could have been incurred to avoid the impacts of current economic activity, is related to environmental distance B of figure I. It does not refer, however, to the actual environmental damage generated by this activity, that is to say, its environmental impacts generated during the accounting period *and* in the future (in other words, the total environmental capacity loss by current activity). This total capacity loss due to current activities is of illustrative interest but to measure it in routine national accounting is hardly possible.

108. Maintenance costs are of course hypothetical because in reality an actual use of the asset that affected the environment *did* take place. The rationale behind this approach is based on the following two criteria:

(a) The application of a strong sustainability concept which has gained a central role in the discussion of integrated (environmentally sound) development;

(b) The extension of the national accounts concept of replacement cost of the consumption of fixed capital, to the use of non-produced natural assets.

109. The maintenance cost concept reflects a more conservationist view of the environment. It measures the cost that economic agents would incur to meet environmental regulations for maintaining the quality of the environment. Also, the use of maintenance costs for valuing environmental functions is similar to valuing the services of produced capital in the national accounts, based on the consumption (wear and tear) and replacement of fixed capital. As such, they can be deducted from GDP and gross

Box 2. Prevention and restoration activities in maintenance costing

Five types of measures for preventing environmental deterioration or restoring environmental quality by economic activities can be distinguished:

a. Reduction of, or abstention from, economic activities (value added forgone);

b. Substitution of the outcomes of economic activities, that is to say, production of other products or modification of household consumption patterns (incremental costs);

c. Substitution of the inputs of economic activities without modifying their outcomes (outputs) by applying new technologies and so forth (incremental costs);

d. Activities to prevent environmental deterioration without modifying the activities themselves (for example, end-of-pipe technologies);

e. Restoration of the environment and measures diminishing the environmental impacts of economic activities.

Source: United Nations (1993a), chap. IV.C.

value added to obtain, after further deduction of conventional capital consumption, the corresponding environmentally adjusted net indicators (see sect. E below).

110. In all cases of permanent environmental degradation and destruction, the value of the maintenance costs depends on the avoidance, prevention or restoration activities chosen. Box 2 lists some of these activities that could be applied under existing conditions of available technologies and knowledge about possible net effects of environmental degradation. The choice of activities for calculating the imputed maintenance costs of discharging residuals will depend on relative costs and efficiencies, in other words, on the best available technologies. Imputed prevention costs of industries should thus be based on the most efficient methods for preserving environmental assets or meeting environmental standards.

3. Contingent valuation of environmental services

111. In assessing the hypothetical costs of keeping environmental assets intact, maintenance costing focuses on the direct impacts of production. In contrast, contingent and related valuations of the demand/benefit side of environmental services attempt to measure the losses of such services, in other words, environmental damage. The SEEA measures environmental damage in separate modules (IV.3, V.3 and V.5), accounting for the costs borne by economic agents due to environmental degradation. These modules combine the market valuation of natural resource depletion, mainly borne by enterprises, with contingent or other valuations of the welfare effects from environmental deterioration, borne by households.

112. The well-known problems of applying these valuations in cost-benefit analyses at the project level[9] accumulate at the national level. At least for the time being, such valuations do not seem to be applicable in recurrent national accounting. However, they might be usefully explored in more experimental studies that focus on selected environmental concerns or regions.

E. Environmentally adjusted economic aggregates

113. The expansion of the asset boundary of conventional accounts for the inclusion and valuation of natural assets and asset changes permits the calculation of a range of aggregates. Their compilation and presentation are described in worksheets of chapter III. Most of the aggregates can be identified by summing up the rows and columns of figure II. This is demonstrated in figure VI which introduces explicitly the environmentally adjusted indicators and aggregates in the framework of figure II. Note that for reasons of simplicity, the thereof rows of environmental protection are omitted in figure VI.

114. The aggregates can be presented as the sum total and elements of conventional accounting identities. These accounting identities are maintained in the SEEA in the following manner:

(a) Supply-use identity:

$$O + M = IC + C + CF + X$$

indicating that the supply of goods and services produced (O) and imported (M) equals their use in intermediate (IC) and final consumption (C), capital formation (CF) and export (X);

(b) Value-added (environmentally adjusted) identity for industry i:

$$EVA_i = O_i - IC_i - CC_i - EC_i = NVA_i - EC_i$$

describing value added generated by an industry (EVA_i) as the difference of output and cost, including fixed capital consumption (CC) and environmental depletion and degradation costs (EC_i) or equivalently as the difference of net value added (NVA_i) and environmental costs (EC_i);

(c) Domestic product identity (environmentally adjusted) for the whole economy:

$$EDP = \sum EVA_i - EC_h = NDP - EC = C + CF - CC - EC + X - M$$

defining environmentally adjusted net domestic product (EDP) as the sum of environmentally adjusted value added of industries (EVA_i) with a further deduction of environmental costs generated by households (EC_h).

115. Depending on the different valuations described above and their scope and coverage, alternative indicators, adjusted for natural resource depletion or both depletion and environmental degradation, can be compiled. They are distinguished by roman numerals, that is to say, as EDP I and EDP II (see chap. III). Further adjustment of EDP by deducting factor incomes and current

Figure VI. Environmentally adjusted accounting indicators

OPENING STOCKS	Economic assets	Environmental assets

+

	DOMESTIC PRODUCTION (industries)	FINAL CONSUMPTION (households, government)	CAPITAL FORMATION	CAPITAL ACCUMULATION	REST OF THE WORLD
SUPPLY OF PRODUCTS	Output (O_i)				Imports (M)
USE OF PRODUCTS	Intermediate consumption (IC_i)	Final consumption (C)	Gross capital formation (CF)		Exports (X)
USE OF FIXED CAPITAL	Fixed capital consumption (CC_i)		Capital consumption (CC)		
Value added (VA)/NDP	$NVA_i = O_i - IC_i - CC_i$ $NDP = \sum NVA_i$				
USE OF NATURAL ASSETS (depletion and degradation)	Environmental cost of industries (EC_i)	Environmental cost of households (EC_h)	Natural capital consumption (EC)		
Environmentally adjusted indicators	$EVA_i = NVA_i - EC_i$ $EDP = \sum EVA_i - EC_h$		ECF = (CF - CC) - EC		

+

Other changes in volume, revaluation

=

CLOSING STOCKS	Economic assets	Environmental assets

transfers, paid to less received from abroad, and further deducting the costs of transnational environmental impacts would yield an environmentally adjusted national income (ENI) figure, as mentioned in chapter I (section C.3). Methodological and data problems have so far precluded such estimates which are therefore not further discussed here. As also discussed in chapter I, the deduction of natural capital consumption (EC), in addition to fixed capital consumption (CC), from gross capital formation, yields environmentally adjusted net capital formation (ECF), an indicator that can be used for demonstrating the non-sustainability of economic performance.

116. The incorporation of asset accounts in figures II and VI adds another set of identities that explain the difference between opening and closing stocks during the accounting period. They do so in terms of gross capital formation (CF), produced and natural capital consumption (CC and EC), other volume changes, and monetary holding gains and losses measured as revaluation . For non-produced economic natural assets, those stocks reflect the natural resource part of the environmental capacities described in chapter I. They are measures of wealth, that reflect the endowment of a country with economic assets, including natural resources, at the beginning and end of the accounting period. Their use is in the analysis of wealth generation and distribution.

Notes

1. An exception is the shift of the environmental costs caused by consumption activities of households to the production accounts where they are allocated to the other industries section. In this manner, pollution caused by final consumption is treated as negative production activity of households and government.

2. Obtained by deducting additionally the consumption (depletion/degradation) of natural capital from the conventional indicator of net capital formation (see chap. III). The more correct, but somewhat unwieldy term is therefore environmentally adjusted net capital formation (ECF). Both terms are used interchangeably herein after.

3. See, for example, the Framework for the Development of Environment Statistics (FDES) (United Nations, 1984), the matrix of indicators of sustainable development (World Bank, 1995), the Framework for Indicators of Sustainable Development (FISD) (Bartelmus, 1994a) and the Driving Force-State-Response Framework (DSRF) (United Nations, 1996).

4. To this end, material/energy processes are aggregated into activities of "industries" rather than processes, asset accounts of the environment are introduced without a description of environmental transformations (for example, pollutant flows through environmental pathways and their effects on ecosystems) and natural resource uses and the emission of pollutants are related to the responsible economic activities (United Nations, 1993a, chap. III).

5. The more controversial aggregation of physical indicators into contributions to environmental themes (greenhouse effects, ozone layer depletion, acidification, eutrophication, waste) is not further discussed here.

6. A brief formalized description of these valuations is given in box 3 of chapter III. For a more detailed comparative discussion of different valuation methodologies and the underlying assumptions, see Bartelmus (1998).

7. See, for example, Pearce, Markandya and Barbier (1989), chap. 6, for a general discussion of discount rates used in natural resource valuation.

8. For more recent applications, see Uno and Bartelmus (1998).

9. Contingent valuation, for instance, faces free-rider attitudes, shortsightedness or ignorance of consumers about long-term environmental impacts, and effects of income levels and distribution when questioning individuals (in opinion surveys) about their preferences for environmental quality and related social values. Also, contingent valuation is inconsistent with the predominant national accounts application of market prices, since it includes consumer surplus which is appropriate for welfare measurement but incorrect in recording national accounts transactions. Other methods such as costing increased travel or estimating change in property values due to environmental deterioration may be more consistent with market values but face problems of distinguishing environmental from other socio-economic effects.

CHAPTER III

IMPLEMENTATION OF THE SEEA: A STEP-BY-STEP APPROACH

A. Introduction

117. The present chapter translates the complex methods of integrated environmental and economic accounting into a logical sequence of activities within the overall SEEA framework. A sequence of "steps" and related "worksheets" is linked to those modules or versions of the SEEA that were tested in practical applications. The worksheets represent tabulations of the raw data that need to be compiled from different sources in order to fit them into the ultimate accounts. Annex I lists the different steps and the activities required to implement them.

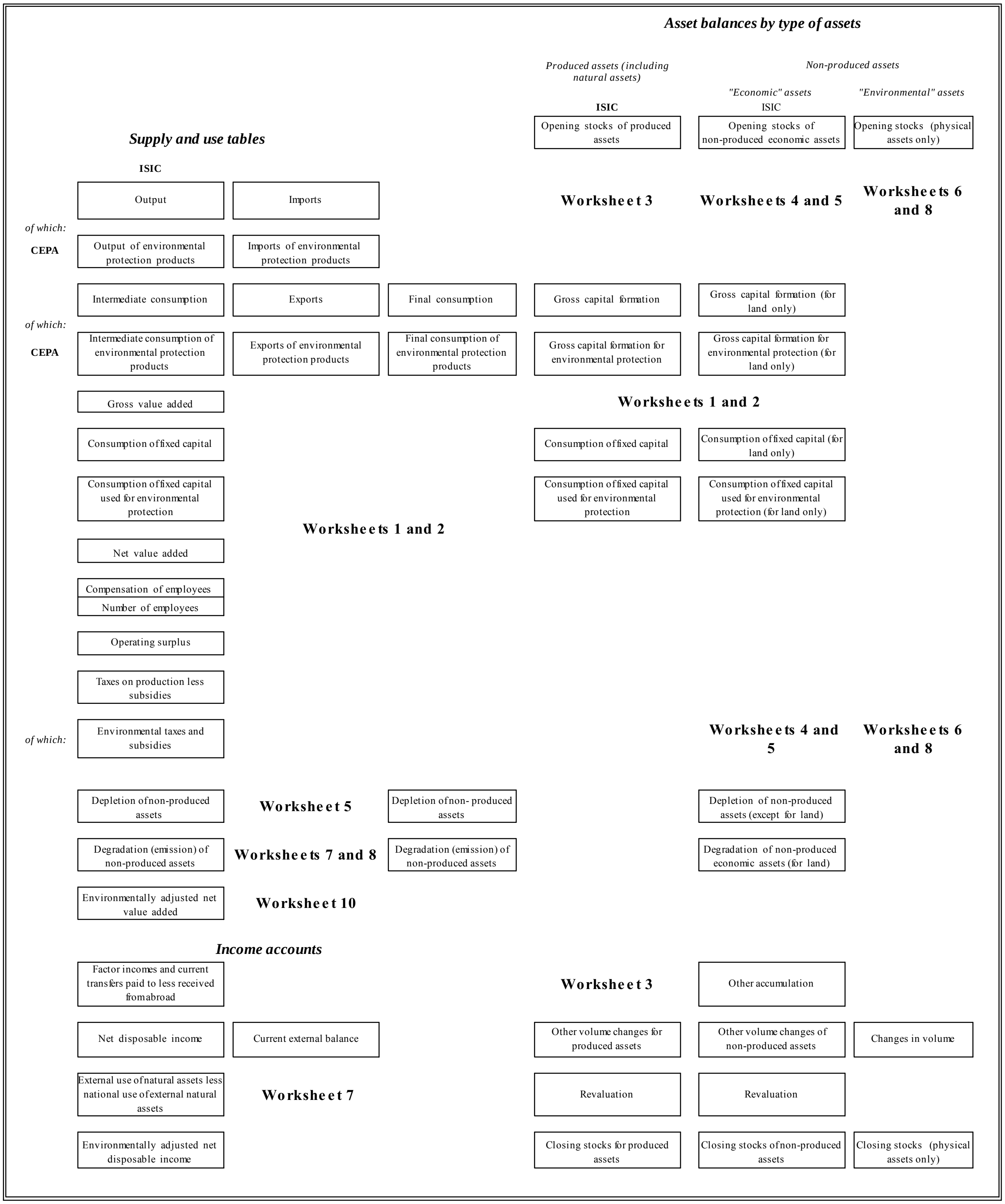
118. A detailed conceptual discussion, notably of alternative approaches, is generally avoided. Further study of concepts and methods by referring to the original SEEA as well as other publications, is encouraged, however. In cases of particularly controversial or unresolved issues, some technical elaboration of the proposed approach is provided in the notes. Annexes include the main environmental classifications that are practical tools for determining the scope, coverage and contents of the different worksheets. Cross-references are also made to the particular areas of environmental accounting presented in chapter IV.

119. Figure VII is an elaboration of figures II and VI.[1] It is a simplified presentation of the SEEA, referring in principle to both physical and monetary data. As discussed in chapter II, the extensions of SEEA, version V, are not taken up here. However, a box of income accounts is added as a placeholder for possible incorporation of transboundary (pollution) flows in expanded national income accounts and aggregates (see chap. V). The figure shows the position of the different worksheets in the overall framework that was described in generic terms in chapter II. As discussed below, not all components of figure VII are recommended in this manual for recurrent compilation, in physical *and* monetary terms. The figure thus provides an overall framework whose components can be implemented in selective or phased approaches, depending on data availability and priority concerns of a particular country. Additions to and modifications of conventional economic accounts are indicated in shaded boxes.

120. Fictitious, but realistic (based on actual country statistics) data are presented in the worksheets. They are designed to facilitate the understanding of the sequence of calculations and data flows. Data producers, that is to say, the statisticians and national accountants responsible for compiling the environmental accounts from a multitude of data sources, should find this chapter particularly helpful in their practical work. The purpose of describing the data sources is to facilitate the collaboration between national accountants who compile economic accounts and environmental statisticians who collect basic environment statistics. At the same time, those data users who want to better understand the nature, scope, coverage and meaning of the accounting aggregates should find this step-by-step description of the SEEA a relatively easy entry into the concepts, definitions and methods of environmental accounting.

121. Sections B, C and D describe the basic and relatively-easy-to-implement modules of the SEEA. They include:

Figure VII. Framework for integrated environmental and economic accounting



(a) The separate identification of environmental expenditures in the supply, use and asset accounts of the SNA (SEEA, version II, described in sect. B);

(b) The accounting of natural resource stocks and use in physical and monetary terms (economic assets part of SEEA, versions III and IV, described in sect. C);

(c) The measurement and valuation of emissions, that is to say, of so-called environmental externalities (environmental assets part of SEEA, versions III and IV, described in sect. D).

Section E indicates some of the uses that can be made of the results of environmental accounting. More generic and broader policy analysis of these results and their use in modelling are discussed in chapter V.

122. Physical accounting for material flows has recently gained much attention, either for the assessment of overall material throughput (Steurer, 1997; Spangenberg and others, 1999) or in physical input-output tables (Stahmer, Kuhn and Braun, 1998). Physical input-output tables and more aggregate material flow accounts are extensions of the SEEA. They are quite demanding in terms of data availability and are not further discussed here.

B. Adaptation of the national accounts for environmental analysis

123. Version II of the SEEA identifies those aspects of the environment that are already accounted for, in principle, in the SNA's supply, use and asset accounts. The following three steps implement this version through:

(a) The rearrangement of the national accounts to highlight those economic activities that exert major impacts on the environment and/or are affected by environmental impacts;

(b) The identification of environmental protection expenditures;

(c) The compilation of produced (including natural) asset accounts.

STEP 1: Compilation of the supply and use accounts

124. Worksheet (WS) 1 shows how the data systems for produced and non-produced (natural, non-financial) economic assets can be integrated into one table of supply, use and asset accounts. Such integration is essential for environmental-economic analysis, as it permits the extending of conventional accounts and accounting identities, incorporating natural assets and changes therein. Box 3 lists those identities in terms of the blocks of WS 1. WS 1A presents the conventional national accounts aggregates in fictitious figures for illustrative purposes. The key aggregates (net value added) such as NDP and its components are part of the accounting equations and are shown (in units of thousands of the monetary units in WS 1A rounded to the nearest thousand) in parentheses in box 3. These aggregates will be

Box 3. SNA accounting identities

The supply and use accounts in WS 1 reflect three basic national accounts identities (figures from WS 1A, in thousands of monetary units):

The supply-use identity:
output (531) + imports (72) = (603) = intermediate consumption (290) + exports (69) + final consumption (156) + gross capital formation (88) = (603);

The value-added identity:
net value added (217) = output (531) - intermediate consumption (290) - consumption of fixed capital (24);

The domestic-product identity, which holds only for the economy as a whole:
gross domestic product (GDP) = total gross value added (241) = final consumption (156) + gross capital formation (88) + (exports - imports) (69 - 72) = (241).

The incorporation of the asset accounts in WS 1 adds another set of identities that explain the difference between opening and closing stocks of assets by flows occurring during the accounting period. For produced and non-produced assets, the balances are defined as:

Closing stocks = opening stocks + gross capital formation - consumption of fixed capital + other changes in volume of assets + holding gains/losses on assets (see WS 1). For produced assets, this identity can be taken from WS 3A to read:

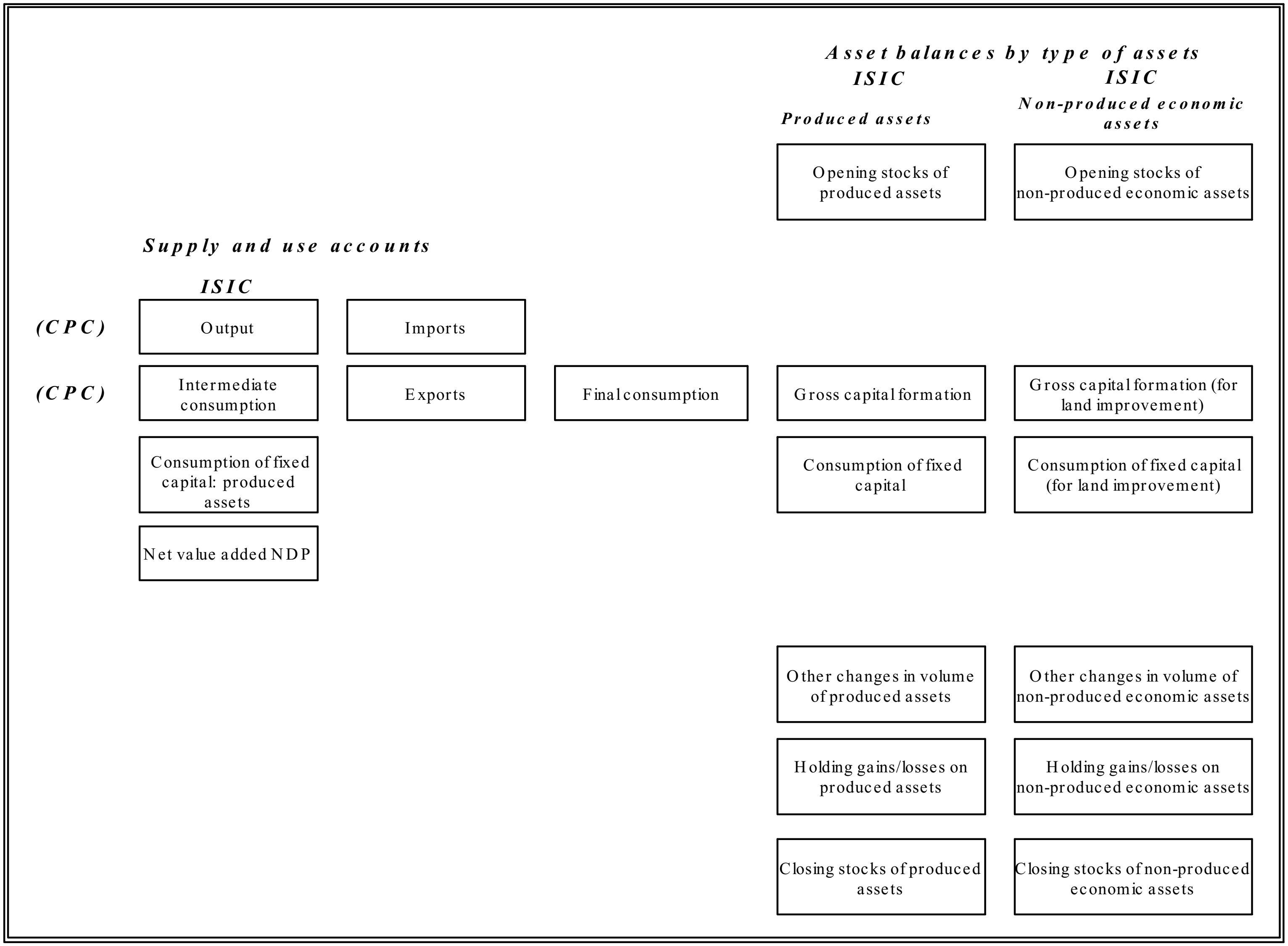
778 = 713 + 88 - 24 - 0.3 + 1.3.

picked up in the following worksheets to specify their modification as a consequence of accounting for environmental protection, natural resource depletion and environmental degradation. WS 1 is not further discussed here since its concepts, definitions and accounting rules are described in detail in the 1993 SNA. Unless otherwise stated, those concepts and definitions apply throughout the SEEA.

125. The SEEA tabulations differ from the conventional accounts in WS 1 with regard to their classifications. For purposes of environmental accounting, the International Standard Industrial Classification of All Economic Activities (ISIC) (United Nations, 1990) is shown, at a relatively low level of detail only, presenting those industries that are particularly relevant for environmental analysis. They are those industries and other economic sectors (households and government) that account for most of the country's environmental impacts and responses to these impacts, in other words, its environmental protection. Other industries and sectors of the economy should be shown at a highly aggregated level to avoid overloading the system with conventional economic data. Of course, the selection of industries will differ according to particular national environmental conditions and protection policies.

126. The Central Product Classification (CPC) Version 1.0 (United Nations, 1998) is applied in WS 1 to the blocks of supply (outputs and imports) and use (intermediate and final consumption, capital formation and exports). The CPC is shown in parentheses to indicate the possibility of compiling so-called make-and-use tables for input-output analysis, for example, in connection with environmental protection activities. However, such compilation requires well-developed input-output tables and is not recommended here for implementing a pilot project.[2]

Worksheet 1. 1993 SNA: supply, use and asset accounts



Worksheet 1A. Supply and use table

(Monetary unit)

	Agriculture	Forestry	Fishing	Mining	Manufacturing	Electricity, gas and water	Construc-tion	Public admi-nistration and defense	Other industries	Total industries	Imports	Exports	Final consumption (government households and NPISHs*)	Gross capital formation**	TOTAL
Output	27,127	9,183	2,201	20,608	240,810	9,618	60,808	29,329	131,786	531,470	71,840				603,310
Intermediate consumption	13,406	4,490	1,016	11,916	174,100	4,333	27,938	10,505	42,388	290,091		69,432	155,846	87,941	603,310
Gross value added	13,721	4,693	1,185	8,692	66,710	5,285	32,871	18,824	89,398	241,379					
Consumption of fixed capital	4,528	885	272	2,303	7,436	1,307	2,311	916	3,967	23,925					
Net value added	9,193	3,808	913	6,389	59,274	3,978	30,560	17,908	85,431	217,454					
Compensation of employees	2,923	2,281	235	2,140	31,701	1,014	21,553	17,904	32,837	112,588					
Operating surplus	5,728	1,340	664	3,827	17,903	2,641	6,336	4	37,790	76,233					
Taxes less subsidies	542	187	14	422	9,670	323	2,671		14,804	28,633					

* Non-profit institutions serving households.

** Including land improvement.

STEP 2: Identification and compilation of environmental protection expenditures

127. Environmental protection (EP) expenditures are actual expenses incurred by industries, households, the government and non-governmental organizations to avoid environmental degradation or eliminate part or all of the effects after degradation has taken place. EP expenditures are included in the SNA, but are usually not identified separately in the conventional production and final use accounts. They are therefore separately accounted for as a subset ("of which") of output, intermediate and final consumption, consumption of fixed capital, capital formation, imports and exports, and value added and its components in Figure 7 and WS 2. They are not deducted from conventional accounts indicators as is sometimes suggested for the treatment of so-called defensive expenditures (Leipert, 1989; Daly, 1989; Pearce, Markandya and Barbier, 1990).[3]

128. WS 2 displays, in the rows, EP expenditure for goods and services by type and sector and, in the columns, EP output and its cost by industry (external and ancillary). The worksheet also includes asset accounts for the stocks of EP equipment, capital formation and consumption. Internal, ancillary EP activities are distinguished from external ones in line with 1993 SNA (paras 5.7-5.16) recommendations. The latter consist of principal and secondary production activities of establishments, that is to say, the provision of EP products (goods and services) to other establishments. Ancillary activities consist of goods and services produced by establishments for own use to support the production of principal or secondary products of the industry; they include activities such as environmental clean-up and maintenance of protection facilities. For a more comprehensive assessment of the EP industry , the production of environmental goods (waste/pollution treatment facilities, filters, cleaning materials) could also be separately identified by an appropriate commodity classification. This is indicated in WS 2 by presenting the output and use of EP goods *and* services.

129. However, some environmental goods are difficult to identify as outputs since their destination for environmental protection or other uses may not be known. For example, filters might be used in conventional industrial processes as well as in environmental protection facilities. In practice, the focus has therefore been on the output and delivery of EP *services* from industry and government to industries and households.

130. For the comprehensive assessment of the production of EP services, internal services provided for own use by households, establishments and government need to be measured as well. Their value would consist of the total cost of carrying out internal EP, that is to say, of purchasing EP goods and the cost of labour and capital used. Details of the accounting procedures for the "externalization" of internal or own-account EP activities, that is to say, the compilation of total output of the environmental protection industry , are presented as version VI of the SEEA. Given the considerable difficulties of obtaining data on internal activities of economic agents, this approach is not further discussed here.

131. The Classification of Environmental Protection Activities (CEPA) (United Nations, Economic Commission for Europe, 1994) is the basis for the identification of EP outputs and expenditures. It is shown in annex II. CEPA includes only those activities and corresponding

Worksheet 2. Environmental protection expenditures

							Asset accounts	
							Produced assets	*of which: for environmental protection*
	ISIC	*of which: for external EP* ***ISIC***	*for ancillary EP* ***ISIC***				***ISIC***	***ISIC***
							Opening stock	Opening stock of EP equipment
	Output			Imports				
of which: ***CEPA***		Output of external EP goods and services	Output of ancillary EP goods and services	Imports of EP goods and services				
	Intermediate consumption	Intermediate consumption for external EP	Intermediate consumption for ancillary EP	Exports	Final consumption of households	Final consumption of government	Gross capital formation	
of which: ***CEPA***	Intermediate consumption of EP goods and services	Intermediate consumption EP goods and services for external EP	Intermediate consumption EP goods and services for ancillary EP	Exports of EP goods and services	Final consumption of households of EP goods and services	Final consumption of government of EP goods and services		Gross capital formation for EP equipment
	Consumption of fixed capital	Consumption of fixed capital used for EP					Consumption of fixed capital	
		Consumption of fixed capital of EP equipment						Consumption of fixed capital of EP equipment
	Net value added	Net value added for external EP	Gross value added for ancillary EP					
	Compensation of employees	Compensation of employees for external EP						
	Operating surplus	Operating surplus for external EP						
	Production taxes	Production taxes for external EP						
	Subsidies	Subsidies for EP	Subsidies for internal EP				Other volume changes	Other volume changes EP equipment
							Revaluation	Revaluation EP equipment
							Closing stock	Closing stock of EP equipment

expenditures that are an immediate response to environmental degradation *caused* by production units, the government and households. It does not cover reactions and expenses related to further repercussions or effects of environmental impacts such as additional health and travel costs, *borne* usually by other than those who caused them. These expenses are sometimes referred to as part of the broader concept of defensive expenditures mentioned above. More details on definitions, classification and financing of environmental protection can be found in the Statistical Office of the European Communities (Eurostat) (1994) European System for the Collection of Economic Information on the Environment (SERIEE).

132. WS 2A is an example of a reduced compilation of EP expenditures for selected industries, omitting the asset accounts. Only the manufacturing, construction and sanitation services are considered separately. The table measures total supply of EP goods and services as output (23,877) and imports (1,209) which equals their total use by industry (total intermediate consumption: 18,034), the rest of the world (total exports: 101), final consumption (total: 3,328) and capital formation (total: 3,623). Overall, in the economy of WS 2A, industry spent about 6 per cent (18,034 out of 290,091) of its purchases of goods and services on EP. The bulk of current expenditure for EP is incurred by other industries in the areas of air (6,954) and water (8,597) protection. Clearly further analysis of the other industries sector is warranted in this case.[4] Environmental taxes (141) include mainly emission charges and charges for the (over) use of natural resources such as water and fossil fuels.[5] Environmental subsidies (294) could include reduction of tariffs and taxes for, or direct payments to, the industries that acquire or import environmental protection equipment.

133. In order to obtain the necessary data on EP goods and services, a full-fledged survey of environmental protection by industry, households and government would have to be carried out. Such a survey would be greatly facilitated by functional classifications that include environmental protection.[6] In the absence of costly surveys, estimates have been obtained from research into governmental budgets, characteristic environmental outlays of industries and households, construction surveys, industrial commodity statistics and input-output tables.[7]

134. WS 2A also contains cost and use data related to the consumption of natural resources of forest products, fish and minerals. These data are of course unrelated to EP but, like EP, are already accounted for in principle in conventional accounts. They are displayed in italics to indicate their different nature as transactions that may be responsible for possible depletion of these resources. Besides uses by industry and households, the demand from other countries is indeed sometimes blamed as the ultimate culprit in natural resource depletion. In WS 2A, this is hardly the case since most of the resources are used by domestic industries (1,286 + 1,663 + 16,962) as compared with those in exports (252 + 104 + 2,897).

STEP 3: Compilation of produced natural asset accounts

135. The 1993 SNA recommends the compilation of produced asset accounts, including produced natural assets. The purpose is to assess comprehensively the level, distribution and changes in national wealth (see chap. I, sect. C.3). Produced natural assets are also important from an

Worksheet 2A. Environmental protection expenditures

(Monetary unit)

		OUTPUT OF INDUSTRIES: Manufacturing	Construction	Sewage and refuse disposal, sanitation and similar activities	Other industries	Total
Total value of goods and services		240,810	60,808	10,345	219,507	531,470
of which:						
Environmental protection goods and services	For internal use	315	56	672	1,511	2,553
	For sale	1,534	1,257	7,568	10,965	21,324
	TOTAL	1,849	1,313	8,240	12,476	23,877

		INTERMEDIATE CONSUMPTION IN INDUSTRIES: Manufacturing	Construction	Sewage and refuse disposal, sanitation and similar activities	Other industries	Total	IMPORTS	EXPORTS	FINAL CONSUMPTION: GOVERNMENT HOUSEHOLDS and NPISHs	GROSS CAPITAL FORMATION
Total value of goods and services		174,100	27,937	4,470	83,584	290,091	71,840	69,432	155,846	87,941
of which: Environmental protection products	Protection of ambient air	569	5	184	6,196	6,954	949	88	457	1,010
	Waste-water management	1,024		235	7,338	8,597	110	13	799	1,340
	Waste management	126	11		899	1,036			1,037	752
	Protection of soil and ground-water	25		35	610	670	57		358	173
	Noise and vibration abatement	4	8	65	62	139			199	57
	Protection of biodiversity and landscape	40		288	49	377	93		303	194
	Protection against radiation				126	126			175	97
	Research and development				75	75				
	Other environmental protection expenditures				60	60				
	TOTAL	1,788	24	807	15,415	18,034	1,209	101	3,328	3,623
of which: Extraction products	*forest products*	*658*	*482*		*146*	*1,286*	*380*	*252*	*25*	
	fish	*1,270*	*0*		*393*	*1,663*	*255*	*104*	*690*	
	minerals	*5,869*	*482*		*10,611*	*16,962*	*102*	*2,897*	*870*	
	Consumption of fixed capital	7,436	2,311		14,178	23,925				
of which:	Consumption of fixed capital for environmental protection	965	659		1,770	3,394				
	NET VALUE ADDED / NDP	59,274	30,560	5,875	121,745	217,454				
	Compensation of employees	31,701	21,553	4,110	55,224	112,588				
	Operating surplus	17,903	6,336	1,194	50,800	76,233				
	Taxes on production less subsidies	9,670	2,671	571	15,721	28,633				
of which:	Environmental taxes	45	2		94	141				
	Environmental subsidies	126	1	53	114	294				

environmental point of view, as they may possess important environmental functions similar to non-produced natural assets.[8] These assets have come into existence as outputs of production processes, described as outputs and inputs in the supply and use accounts (step 1). Figure VII shows this overlap between supply/use and asset accounts in terms of capital formation and capital consumption boxes. Produced natural assets are distinguished from non-produced assets in the SEEA Classification of Non-Financial Assets (CNFA) which is reproduced in annex III. Another term used for produced natural assets is cultivated assets .

136. The SNA definition of cultivated assets (1993 SNA, paras. 10.12 and 10.83-10.86) is maintained in the SEEA and applies, therefore, to both fixed assets, used repeatedly or continuously over more than one year, and single-use products in inventories. It may be difficult to make the distinction between produced and non-produced assets for some natural resources such as fish and forests which can be the result of cultivation or natural growth in the wilderness. In these cases, one would have to examine whether the natural resources are actually owned by institutional units (households, government, enterprises) and whether their renewal is under the direct control, responsibility and management of these units according to the SNA definition.

137. WS 3 renames the CNFA terms of cultivated natural growth assets and man-made assets as produced natural assets and other produced assets to emphasize the focus on natural assets in environmental accounting. For each category of asset change, the SNA code is given in parentheses in the worksheet. Each of the items in WS 3 can be compiled directly. However, in practice, revaluation is frequently estimated as a balancing item. Box 4 presents the activities that have to be carried out to fill in WS 3. In many instances, the *changes* (transactions or flows) in the assets might be easier to assess than the *stocks* at the beginning and end of the accounting period. Flow data have also been considered more relevant for economic analysis than the stocks of wealth at a particular point in time. The choice of parts or all of the different items in WS 3 thus depends on the statistical capacities, as well as on the analytical interest and political priorities, in a country.

138. WS 3A shows the asset accounts of cultivated and other produced assets for agriculture, forestry and the remaining industries. Opening and closing stocks include both fixed assets and inventories. For agriculture, the stocks of cultivated assets (opening and closing stocks: 3,521 and 3,690) include trees used in the production of fruits, breeding stock, dairy cattle, sheep reared for wool, draught animals, and animals and trees produced on own account. For the forestry industry, cultivated assets (opening and closing stocks: 1,062 and 1,127) include the stocks of trees grown for timber production, and stocks of timber and other natural forest products for intermediate consumption or for resale. Produced natural capital wealth (opening stock: 3,521 + 1,062 = 4,583) is small compared with other produced capital in agriculture, forestry and industry (5,139 + 2,352 + 701,391 = 708,882), indicating a relatively industrialized country situation. Of course, further analysis of the nature of other (non-natural) capital might reveal more about the stage of development in the country.

Box 4. STEP 3: Compilation of produced natural asset accounts

3.1 Identify the industries for which produced asset accounts are to be compiled, focusing on cultivated natural assets (agriculture, forestry, fishery and so forth).

3.2 Estimate the value of the fixed asset/inventory stocks at the beginning of the accounting period in current prices (from wealth surveys or research studies).

3.3 Incorporate national accounts data on gross fixed capital formation, changes in inventories and capital consumption.

3.4 Assess the value of other volume changes due to natural disasters or other destruction (for example, loss of livestock in floods) (K.7), uncompensated seizures by authorities (K.8), unforeseen obsolescence (K.9, for example, effects of acid precipitation on buildings and vehicles) and changes in asset classifications (K.12, for example, pastures turned into built-up land).

3.5 Calculate the value of revaluation of assets, that is to say, holding gains and losses resulting from changes in the prices of the assets.

3.6 Estimate the value of the fixed asset/inventory stocks at the end of the accounting period in current prices.

Note: Codes in parentheses refer to 1993 SNA (chap. XII) categories of other changes in the volume of asset accounts .

139. Gross capital formation of natural produced assets is the total value of acquisition less disposal of all mature and immature animals, trees and so forth, including work in progress, that is to say, growth of fixed assets such as orchards, trees, livestock and fish in aquaculture. Growth should not be considered a natural process, but rather a process of production, since it is organized, managed and controlled by institutional units. WS 3A shows gross fixed capital formation on cultivated assets only for agriculture (274) at about a third of total capital formation. No fixed capital formation is reported for the forestry industry since growth of trees intended for timber production is considered work in progress accounted as change in inventories rather than fixed capital formation. Such growth (128) is about half of other capital formation (215 + 32 = 247).

140. Consumption of fixed capital represents the reduction in value of fixed assets used in production (namely, trees, animals, and so forth) resulting from physical deterioration or normal accidental damage. For natural capital, only agriculture shows such deterioration (-48), given that no fixed capital formation takes place in forestry. Other volume changes are caused by natural disasters or other non-economic factors (wars and so forth), reducing natural capital by -21 (agriculture) and -11 (forestry). Revaluation is calculated in practice as a residual; its values of -83 and -52 for natural capital of agriculture and forestry, respectively, reflect a decrease in prices in contrast to price increases experienced by other asset categories. As a balancing item, revaluation also contains statistical errors and needs to be interpreted with caution.

Worksheet 3. Monetary asset accounts: produced assets, including natural assets

	ISIC	ISIC
	Produced natural assets	Other produced assets
Opening stock	Value of the stock of livestock, fish, fowl, orchards, plantations, timber tracts and other vegetation (AN.1114, AN.1221)	(AN.1, except AN.1114, AN.1221)
Gross capital formation		
Gross fixed capital formation (P.51)	Value of acquisition less disposal of fixed assets, namely, livestock, plantations, orchards, fish and so forth Value of unfinished assets produced on own account	
Changes in inventories and acquisitions less disposals of valuables (P.52, P.53)	(a) For single-use plants, livestock or fish, value of crops, livestock or fish not yet harvested or slaughtered (b) For trees and livestock intended for repeated or continuous use in production, value of uncompleted assets (for example, assets produced by specialized producers such as breeders of horses and other animals, nurseries and so forth)	
Consumption of fixed capital (K.1)	Decline in the value of fixed natural assets (normal wear and tear)	
Other volume changes Economic appearance of other produced assets (K.4) Catastrophic losses (K.7) Other (K.8, K.9, K.12)	Value of positive or negative changes due to natural disasters, political events, or change in use of assets	
Revaluation (K.11)	Holding gains and losses	
Closing stock	Value of the stock of livestock, fish, fowl, orchards, plantations, timber tracts and other vegetation (AN.1114, AN.1221)	(AN.1, except AN.1114, AN.1221)

Worksheet 3A. Monetary asset accounts: produced assets, including natural assets

(Monetary unit)

	Agriculture		Forestry		Other industries	Total
	Cultivated assets	Other	Cultivated forest	Other		
Opening stock	3,521	5,139	1,062	2,352	701,391	713,465
Capital formation:						
Gross fixed capital formation *	274	633		215	86,784	87,906
Changes in inventories	47	41	128	32	-213	35
Consumption of fixed capital *	-48	-73		-39	-23,765	-23,925
Other volume changes	-21	-33	-11	-29	-174	-268
Revaluation	-83	106	-52	65	1,266	1,302
Closing stock	3,690	5,813	1,127	2,596	765,289	778,515

* Including land improvement.

141. Opening and closing stocks of cultivated assets should be valued at purchasers prices at the beginning and at the end of the accounting period. Changes in the stock should be valued at the prices prevailing at the time the changes occur. In practice, they are usually valued at average prices of the accounting period.

C. Natural resource accounting

142. The term "natural resource" as used here is short for the SNA definition of "economic non-produced natural assets". In the SNA, they are those assets of CNFA category 2 (non-produced assets) over which ownership rights are enforced and that provide economic benefits to their owners.[9] Their products are generally valued in the market (see step 5 below). Economic non-produced assets are distinguished from environmental ones, not so much because of any scarcity criteria, which apply to environmental assets as well, as because of the following:

They are clearly different from intangible environmental *services* of waste absorption and life support in general, being material *goods* that enter the economic system for intermediate or final consumption;

Market values for economic assets are readily available;

Most of the economic assets are already defined and classified in the conventional accounts.

143. A major difference between the SNA and SEEA, however, is that the depletion and degradation (emission) of non-produced assets are accounted as production *costs* in the SEEA, whereas in the 1993 SNA (chap. XII) those items are part of other volume changes, termed economic appearance, disappearance, growth and so forth of non-produced assets; they are thus presented in the assets accounts only, outside the production accounts. Environmental costing by the SEEA modifies the conventional production and income indicators of the SNA, obtaining, notably, environmentally adjusted value added, its sum total, the environmentally adjusted net domestic product (EDP) and environmentally adjusted net capital formation (ECF) (see chap. II, sect. E, and WS 10 below). As in the case of fixed capital consumption and formation, depletion (and degradation: see below) cost and ECF represent the bridge (overlap) between the environmentally adjusted asset and production accounts of the SEEA, as shown in additional boxes of figure VII.

STEP 4: Compilation of physical natural resource accounts

144. WS 4 records the stocks and the changes therein during the accounting period, in physical measures (square kilometres (km^2), cubic metres (m^3) and metric tons). Opening and closing stocks are measured as the economically exploitable quantity of reserves or stocks available at the beginning and end of the accounting period. Changes in quantity are brought about by the direct economic use/exploitation of the asset, including the extraction of minerals, logging, fish catch, water abstraction and so forth. For renewable resources, economic use is a gross concept that includes sustainable use ,

made possible by natural regeneration or replenishment, as well as "depletion" which represents exploitation of the resource beyond long-term sustainable levels or yields. Natural resource depletion is the notion underlying environmental costing, described below under step 5.

145. Changes in the quality of natural resources affect their productivity and economic value. Quality changes are thus relevant (physical) aspects of environmental costs but they are difficult to incorporate into physical *quantitative* asset accounts. They are therefore shown as a memorandum item in shaded areas below the closing stocks of the worksheet. Quality changes of economic non-produced assets are not further discussed here[10] (except for soil erosion, discussed below) but will be taken up in section D as an issue of environmental (maintenance) costing of emissions into air, water and land. Soil erosion, measured in metric tons of soil lost or area affected, can be considered a quality change of agricultural and other land. Because of its importance in affecting the productivity of (notably agricultural) land, it is explicitly recorded (and costed) as an economic use of natural capital.[11]

146. Other accumulation and other volume changes in the SEEA are those quantitative changes in the asset accounts that continue to be accounted for outside the production and income accounts. They therefore do not affect value added and income-generation (as cost), but are important elements in the assessment of the availability of natural resources. Other accumulation is distinguished from other volume changes, with the former referring to changes due to economic decisions or interest, and the latter referring to non-economic causes (political or natural events/disasters). WS 4A is an example of a tabulation of the results of physical natural resource accounts in a detailed breakdown of the natural assets. The worksheet distinguishes explicitly between sustainable use and depletion in anticipation of environmental costing carried out by WS 5B. Discussed below are key questions in respect of the compilation of the different resource accounts presented in the columns of WS 4 and WS 4A. Further details on concepts, definition and measurement of selected natural resources are provided in chapter IV.

(a) Land and soil accounts

147. Opening and closing stocks consist of the land area over which ownership rights are enforced, including land underlying buildings and works, agricultural land, forest and other wooded land, recreational land, and associated surface water, and other open land and areas of artificial watercourses or water impoundment (CNFA 2.1.3.2). There are no quantitative losses of land due to economic uses since changes in the area of a country can be caused only by wars or political decisions and, in some cases, natural disasters. Such losses are therefore recorded in other volume changes. This category includes also long-term (as opposed to fallow period) transfers of land from economic use to the environment since such changes in land use are usually prompted by environmental policy or natural events, rather than by economic concerns.

148. Land area can be increased for economic reasons by means of land reclamation as indicated under other accumulation .[12] This category includes also changes in land use and transfers of non-

Worksheet 4. Physical asset accounts: non-produced economic assets

	Non-renewable resources		**Renewable resources**		
	Land/soil (km^2)	Subsoil assets (metric tons)	Forests (economic functions) (m^3, metric tons)	Fishery resources (m^3, metric tons)	Water resources (m^3)
Opening stock	Area of land underlying buildings, land under cultivation, recreational land	Proven reserves	Volume of standing timber	Biomass	Volume
Economic use (sustainable use, depletion)		Extraction of minerals (measured in ore or processed form)	- Logging (tons) - Clearing of forests (loss of timber)	Total catch	Water abstraction
Other accumulation	- Changes in land use - Transfer of land from the environment to economic use - Land reclamation (asset increase)	- Discoveries - Reassessment of reserves due to changes in technology and relative prices	- Natural growth - Natural mortality - Transfers from the environment to economic use	- Natural growth - Natural mortality	-Transfers (discovery) from the environment to economic use - Replenishment
Other volume changes	- Changes in land use and land area due to natural, political or other non-economic causes - Transfer of land from economic use to the environment	Reduction in volume due to natural disasters or other non-economic factors	- Reduction in volume due to natural disasters or other non-economic factors (fires, floods, earthquakes) - Transfer of forest from economic use to the environment	Reduction in volume caused by natural disasters or other non-economic factors	Changes due to natural disasters (flooding, droughts, and so forth)
Closing stock	Area of land underlying buildings, land under cultivation, recreational land	Proven reserves	Volume of standing timber	Biomass	Volume
Memorandum item: changes in quality [a]	- Soil erosion (km^2 or metric tons) or nutrient loss (metric tons) - Land/soil contamination including salinization and other changes in soil quality (km^2, ambient concentration)		Quality effects of forest disease, acid precipitation and so forth	Quality effects of acidification and other environmental impacts on aquatic animals	Water quality change (index value)

[a] Quality measures are not part of the asset accounts, but are used in assessing the cost of productivity losses.

Worksheet 4A. Physical asset accounts: non-produced economic assets

	LAND (thousand km2)					SOIL (million metric tons)	SUBSOIL ASSETS			
	Agricultural land	Forest land	Built-up land	Recreational land	Other land	(economic use)	Oil (million metric tons)	Gas (billion m3)	Coal (million metric tons)	Copper (million metric tons)
Opening stocks	25.0	61.0	4.3	2.9	6.5		1,589	9,144	93	10.5
Sustainable use										
Depletion (including soil erosion)						-148.8	-62.5	-147	-11	-0.2
Other accumulation	0.3	-0.8	0.2	0.2	0.2		15.2	146	24	0.4
Other volume changes	-0.1	-0.1					-13.7	-18	-2	-0.1
Closing stocks	25.2	60.1	4.5	3.1	6.7		1,528	9,125	104	10.6

	FOREST (million m3) (economic uses)			FISHERY RESOURCES (million metric tons)		OTHER BIOTA (thousand metric tons)	WATER (billion m3)		
	Coniferous	Deciduous	Mixed	Marine water species 1	Freshwater species 1	Species 1	Aquifers	Other groundwater	Other freshwater
Opening stocks	1,228	771	724	218	91	109	98	75	65
Sustainable use	-100	-51	-48	-31	-10	-16	-31	-10	-15
Depletion (including soil erosion)	-3	-90	-85	-5	-1	-6	-3	-5	
Other accumulation	101	50	49	32	10	16	32	11	19
Other volume changes	-20	-13	-6	-1	-1	-6	-2	-1	-1
Closing stocks	1,206	667	634	213	89	97	94	70	68

economic (in the SEEA sense) land from the environment into the economy for purposes of economic land use (cultivation, construction and so forth).

149. WS 4A shows a slight decrease in total (economic) land area during the accounting period from 99,700 km^2 to 99,600 km^2, which is due to the loss of economic land from natural disasters affecting agriculture (-100 km^2) and forest land (-100 km^2), and land reclamation of 100 km^2 as the balance of other accumulation . Total agricultural land increased by 300 km^2, at the expense of forest land (clearing). Forest land was transferred to other uses because of economic decisions (-800 km^2) and reduced by a natural disaster (-100 km^2). Similar interpretations can be made for the other land categories.

150. Soil degradation refers to quantitative changes in the availability of soil and can therefore be treated as depletion of soil. However, from an economic point of view, the main issue with respect to soil degradation is the change in the quality of land due to the loss of topsoil. Erosion is therefore considered in the shaded row of WS 4 as an issue of land quality change. Owing to the importance of soil erosion for the productivity of (notably agricultural) land, soil is presented as a separate economic asset category in WS 4A. Soil loss from erosion (148.8 million metric tons) is shown in WS 4A as a depletion , in anticipation of total (mainly depletion) costing of natural economic resources. The ambiguous character of soil erosion as a quantitative and qualitative asset change makes it quite impossible to assess total soil availability as stocks at the beginning and end of the accounting period. WS 4A thus contains erosion as the only item of the soil accounts.[13]

151. Soil can be considered a renewable resource, as it possesses recuperative capacities that allow some erosion to be sustained without productivity losses. (Solórzano and others, 1991). As for the other renewable resources, only net erosion loss, the erosion above sustainable erosion, should be accounted as production cost in the SEEA. In practice, however, the estimation of sustainable erosion is difficult and imprecise. WS 4A shows only total erosion, assuming that all erosion produces productivity losses.

152. In principle, erosion from economic activities, such as land-clearing for purposes of farming or economic (residential, industrial) development, needs to be distinguished from natural (wind and water) erosion. A further distinction needs to be made between direct impacts of economic activities such as erosion from improper cultivation of agricultural land, and indirect effects, for example, deforestation through exposure of land to wind and water, for the purpose of an appropriate (maintenance) costing (see step 5 below). Also, economic impacts of permanent productivity losses should be separated out from environmental effects of deteriorated landscapes or ecosystems in order to calculate the different indicators referring to depletion/degradation of economic and environmental assets. The treatment of erosion in this chapter is therefore more in the nature of a place marker (for further research) than a practical guide for incorporating erosion impacts in the SEEA. Further insight into the complex measurement and valuation methods of land degradation can be gained from section C of chapter IV.

153. Typical data sources are land-use statistics and administrative records kept by municipalities, ministries of land or cartographic institutes. Soil quality data can be obtained from agricultural surveys, ministries and associated research institutes.

(b) Subsoil asset accounts

154. The opening and closing stocks of subsoil assets are proven reserves of mineral deposits, located on or below the earth s surface, that are economically exploitable, given current technology and relative prices. They consist of coal, oil, natural gas reserves, and metallic and non-metallic mineral reserves. Alternatively, the assessment of "established" or demonstrated reserves, which include both proven and "probable" reserves, has been proposed. Proven reserves are the estimated quantities at a specific date, which analysis of geological engineering data demonstrate, with reasonable certainty, to be recoverable in the future from known reservoirs under the economic and operational conditions at the same date (1993 SNA, para. 21.152). Probable reserves are defined as "the estimated quantity and grade of a mineralized body for which sufficient information on continuity, extent, grade, operating and capital costs, and so forth is available on the basis of a study indicating an economically viable operation at long-term forecast average mining prices (see Born, (1992)).

155. Established (proven and probable) reserves are considered to better represent the quantity of resources available for the assessment of long-term sustainable production and consumption. However, they introduce an element of uncertainty, notably for the valuation of these reserves. In addition to established reserves, undeveloped reserves and undiscovered resources can also be presented, in physical terms only. The different reserve categories are further elaborated according to their probability of existence and other criteria in chapter IV, section B.

156. As indicated in WS 4, changes in stock of subsoil assets include the extraction of minerals, discoveries, reassessments of the exploitability of reserves, and other changes due to non-economic causes. Even though all elements can be measured directly, in practice other volume changes are frequently calculated as a residual (balancing item). WS 4A contains the asset accounts of selected subsoil assets. It should be noted that, aggregation in weight units, of different categories of mineral resources in contrast with other natural resources presented in the worksheet, is not feasible, except where these weights can be converted into equivalents such as oil or coal equivalents for energy resources. For the more important subsoil assets (oil and gas), extraction exceeded discoveries and reassessment, that is to say, other accumulation. For instance, oil reserves were depleted by 62.5 million metric tons; but, at the same time, new reserves of 15.2 million metric tons were proven. Closing stocks are therefore lower than the opening stocks.

157. Some disagree with the current practice of treating discoveries as part of other accumulation outside the production accounts. The argument is that discoveries should be treated in the same manner as land improvement. In particular, the increase in value of the resource when it is reclassified as a proven as opposed to a probable or a possible reserve (United States Bureau of Economic Analysis, 1994) should be treated as gross capital formation. The present manual, however, follows the recommendation of the SEEA to treat the exploitation of non-renewable mineral resources as permanent depletion of the resource (subsoil assets: 220.7 million metric tons).

158. Data on mineral reserves are collected typically by engineers of the Bureau of Mining, Ministry of Energy or other governmental agencies. Those data refer to the geologic or geophysical characteristics of the reserves and their probability of existence, regardless of whether they are economically exploitable. In order to obtain data on (proven) reserves, geologic data therefore need to be adjusted, taking into account current technology, market prices and costs of extraction. Given the volatility of the market prices of some subsoil assets, these adjustments have to be made frequently and reported under other accumulation (as reassessment). Data on extraction of minerals may be compiled as amount of ores weighted by mineral contents or processed (ingot) matter. For valuation purposes (see step 5 below), the latter need to be estimated.

(c) Forest accounts (economic functions)

159. Economic forest assets include all economic functions such as the provision of timber, bark, fibers, fruits and other forest products that are commercially exploitable. It is the stock and use of these economic products that are the basis for the application of market valuation discussed below. The economic functions of forests should be clearly distinguished from environmental ones (see sect. D below), since both functions are usually exhibited by commercially exploitable forests.

160. Illegal logging, for instance in protected areas, represents a reduction in the quantity of an environmental asset while at the same time providing economic benefit to the loggers. According to SNA conventions, such an activity should be included in the production boundary of the system as an economic transaction. A possible solution to the treatment of illegal logging in the asset accounts for economic forest is to record the volume of timber logged in these areas as other accumulation, that is to say, as a transfer from the environment to the economy, and upon its economic appearance as depletion, since non-sustainable use of the resource can be assumed for illegal activities. The opening and closing stock of economic forest would thus not be affected by these transactions.[14]

161. As indicated in WS 4, all the elements of the forest accounts are calculated in volume or weight (cubic metres or tons of biomass). Opening and closing stocks are defined as the total standing volume of timber, including only those trees whose diameter is large enough to allow harvesting.[15] Direct economic use of forests consists of logging or other activities such as land clearance for agriculture. The volume of timber logged, above the long-term net growth of the forest, is considered non-sustainable and termed depletion . Sustainable use refers to the volume of timber logged without impairing the long-term capacity of the forest to yield economic products. Sustainable management of forests aims at maintaining this capacity through practices such as selective cutting.

162. Reforestation and preservation are remedial actions similar in nature to reinvestment of depreciated fixed capital. Natural growth under these activities are recorded as other accumulation in WS 4 (see note 12 below). Other accumulation thus includes increase in volume due to net natural growth (after accounting for natural mortality) and transfers from the environment to economic use. The decrease of forest available for economic exploitation, for example, from transfer of forests into a protected status where no logging is permitted, or natural events (such as a flood or fire), is recorded as other volume change.

163. Sustainable cut should be estimated in principle by means of models that include the age of the trees, soil characteristics, weather, and so forth as explanatory variables. The age of the forest should be taken into account, in particular given that mature forests tend to grow less. However, sustainable cut is usually roughly equalized with the net growth of the forest. In the absence of transfers of forests from the environment to the economy, sustainable cut is approximately equal to other accumulation, in other words, net natural growth.

164. WS 4A shows the asset accounts for coniferous, deciduous and mixed forest. For all three categories, the stock has decreased. For example, the deciduous forest stock decreased by 104 million m^3 during the accounting period (from 771 million m^3 to 667 million m^3). The depletion of deciduous forest resulted from logging and land clearance (-90 million m^3), beyond sustainable use (-51 million m^3) and net natural growth (50 million m^3). Forest fires or other natural disasters were responsible for an additional loss of 13 milion m^3 of timber.

165. Data collection on forests is typically based on forest inventories containing area and volume information. Area information frequently differs from one source to another (Ministry of Forests and Forestry, research institutes, remote sensing agencies), according to the particular concepts and interests of these agencies. The methods of data collection and the validity of their results need to be carefully assessed. For instance, data obtained through satellite images need to be further disaggregated by species and use (namely, plantation, commercial logging, protected areas, and so forth) in order to identify whether they should be accounted as produced or non-produced, or economic or environmental assets; ground-truthing of remote sensing data is a sine qua non for their use in environmental accounts.

(d) Fishery and other biota accounts

166. WS 4 presents the opening and closing stocks of fish and other aquatic animals likely to be exploited for economic purposes. Direct economic use is effected by fish catch. Fish catch refers to the weight/volume of fish caught in the actual fishing site. Sustainable catch is distinguished from depletion and is the amount of fish that can be caught without reducing stock in the long term. It has to be estimated by using models that take into account the current size and age structure of the stock, its reproductive potential and climatic and environmental variables (see chap. IV, sect. D). Depletion is that part of the catch that exceeds sustainable exploitation of the stock.

167. Stock data are obtained from direct observation or are inferred from data on catch and catch per unit of effort (CPU). The latter is estimated from the number of days fish vessels spend fishing, the capacity and level of technology of fishing gears, and so forth. A description of the models typically used in this context is presented in chapter IV. Information on other accumulation and other volume changes, that is to say, the changes in stock through natural growth, mortality and recruitment, is difficult to assess. A rough estimate can be obtained by considering the difference between the opening and closing stocks and fish catch.

168. WS 4A includes the asset accounts for one marine, one freshwater and one other economic species. Other biota refer to species from terrestrial ecosystems, for example, that comprising elephants, tigers and other wild animals. For the marine species, the stock decreased (from 218 million metric tons

to 213 million metric tons). The total of fish catch (-5 million metric tons and -31 million metric tons) and the reduction in volume from natural causes (-1 million metric tons) exceeded the net natural growth and recruitment (32 million metric tons) by 5 million metric tons, which equals (long-term) depletion modelled at -5 million metric tons. Depletion was also recorded for the freshwater (1 million metric tons) and other biota (6,000 metric tons).

(e) Water accounts

169. Measuring the long-term-availability of water, under current economic and technical conditions for assessing the (non-) sustainability of water use, is one of the most difficult tasks of natural resource accounting. Water is a cyclic natural resource that moves rapidly, escaping human control and ownership (Møllgaard, 1997).[16] The present manual focuses, therefore, on more stationary water bodies for which long-term availability might be more easily established. Some of these bodies, especially aquifers and other groundwater, are particularly important sources of drinking water.

170. The stocks of water resources in WS 4A thus include aquifers, other groundwater resources and other freshwater bodies to the extent that their scarcity has led to the enforcement of use rights and their quantitative exploitation has incurred increased costs of provision and use. Changes in stocks are brought about by abstraction of water for industrial or household use,[17] other accumulation and other volume changes. The last-mentioned includes transfer of water from the environment to economic use and replenishment by precipitation, natural recharge or human activity (for example, of reservoirs). Natural causes that affect water levels and flows are floods and droughts; their effects are recorded as other volume changes. WS 4A indicates for groundwater a total economic use of water of 49 billion m^3 (-31-3-10-5), of which 8 billion m^3 (-5-3) are non-sustainable, representing long-term mining of the resource. The stock of other freshwater bodies increased: it was considered sustainable, and no depletion was therefore recorded.

171. Detailed water balances have been frequently established without distinguishing between economic and non-economic uses. Those balances are useful for the management of the resource, for example, in a particular drainage basin. The role of water in the economic (production and consumption) system can not, however, be clearly established in this manner. Changes in water quality are measured by indices referring to particular spatial points or limited areas. The description of water quality and quality standards set for different water uses is an established part of environment statistics. The link of quality indicators with particular water uses in environmental accounts is beyond the scope and coverage of this manual. However, the compilation software accompanying this manual does present some indicators of water quality in an additional worksheet (worksheet 11).

STEP 5: Valuation of natural resources: compiling the monetary accounts

172. The first market valuation based monetary version (IV.1) of the SEEA is the closest to conventional accounting. It records the value and changes in the value of natural assets that are already accounted for in the SNA asset accounts. As explained above, the cost of depletion and degradation of natural resources is shifted from other volume changes in the SNA asset accounts as environmental cost to the production accounts in the SEEA.

173. The monetary accounts are derived from the physical accounts by applying monetary unit values, that is to say, market prices or estimated (imputed) market values, to the physical stocks and stock changes of a somewhat modified WS 4. This is illustrated in WS 5 which shows the same column headings for the different categories of natural resources but modified headings for the rows. As in the monetary asset accounts of produced assets (WS 3), items of capital formation and revaluation are introduced. It should be noted that the only possibility of capital formation in non-produced assets is through land improvement as already accounted for in the SNA. For other non-produced environmental assets, production of new capital is not possible by definition, and capital formation is marked as n.a. (not applicable). In the case of acquisition and disposal of natural assets, only land and subsoil assets are shown, though such transactions might in principle also occur for other assets but they are less likely to, or if they do occur, they are of minor significance. Asset and asset change categories that are the same as in WS 4 are simply cross-referenced.

174. Two further (monetary) items, "depletion" and "degradation", are also introduced. They are based on the (physical) items of "economic use" and the memorandum item "changes in quality" of WS 4, but differ owing to the introduction of sustainability criteria into cost concepts of the monetary accounts. In fact, WS 4A already introduced non-sustainable resource use as physical depletion, in preparation for its costing in WS 5. These criteria can be seen as an extension of a sustainability (capital maintenance) criterion already inherent in conventional production and income accounting.[18] Thus, not all direct use of natural assets through resource extraction and waste/pollution disposal is to be accounted as cost in the production account, but only that part which is not renewed or safely absorbed. As indicated under step 4, complex models are required, especially for fisheries, in respect of assessing the sustainability of natural resource exploitation. Owing to the difficulties of measuring productivity loss of economic assets due to environmental degradation from acidification or other contamination, only soil erosion is taken up in WS 5 from the changes-in-quality row of WS 4. Degradation of all other assets is reported in WS 5 as (n.a.) , meaning that, although feasible in theory, estimating changes in value of the asset as a result of degradation is very difficult in practice.

175. Stocks of non-produced tangible assets that are marketed, such as land, can be valued by applying the market prices observed in statistical surveys of market transactions. However, stocks of depletable natural assets like subsoil assets or wild biota usually do not have a market price, as they are rarely sold/bought in total. A number of methods to estimate the market price/value of the stocks of scarce (depletable) natural resources and changes in the value of stock have been proposed and applied in practice. Box 5 provides a brief description of commonly proposed valuation methods for non-produced (economic) assets, including the so-called "net price" (Repetto and others, 1989) and "user cost" (El Serafy, 1989).

Box 5. Methods of market valuation of natural resources

Net present value method: the present value V_o of a natural resource is the sum of the expected net revenue flows N_tQ_t, discounted at nominal or real interest rate r:

$$V_0 = \sum_{t=0}^{T} \frac{N_t Q_t}{(1+r)^t}$$

where r is assumed to be constant for the life T of the asset, N_t is defined as the total unit (sales) value of the resource less the production cost -- that is to say, the costs of extraction, development and exploration, including a normal return to capital -- and Q_t is the quantity exploited during the period t.

Net price method: the value of a resource at the beginning of period t, V_t, is the volume of the resource $Q = \sum Q_t$ (annual extractions over the lifetime of the resource) multiplied by the difference between the average market value per unit of the resource p_t and the per-unit production cost c_t:

$$V_t = (p_t - c_t)\, Q = N_t Q$$

User cost method: The user cost is the difference between the finite net returns R (=N_tQ_t) from the sales of an exhaustible reserve during the accounting period t (expected annually during the lifetime of the resource T) and a "perpetual income stream" X resulting from the investment of the user cost at an interest rate r:

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

The user cost method is applied to depletion rather than stocks.

176. Natural resource stocks, at the beginning and end of the accounting period, as presented in the physical accounts, are multiplied by the current market price for the asset; in its absence, a market value can be imputed, either by estimating the net present value of the asset or by multiplying expected extraction/use quantities (over the lifetime of the resource) by the current net price. The net price method can be shown to be an approximation of the net present value calculation under a number of assumptions, notably the so-called Hotelling rule. It is at this discounted value that, in the absence of markets and market prices (but assuming perfect market conditions), natural assets would be purchased, in preference over alternative investment. For asset *changes* through extraction, other accumulation and other volume changes, the net price and, alternatively, the user cost method have been proposed. Both methods can be seen as simplifications of the basic principle of measuring the change in net present value of the asset during the accounting period (Bartelmus, 1998).

177. Apart from applying a discount factor to net returns (in the user cost allowance), the two methods differ in catering to two different sustainability criteria: the net price is applied to (physical) non-sustainable use of the resource (see also step 5.7 in box 6) to obtain the monetary value of depletion, whereas the user cost allowance aims at (monetary) income maintenance by reserving a certain amount of the net returns for investment (see step 5.13 in box 6). The net price valuation and the user cost provide upper and lower limits for depletion and income maintenance cost estimates. This is evident from the definition of the user cost (see box 5) as the *difference* between the net rent/return and the perpetual income stream obtained from investing the user cost.

178. Box 6 summarizes the different activities that need to be carried out to estimate the monetary (market) value of natural asset stocks and changes therein during the accounting period. They are

Worksheet 5. Monetary asset accounts: non-produced economic assets

	Land/soil	Subsoil assets	Forests (economic functions)	Fishery resources	Water resources
Opening stock	See WS 4	See WS 4	See WS 4	See WS 4	(Use value of selected water bodies)
Gross fixed capital formation	Expenditures on land improvement, including: Land reclamation Clearance of forest land Drainage of wetlands Prevention of flooding or erosion	n.a.[a]	n.a.[a]	n.a.[a]	n.a.[a]
Depletion	Capital consumption: decline in the value of land improvement	Value of extraction	Value of non-sustainable cut	Value of non-sustainable catch	Value of non-sustainable abstraction
Degradation	Change in market value due to contamination and erosion	(n.a.)[b]	(n.a.)[b]	(n.a.)[b]	(n.a.)[b]
Other accumulation	Acquisitions less disposals of land Other: see WS 4	Acquisitions less disposals of subsoil assets Other: see WS 4	See WS 4	See WS 4	See WS 4
Other volume	See WS 4	See WS 4	See WS 4	See WS 4	See WS 4
Revaluation	Holding gains and losses	Holding gains and losses	Holding gains and losses	Holding gains and losses	(Holding gains and losses)
Closing stock	See WS 4	See WS 4	See WS 4	See WS 4	(Use value of selected water bodies)

[a] Not applicable.
[b] Difficult to estimate in practice.

the activities used to compile WS 5B by using the values recorded in WS 5A. The depletion and degradation rows of WS 5B contain the environmental cost to be incorporated into the production accounts of the SEEA as indicated in figure VII. Such incorporation requires the allocation of the depletion cost to depletion-causing activities, as carried out in WS 5C. Some of these activities are described below in more detail for the different assets.

(a) Land/soil

179. Land accounts are already dealt with in detail in the SNA. Acquisitions and disposal of non-produced, non-financial assets (land, subsoil assets) are capital transactions that do not affect capital formation, value added and income-generation; they are dealt with as a separate item in the capital accounts of the SNA (1993 SNA, paras. 10.120-10.130)[19] and the SEEA asset accounts (as other accumulation in WS 5). However, in the case of land there *can be* gross fixed capital formation defined as the total expenditures related to land improvement, including land reclamation, clearance of forest land, and drainage of wetlands, and to the prevention of flooding and erosion. Capital consumption (shown in WS 5 under "depletion") is the decline in the value of land improvement during the accounting period due to the depreciation of the produced capital acquired for land improvement. Land degradation consists of decreases in land quality that may affect the market value of land. The residual change in value, after accounting for other accumulation and other volume changes (see WS 5), is revaluation which includes holding gains and losses of land.

180. Contrary to the other asset categories, land is usually traded in the market, and market prices can be applied to the stocks and transactions. WS 5A shows the market prices applied to the land areas, resulting in the monetary asset accounts for land (WS 5B). The value of the land for all uses has increased during the accounting period. For example, the value of built-up land has gone up from 2,156,919 to 2,293,083 as a result of acquisition of land for building purposes (6,449), investment for land improvement (386), transfer of land from the environment (101,118) and revaluation (28,230).

181. As indicated in WS 4, the value of land can also be affected by contamination with toxic chemicals. It is hardly possible, however, in recurrent compilations of national accounts to assess that portion of the change in market value that is caused by such contamination, separately from the effects of other social and economic factors of supply and demand for different land categories and uses. WS 5 refers therefore only to soil erosion as a factor of land degradation, and WS 5A and WS 5B cost soil erosion as a matter of depletion (as was done in physical terms in WS 4A). Catering to the significance of productivity losses from land erosion (soil loss) in agricultural and other cultivated land, especially in developing countries, soil erosion is explicitly measured and costed in the SEEA. As already discussed in step 4(a), only direct erosion effects of economic activities are accounted for to avoid double-counting and to facilitate cost allocation to erosion-causing activities.[20]

182. Two types of valuations are commonly applied to assess the economic effects of soil loss: (a) the cost of nutrient replacement, as a maintenance costing approach and (b) the net price estimation applied to future net rents in sales of agricultural products lost due to decreased soil

Box 6. STEP 5: Valuation of natural resources (see WS 5A)

A. Net price method

5.1 Determine the market prices of different natural resource outputs:
Domestic or export price as applicable;
Price at the beginning and end of the accounting period and average during the period;

5.2 Assess the total production cost per unit of resource output:
Unit cost at the beginning and end, and average cost during the accounting period;

5.3 Assess normal return to the invested capital, used in the exploitation of the resource;

5.4 Determine the net operating surplus of the industry exploiting the resource;

5.5 Calculate the net price as the difference 5.1 - (5.2 + 5.3), or as the difference between 5.4 and 5.3.

B. Net rent method

This method is an alternative to the net price method, avoiding the calculation of a normal return to capital which has to adopt a controversial interest rate. It also prevents the occurrence of negative net rents due to exogenously determined rates of return to produced capital. The idea is to subtract the value of the produced capital stock K from the gross value of the resource stock (Born, 1997). The method is not presented in WS 5A.

Assess the replacement value of the produced capital stock K, at the end of the accounting period;
Calculate total net rent generated during the accounting period as {[(TR - C)/(quantity extracted)] times (total remaining resource stock)} minus K (where TR = total revenue from resource exploitation and
C = current extraction costs);
Use total net rent for valuing total resource stock directly or as the basis for applying the net present value method (see box 5).

C. Application of net price method

5.6 If the market value (at current prices) of the resource stock or the total net rent is not available, apply net price at the beginning of the accounting period to the physical opening stocks of non-produced economic assets (see WS 4A);

5.7 Apply average net price (during the accounting period) to changes of non-produced economic assets from exploitation/extraction (sustainable use and non-sustainable depletion), other accumulation and other volume changes (see WS 4A);

5.8 If the market value (at current prices) of the resource stock or the total net rent is not available, apply net price at the end of the accounting period to the physical closing stocks of non-produced economic assets (see WS 4A);

5.9 Calculate revaluation item as the balance between opening and closing stocks and all other changes listed in WS 5B;

5.10 Allocate depletion cost to causing activities (WS 5C), enter into SEEA for EVA I,[a] EDP I[b] and so forth calculation (see WS 9).

D. User cost allowance (as an alternative to A and B)

5.11 Establish the discount rate as the opportunity cost of next-best investment of the resource owner (in practice, rates between 3 per cent and 10 per cent have been chosen);

5.12 Estimate the lifetime of the resource at current exploitation rates;

5.13 Calculate the user cost allowance, applying the discount rate (5.11) and lifetime (5.12) of the resource to the current net return (net price times extraction/depletion of resource output);

5.14 Enter user cost allowance into SEEA for alternative EVA II,[c] EDP II[d] and so forth calculation.

[a] Environmentally adjusted value added at market values.
[b] Environmentally adjusted net domestic product at market values.
[C] Environmentally adjusted value added at maintenance cost (or combined market value/maintenance cost).
[d] Environmentally adjusted net domestic product at maintenance cost (or combined market value/maintenance cost).

Worksheet 5A. Market valuation of non-produced economic assets

Monetary unit per	(thousand km2)					(thousand metric tons)	(million metric tons)	(billion m3)	(million metric tons)	(million metric tons)
	LAND					SOIL	SUBSOIL ASSETS			
	Agricultural land	Forest land	Built-up land	Recreational land	Other land	(economic use)	Oil	Gas	Coal	Copper
A. Net price estimation										
(1) Market price										
At beginning of accounting period	17,611	6,144	501,609	11,606	19,231		70.5	33.2	9.4	20.0
At end of accounting period	18,136	6,358	509,574	13,293	19,958		64.3	31.6	9.6	27.0
Average during accounting period	17,874	6,251	505,592	12,450	19,595		67.4	32.4	9.5	23.5
(2) Production cost per unit of resource (including normal return to capital)										
At beginning of accounting period							31.8	11.3	3.3	9.0
At end of accounting period							25.4	11.5	3.5	7.0
Average during accounting period							28.6	11.4	3.4	8.0
(3) Net price = (1) - (2)										
At beginning of accounting period						2.7	38.7	21.9	6.1	11.0
At end of accounting period						3.1	38.9	20.1	6.1	20.0
Average during accounting period						2.9	38.8	21.0	6.1	15.5
B. User cost calculation (per unit of extraction)										
(4) n = estimated life span of resource							10.0	15.0	8.0	5.0
(5) r = discount rate							0.05	0.05	0.05	0.05
(6) Unit user cost = (3)/(1+r)^(n+1)							22.7	9.6	3.9	11.6

Worksheet 5A. Market valuation of non-produced economic assets *(continued)*

Monetary unit per	(million m3)			(million metric tons)		(thousand metric tons)	(billion m3)		
	FOREST (economic uses)			FISHERY RESOURCES		OTHER BIOTA	WATER		
	Coniferous	Deciduous	Mixed	Marine water Species 1	Freshwater Species 1	Species 1	Aquifers	Other groundwater	Other freshwater
A. Net price estimation									
(1) Market price									
At beginning of accounting period	26.8	30.9	23.8	125.7	102.5	58.9	10	7	4.5
At end of accounting period	27.3	34.9	24.8	138.5	98.7	62.8	12	9	5
Average during accounting period	27.1	32.9	24.3	132.1	100.6	60.9	11	8	4.8
(2) Production cost per unit of resource (including normal return to capital)									
At beginning of accounting period	17.4	22.0	14.4	58.8	42.8	12.1	8.6	5	3.2
At end of accounting period	17.2	22.4	14.9	60.2	42	21.3	8.9	5.6	2.8
Average during accounting period	17.3	22.2	14.7	59.5	42.4	16.7	8.8	5.3	3.0
(3) Net price = (1) - (2)									
At beginning of accounting period	9.4	8.9	9.4	66.9	59.7	46.8	1.4	2	1.3
At end of accounting period	10.1	12.5	9.9	78.3	56.7	41.5	3.1	3.4	2.2
Average during accounting period	9.8	10.7	9.7	72.6	58.2	44.2	2.3	2.7	1.8
B. User cost calculation (per unit of extraction)									
(4) n = estimated life span of resource									
(5) r = discount rate									
(6) Unit user cost = (3)/(1+r)^(n+1)									

Worksheet 5B. Monetary asset accounts: non-produced economic assets

(Monetary unit)

	LAND					SOIL	SUBSOIL ASSETS			
	Agricultural land	Forest land	Built-up land	Recreational land	Other land	(economic use)	Oil	Gas	Coal	Copper
Opening stocks	440,275	374,784	2,156,919	33,657	125,002		61,494	200,254	567	116
Gross fixed capital formation	53	49	386	4	3					
Sustainable use										
Depletion (including soil erosion) *	-3	-2	-19			432	-2,425	-3,087	-67	-3
Other accumulation										
Acquisition less disposal of non-produced non-financial assets	12,354	-18,804	6,449							
Other	5,362	-5,001	101,118	2,490	3,919		590	3,066	146	6
Other volume changes	-1,787	-625					-532	-378	-12	-2
Revaluation	773	31,715	28,230	5,057	4,796		312	-16,442		95
Closing stocks	457,027	382,116	2,293,083	41,208	133,719		59,439	183,413	634	212

(Monetary unit)

	FOREST (economic uses)			FISHERY RESOURCES		OTHER BIOTA	WATER		
	Coniferous	Deciduous	Mixed	Marine water species 1	Freshwater species 1	Species 1	Aquifers	Other groundwater	Other freshwater
Opening stocks	11,543	6,888	6,830	14,584	5,433	5,101	137	150	85
Gross fixed capital formation									
Sustainable use	-977	-550	-463	-2,251	-582	-706	-70	-27	-26
Depletion (including soil erosion) *	-29	-958	-820	-363	-58	-265	-7	-14	
Other accumulation									
Acquisition less disposal of non-produced non-financial assets									
Other	986	537	473	2,323	582	706	72	30	33
Other volume changes	-195	-142	-56	-73	-58	-265	-5	-3	-2
Revaluation	893	2,540	294	2,457	-270	-546	163	102	60
Closing stocks	12,221	8,315	6,255	16,678	5,046	4,026	291	238	150

* At net prices (see WS 5A). User cost (for subsoil assets only, at 5 per cent discount rate) are for oil: 1,419; gas: 1,411; coal: 43; copper: 2. For land, depletion is consumption of fixed capital in land improvement.

Worksheet 5C. Allocation of depletion costs to economic activities

(Monetary unit)

	Agriculture/hunting	Forestry	Fishing	Mining	Manufacturing	Electricity, gas and water	Construction	Public administration and defence	Final consumption
Soil (erosion)	432								
Subsoil assets				-5,582					
Forest		-1,446							-361
Fish			-421						
Other biota	265								
Water	-7								-14

productivity. The values of degradation costs shown as net price of soil in WS 5A can be interpreted as an application of either method, although the values of the second method are generally higher as they represent more fully the effects of soil degradation. By multiplying the average cost of soil erosion (2.9) with the total amount of soil lost (148.8 million metric tons in WS 4A) the total cost of soil erosion is obtained as 432 in WS 5B.

(b) Subsoil assets

183. Opening stocks and acquisitions/disposals of subsoil assets are valued at current market prices (if available) and treated as in the above-described land accounts. In the SEEA, as in the SNA, there is no capital formation in subsoil assets. Expenditures for mineral exploration, whether on own account or purchased, are treated as the acquisition of an intangible fixed asset, that is to say, capital formation of the mining industry. As aready discussed, new discovery, which may be the result of such explorative investment, is accounted as other accumulation. Since subsoil assets are non-renewable resources, all extraction is treated as depletion.

184. In the absence of market prices for mineral deposits, any of the valuations discussed in box 5 could be applied. WS 5A presents both the net price and user cost calculations. The net price should be calculated from (domestic or world) market prices of the processed ore (the metal content) rather than the extracted ore itself. Exploitation costs to be deducted from the market price of the processed ore include current costs of development, extraction, primary processing and transportation of the mineral, including depreciation of capital employed and a normal return to capital. The user cost allowance is calculated as an alternative, reflecting, as discussed above, an income (rather than a capital) sustainability concept.

185. If costs exceed the sales value, negative net returns may occur. In cases where negative net rents occur at the beginning and end of the accounting period, the monetary accounts of the resource will all be zero accounting for an economic disappearance (in SNA terminology: K.6). If the net rent occurs at the beginning (ending) of the accounting period and a positive value is obtained at the end of the period (an economic appearance : K.3), a zero value should be reported in WS 5A for the opening stock, and changes in stocks should be estimated at half the value of the closing stock.

186. WS 5B presents the monetary asset accounts for selected minerals using the net price method. No acquisition or disposal of the assets has taken place during the accounting period. Different movements of physical and monetary asset changes can be observed when comparing WS 4A and WS 5B. This indidates the need for examining both physical and monetary data in the assessment of natural resource exploitation. Only depletion is accounted as production cost (largest value for gas: 3,087, followed by oil and coal) of the extracting industries. In the case of coal and copper, the higher values of the closing stocks (opening stock for coal: 567; closing stock: 634) are brought about by discovery (146). Note that for coal the effects of a small price increase (from 9.4 to 9.6) are offset by statistical errors in the revaluation item.

187. Depletion cost at net price in WS 5B can be compared with the user cost indicated in the note to the table. Since the user cost can be seen as an application of a discount rate to the net-priced depletion value, it is generally lower than the net price calculation of depletion, amounting to 58 per cent for oil and 74 per cent for copper. As discussed above, this comparison provides a useful range, reflecting upper

and lower limits for the depletion estimates.

(c) Economic functions of forests

188. Depletion of the economic functions of forests consists mainly of logging beyond sustainable cut. Sustainable yield models, using time-series of logging by tree species, soil fertility, weather conditions and so forth, need to be applied in order to establish sustainable cut (see chap. IV, sect. A). The depletion cost of forest-land clearing by agriculture, construction and other economic activity should be allocated to the industry/sector conducting the depleting activity. In WS 5C, these costs are allocated to forestry (1,446) and household consumption (361).

189. The monetary accounts can be obtained by multiplying the volume of timber (WS 4A) by the stumpage value. This value is the maximum amount potential concessionaires are willing to pay for harvesting rights. Under perfect market conditions and rational market behaviour, this value reflects the net present value of the discounted expected net returns. However, as willingness-to-pay is difficult to assess, the net price -- defined as the difference between the market price (or unit export value) of timber and the cost of felling, extracting, transporting and milling a log, including a normal return to capital -- is frequently used as an approximation. In principle, the user cost allowance could also be calculated for income generated from non-sustainable use of forests.

190. All forest categories incurred depletion (-29 -958 -820 = -1,807) beyond sustainable use. As forests assets are rarely traded, no acquisitions or disposal is recorded in the asset accounts. Payments for the acquisition of logging rights are treated as royalties or rents in the 1993 SNA (para. 7.87) sense, that is to say, as property income from leases of tangible non-produced assets.

(d) Fishery resources

191. Fish and other aquatic species are also a renewable resource, requiring the modelling of sustainable catch. The explanatory variables in such models include fishing effort, allowing for different efficiencies of vessels, annual yields and other biological characteristics of the species harvested. Net price valuation is commonly applied. Of course, market valuation applies only to the economic functions/use values of the assets. Other (option or existence) values would have to be applied to capture the non-economic environmental value of fish species, forests and other biota (not further discussed in this manual: see sect. E, step 8).

192. The application of WS 5A to the physical accounts of WS 4A produces the monetary accounts for fish and other biota of WS 5B. Two representative aquatic and one other species are shown for illustrative purposes. Depletion cost for species totalled -686 (-363, -58, -265) to be deducted from the value added of the fishing and hunting industries.

(e) Water resources

193. As in other renewable resources, depletion beyond replenishment is the environmental cost of exploitation. In many cases, depletion will be measurable only for selected` permanently depletable water bodies such as lakes, aquifers and other groundwater. Depletion is assessed by applying the net price to the quantities depleted. However, prices of water provision might not be available, might differ considerably according to water uses and/or might be heavily subsidized. That the cost data of water provision vary considerably with regard to the water quality provided is an issue to be assessed in a maintenance costing approach (see step 8 below). Since non-sustainable water use takes place only in aquifers and groundwater in the example of WS 4A, depletion is accounted only for these categories (-7, -14) in WS 5B.

194. The large amount of revaluation -- greater, for example, than the value of the stock of aquifers at the beginning of the accounting period -- reflects dramatic price increases in WS 5A. The net price more than doubled for aquifers and increased by 70 per cent for other groundwater.

D. Accounting for environmental assets

195. Non-produced "environmental" assets are those for which neither ownership rights are enforced nor direct economic benefits (income) are derived from their use. Since many natural assets may exhibit both economic functions and benefits and non-economic "amenities" or environmental functions, they are quite similar in categorization to economic assets. Therefore the Classification of Non-Financial Assets (CNFA) (annex III) does not distinguish between economic and environmental assets but adds air as a non-economic asset.

STEP 6: Compilation of physical environmental asset accounts (optional)

196. Environmental assets thus include air, water bodies (excluding aquifers and groundwater accounted for only for their economic uses in WS 4 and WS 5), land (other than economic land of WS 4 and WS 5, but including forest and water ecosystems of high amenity value) and wild fauna and flora that might or might not be protected from economic use. The categorization of natural systems into ecosystems, ecozones, biomes, and so forth is a difficult task, usually addressed in systems of environmental or ecological statistics. Moreover, the identification and measurement of the different types of asset changes specified in the asset accounts are hardly possible.

197. WS 6 is therefore introduced in this operational manual as a link between physical statistics and indicators, obtained from environment statistics, and the environmental accounting framework for possible more detailed analysis of environment-economy interaction. Such analysis would mostly use physical data for establishing inventories of environmental assets and changes therein. The worksheet does not distinguish, therefore, between different categories of asset changes, as in WS 4, but presents changes in volume only. These changes may include transfers from/to the environment, as well as other natural processes and events. The monetary value of these assets, that is to say, the social benefits

of their existence , is difficult and controversial to assess. The compilation of environmental asset accounts is therefore not further discussed in this practical accounting manual.

198. The worksheet thus serves as a reminder only of certain quantitative and qualitative *changes* in the non-economic environment that could be measured in physical terms and costed when direct connections with economic activity can be established. This is the case in particular for emissions of productive and consumptive activities, resulting in quality changes of environmental media and biota, as indicated in the changes in quality row in WS 6.[21] Selected quality indices are taken up again in a separate worksheet in the software developed for this manual (see annex VII). The compilation of emissions and the application of maintenance costing to these data are discussed in the following steps.

E. Emission Accounts

STEP 7: Compilation of emissions by economic sector

199. Data on emissions, including discharge of wastes, from polluting sectors are compiled in WS 7. Such tabulations are typically found in environment statistics compendia. There are, however, no widely accepted international classifications. The most important pollutants and waste categories need to be identified separately since the costing of these impacts varies considerably by type of pollutant and waste. Polluting sectors are industries, households, government (including non-profit organizations) and the rest of the world. The latter is introduced to capture transboundary pollution transmitted through the pathways of air and water, or transported over land (and legally or illegally dumped abroad). The overall SEEA framework of figure VII refers also (in a separate box) to transboundary flows of pollutants as "external use of natural assets". Such flows across the borders of a country are presented in physical terms as emissions from and to the rest of the world in WS 7.

200. Data on pollution are typically compiled from monitoring stations. They provide measures of ambient concentrations of pollutants in environmental media of air, water and land/soil as a basis for estimates of environmental quality (changes). However, for the allocation of environmental costs to those sectors that caused them, as required in the maintenance costing approach of the SEEA (see step 8 below), emission rather than concentration data need to be obtained. As it is difficult to trace ambient concentrations back to their origins (both in time and space and by sector), emission coefficients are usually used for emission sources where direct measurements of emissions are not available. Those coefficients are available from research or engineering studies, other countries with a similar economic structure and international work on "typical" industries and their emissions. Of course, any such listing would have to be adapted to the particular economic and technological characteristics of national production and consumption patterns (see chap. IV, sect. E).

Worksheet 6. Physical asset accounts: non-produced environmental assets

	Land and other ecosystems (forest, water, and so forth) (km^2)	Rare and endangered species of fauna and flora (number)	Air
Opening stock	Area of land not covered in the economic asset accounts (WS 4)	Population	n.a.[a]
Changes in volume	Changes in classification (transfer of land from/to economic to/from environmental use and changes in ecosystem boundaries) Changes in area due to natural, political or other non-economic causes	Status change of species (from/to economic to/from environmental) Changes in number due to natural disasters Net natural growth Number of species introduced	n.a.[a]
Closing stock	Area not covered in the economic asset accounts (WS 4)	Population	n.a.[a]
Changes in quality[b]	Soil erosion (metric tons) Land contamination (loading and ambient concentration) Forests affected by disease and acid precipitation (change in area or volume) Change in water quality (index)	Species affected by disease (change in numbers)	Change in air quality (index)

[a] Not applicable.

[b] Quality measures are not part of the asset accounts, but are relevant for estimating environmental degradation cost -- either for tracing the cost caused by economic activity or for applying damage valuations.

201. As in the case of renewable resources, where regenerative capacities may reduce the long-term effects of resource use, only emissions that cannot be safely absorbed by environmental sinks should be recorded and costed, in application of the sustainability principle. Standards set by the national Government or by international agreements can be used as proxy of sustainable emissions. Emissions (estimated in most cases by input or output coefficients) and in some cases ambient concentrations that are mitigated by emitting industries, government or other agents during the accounting period should not be valued in maintenance costing. A simplifying assumption would be to regard all emissions that cannot be abated using current technologies as safely absorbed by the environment. Alternatively, avoidance costing would require the abstention from using particular production and consumption processes, with maintenance costs estimated as corresponding income (value added) losses.

202. WS 7 shows the emissions by type of pollutant and emitting sector in physical terms. Comparison of emissions of particular pollutants by different sectors reveals that the bulk of sulphur dioxide (SO_2) is generated by manufacturing (981,700 metric tons), the energy sector (655,400 metric tons) and households (472,700 metric tons), while suspended particulates are mostly the responsibility of electricity-generation (total suspended particulate matter (TSPM): 200,600 metric tons). The country is also a net exporter of pollutants through waterways (1,621,700 metric tons biochemical oxygen demand (BOD)) and the air (SO_2: 85,900 metric tons - 43,000 metric tons = 42,900 metric tons); it also contributes 528,400 metric tons (483,700+19,500+4,700+20,500) metric tons of carbon dioxide (CO_2) per year to atmospheric pollution. The worksheet also demonstrates the limited use of physical data for comparisons of different pollutants. One possibility would be to apply equivalent factors in order to convert tons into relative contributions to a particular theme such as global warming from greenhouse gases.[22]

STEP 8: Maintenance costing of emissions

203. The rationale for maintenance valuation of impacts on environmental assets is discussed in chapter II, section D.2. WS 8 presents the environmental costs of net (beyond absorption/ mitigation: see step 7) emissions specified in WS 7, except for transboundary emissions. The valuation as transfers from and to the rest of the world is controversial.[23] Transboundary transfers to other countries and global commons such as the atmosphere (CO_2) or oceans are therefore omitted in WS 8.

204. In the case of land degradation, wastes and emissions may affect land values owing to land quality changes. These quality changes are accounted as other changes in volume in the asset accounts of the 1993 SNA (para. 12.33). Contrary to the case of depletion or economic disappearance , in SNA language, where the depletion effects can be directly allocated to the depleting activity, it would be difficult to allocate land quality changes as cost from the asset accounts to particular sectors (and time periods) of the production accounts. In practice, land quality changes are rarely compiled in asset accounts, and maintenance costing would be directly applied to the causing economic activity.

Worksheet 7. Emissions by economic sector

(Thousand metric tons)

	Manufacturing	Electricity, gas and water	Government	Households	Rest of the world from	Rest of the world to
Air						
SO2	981.7	655.4	38.3	472.7	43.0	85.9
NOx	69.6	8.5	9.5	95.2	2.4	5.5
TSPM		200.6	6.2	36.4		
CO2	483.7	19.5	4.7	20.5		
Water						
BOD	12,243.5	24,769.1	7,146.2	9,899		1,621.7
Land/soil						
Wastes/contaminants	13,287	6,373	15,391	23,208	1,165.2	

Worksheet 8. Maintainance cost of emissions by economic sector

(Monetary units)

	A. Cost per thousand metric tons				B. Total cost			
	Manufacturing	Electricity, gas and water	Government	Households	Manufacturing	Electricity, gas and water	Government	Households
Air								
SO2	0.907	0.907	0.907	0.907	890	594	35	429
NOx	4.668	4.668	4.668	4.668	325	40	44	444
TSPM	3.057	3.057	3.057	3.057		613	19	111
Water								
BOD	0.026	0.027	0.023	0.029	318	669	164	287
Land								
Wastes	0.014	0.019	0.011	0.011	183	122	169	255
Total					1,716	2,038	431	1,526

205. The maintenance costs, applied to emissions, reflect the most efficient (least-cost) practices and technologies applicable in abating/mitigating current emissions, thus maintaining the waste/pollution absorption capacity of environmental assets. In practice, best-available technologies applied to current production and consumption processes would in some cases be capable of abating only part of the emissions generated during the accounting period. Remaining emissions would have to be endured , as their removal should be considered suboptimal (owing to marginal costs exceeding social standards) in simulated markets. It is often assumed that these remaining emissions are safely absorbed by the environment, or are within the set standards. Alternatively, the cost of avoiding the polluting activity altogether, in order to meet an explicitly set standard, would have to be estimated.

206. Maintenance cost applies to flow variables and represents the imputed cost to meet environmental regulations so as to maintain environmental quality. Box 7 describes the activities that need to be carried out to determine the maintenance cost required for conserving the environmental sink functions of natural assets. An important source of raw data for maintenance costing are databases of technologies held by research institutes. Governments also increasingly collect physical characteristics and cost data of best-available technologies for administrative purposes such as the granting of authorization to operate installations (permits). An example of this trend is the reporting and information exchange mechanisms set up in Europe through the European Union s Council Directive 96/61/EC of 24 Septembeer 1996 concerning Integrated Pollution Prevention and Control (IPPC). Data from such sources contribute the first step towards increased comparability. However, they are incomplete, especially for cost data.

Box 7. STEP 8: Maintenance costing of emissions

8.1 Assess the minimum cost activities (see chap. II, box 2) for avoidance/abatement/mitigation of environmental degradation by means of industrial surveys of environmental protection expenditure or research on environmental technologies (for example, technology databases).

8.2 Apply minimum unit costs of WS 8 (part A) to emissions presented in WS 7 so as to obtain part B of the worksheet.

8.3 Enter environmental maintenance costs in an alternative version of the SEEA and add to depletion cost (for calcuation of EVA II, EDP II and so on, see steps 9 and 10).

207. The total costs of part B of WS 8 are calculated by multiplying the emissions (in metric tons) of WS 7 by the unit maintenance costs of part A of WS 8. For simplicity s sake, WS 8, part A, reports values of unit maintenance costs for highly agregated economic sectors. However, costs may vary considerably in practice, depending on different production/consumption processes applied in industries and households. WS 8 (part B: total cost) shows air pollution and water pollution to be the country s major environmental degradation problems. Pollution is generated by manufacturing (1,716), utilities (2,038) and private and public households (431+1,526=1,957) at similar (cost) levels. SO_2 is responsible for over a third (1,948) of the total (hypothetical) avoidance cost (5,711).

F. Presentation and analysis

208. The present section describes the final steps for the aggregation, summary presentation and interpretation of the results of an environmental accounting project. Tabulations presenting the results of the project figure prominently in the final project report or publication. For a pilot project, this report would be the main tool of evaluating the results and making recommendations for the more permanent institutionalization of environmental accounting (see chap. VI). The report should also assess the use of environmental accounts in direct policy support, including management of particular natural resources and pollution control, and should suggest further analysis of the figures in modelling and research.

STEP 9: Aggregation and tabulation

209. Aggregation of the physical accounts is limited to selected natural resources and environmental concerns. Aggregation across assets and environmental themes (see note 22) requires a common numeraire such as the market value or maintenance cost. The application of monetary valuation to physical stocks and stock changes thus permits the calculation of environmentally modified aggregates such as natural capital/wealth, environmentally adjusted value added (EVA) and environmentally adjusted net domestic product (EDP).[24]

210. WS 9 presents the results of the above-described compilations of monetary values of natural asset stocks and their depletion and degradation, accounted as environmental cost of production. The accounting rules and identities allowing the presentation of these values in the SEEA framework were described in chapter II. The links between the SEEA framework and the worksheets are shown in figure VII. WS 9 thus represents the compiled integrated environmental and economic accounts presented in figure VII, filled in with the results of WS 2A, 3A, 5B, 5C and 8B. Step 10 provides a comparison of the conventional and environmentally adjusted accounting indicators presented in WS 9.

STEP 10: Comparison of conventional and environmentally adjusted indicators

211. WS 10A presents a summary comparison of conventional and environmentally adjusted indicators obtained from WS 9. Environmentally adjusted net domestic product at market values (EDP I) (208,926), calculated as NDP (217,454) minus depletion cost (7,721 + 375 + 432 (cost of soil erosion[25]) = 8,528), reduces NDP by almost 4 per cent. The move from EDP I to environmentally adjusted net domestic product at maintenance cost (EDP II) (203,214), that is to say, the additional accounting for environmental impacts (4,618 - 432 (cost of soil erosion) +1,526 = 5,712), decreases NDP further by almost 3 per cent to a total of 6.5 per cent of NDP.

212. Environmental costs in WS 9 (5,712 + 8,528 = 14,240) are mirrored in the SEEA asset accounts in volume changes of capital disaccumulation (depletion: -5,582 - 1,807 - 421 - 265 -20;

Worksheet 9. Integrated environmental and economic accounts

(Monetary units)

			Agriculture	Forestry	Fishing	Mining	Manufacturing	Electricity, gas and water	Construction	Public administration and defence	Other industries	Total industries
Opening stocks												
Supply	Output		27,127	9,183	2,201	20,608	240,810	9,618	60,808	29,329	131,786	531,470
	of which: environmental protection products						1,848		1,313		20,716	23,877
Intermediate and final uses	Intermediate consumption and final use		13,406	4,490	1,016	11,916	174,100	4,333	27,937	10,505	42,388	290,091
	of which: environmental protection products						1,788		24		16,222	18,034
	Consumption of fixed capital		4,528	885	272	2,303	7,436	1,307	2,311	916	3,967	23,925
Economic use of natural assets	Depletion	Minerals				5,582						5,582
		Forest products		1,446								1,446
		Fish			421							421
		Other biota	265									265
		Water	7									7
		Subtotal	272	1,446	421	5,582						7,721
	Shift										1,901	1,901
	Degradation	Land/soil	432				183	122		169		907
		Air					1,215	1,247		98		2,561
		Water					318	669		164		1,151
		Subtotal	432				1,716	2,038		431		4,618
Gross value added			13,721	4,693	1,185	8,692	66,710	5,285	32,871	18,824	89,398	241,379
Net value added			9,193	3,808	913	6,389	59,274	3,978	30,560	17,908	85,431	217,454
	Compensation of employees		2,923	2,281	235	2,140	31,701	1,014	21,553	17,904	32,837	112,588
	Operating surplus		5,727	1,340	664	3,827	17,903	2,641	6,336	4	37,790	76,233
	Taxes less subsidies on production and imports		542	187	14	422	9,670	323	2,671		14,804	28,633
Environmentally adjusted value added			8,490	2,362	492	807	57,558	1,940	30,560	17,477	83,530	203,214
Other accumulation												
Other volume changes												
Revaluation												
Closing stocks												

Worksheet 9. Integrated environmental and economic accounts *(continued)*

(Monetary units)

			Asset accounts										
				Natural "economic" assets							"Environmental" assets		
Imports	Exports	Government, households and NPISHs	Produced assets	Land	Soil	Mineral reserves	Forest	Fish	Other biota	Water	Land	Air	Water
			713,465	3,130,637		262,431	25,261	20,017	5,101	372			
-71,840	69,432	155,846	87,941	495 *									
-1,208	101	3,328	3,623										
			-23,925	-25 *									
						-5,582							
		361					-1,807						
								-421					
									-265				
		14								-20			
		375											
		255			-432						-729		
		984										-3,545	
		287											-1,439
		1,526											
				107,888		3,808	7	73		12			
			-268	-2,412		-923	-396	-131	-265	-9			
			1,302	70,570		-16,035	3,727	2,187	-546	325			
			778,515	3,307,153		243,698	26,792	21,724	4,026	679			

* Of which for land improvement.

Worksheet 10A. Comparison of conventional and environmentally adjusted aggregates

		Agriculture	Forestry	Fishing	Mining	Manufacturing
			(Monetary units)			
NDP[a]	217,454	9,193	3,808	913	6,389	59,274
EDP I[b] (EVA I[c])	208,926	8,490	2,362	492	807	59,274
EDP II[d] (EVA II[e])	203,214	8,490	2,362	492	807	57,558
(NDP - EDP II)/NDP	6.5%	7.7%	38.0%	46.1%	87.4%	2.9%
(NDP - EDP I)/NDP	3.9%	7.7%	38.0%	46.1%	87.4%	0.0%
C[f]/NDP	71.7%					
C/EDP II	76.7%					
NCF[g]/NDP	29.7%					
ECF[h]/NDP	23.1%					
NDP/CAP[i]	30.5%					
EDP I/CAP I[j]	5.0%					
CAP/CAP I	17.2%					
ICEP[k]/GDP[l]	7.5%					2.7%
GCFEP[m]/GDP	1.5%					

a Net Domestic Product.
b Environmentally adjusted net domestic product at market values.
c Environmentally adjusted value added at market values.
d Environmentally adjusted net domestic product at maintenance cost (or combined market value/maintenance cost).
e Environmentally adjusted value added at maintenance cost (or combined market value/maintenance cost).
f Final consumption.
g Net capital formation.
h Environmentally adjusted net capital formation.
i Capital stock (produced).
j Capital stock including (economic) natural capital at the beginning of the accounting period.
k Intermediate consumption for environmental protection.
l Gross domestic product.
m Gross capital formation for environmental protection.

degradation: - 432 - 729 -3,545 -1,439). WS 10A shows that the depletion of natural resources lowers environmentally adjusted net capital formation (ECF) by almost 7 per cent. As this still leaves the country with a positive amount of net capital accumulation overall, weak (allowing for capital substitution) sustainability of economic performance during the accounting period cannot be ruled out. The worksheet also presents environmental expenditures as percentage of GDP since net figures of capital formation for environmental protection are usually not available. Current expenditures (ICEP) are 7.5 per cent and capital expenditures (GCFEP) 1.5 per cent of GDP.

213. Reductions in capital productivity are reflected in the overall value added per unit of capital: NDP/CAP (30.5 per cent) and EDP I/CAP I (5.0 per cent). Note: CAP = capital stock, CAP I = capital stock including (economic) natural capital. The ratios indicate a dramatic overall reduction in capital efficiency resulting from the inclusion of natural capital and natural resource depletion. If land, whose productive contribution is difficult to assess, is excluded, capital productivity is lowered by about 10 per cent only (to 20.4 per cent). However, this overall ratio may hide large fluctuations for individual sectors which would have to be assessed by an appropriate breakdown of the produced and natural capital stock by holding industries.

214. The importance of environmental costs increases dramatically for particular sectors of the economy. The five industries shown in WS 10A display widely differing environmental cost. Mining incurs depletion cost which reduces its value added by nearly 90 per cent. As to environmental degradation, utilities generated environmental costs that about halved their value added.

215. WS 10B is an example of a more systematic and comprehensive analysis of the aggregates shown in WS 10A. It presents a percentage breakdown of the conventional and environmentally adjusted indicators of WS 10A, with added information on environmental protection (EP) expenditures, and exports and imports. The percentages presented in the left-hand column of WS 10B refer to components of NDP as measured in the SNA, while those in the right-hand column show the breakdown of EDP II of the SEEA. The differences between NDP and EDP analyses are explained by detailing the economic transactions related to natural assets , presented between the SNA and SEEA indicators.

216. The following explains how the elements in the middle of WS 10B relate to the economic and environmental aggregates presented in the SNA and SEEA columns:

(a) *NDP and EDP*: environmental charges less subsidies (-0.05 per cent for both NDP and EDP), intermediate consumption/use of environmental protection products (8.29 per cent and 8.87 per cent of NDP and EDP respectively) and uses of natural resources (5.67 per cent and 6.07 per cent) are identified as of which elements of NDP and EDP. EP expenditures (environmental charges less subsidies, intermediate consumption/use of environmental protection products) are identified in the middle of the table, according to the media they affect (land: 0.96 per cent, air: 3.32 per cent, water: 3.95 per cent). The cost of uses of natural resources by industries (as percentage of NDP) refers to depletion of forests (0.66 per cent), fish (0.19 per cent),

Worksheet 10B. Percentage distribution of conventional and environmentally adjusted indicators

SNA		Economic transactions related to natural assets as percentage of NDP								SEEA	
		Depletion					Degradation				
Conventional indicators	(as percentage of NDP)	Forests	Fish	Minerals	Water	Other biota	Land/soil	Air	Water	(as percentage of EDP)	Environmentally adjusted indicators
NDP	**100.00**									**100.00**	**EDP II (as percentage of NDP)** **93.45**
of which:											
Environmental taxes less subsidies	-0.05									-0.05	
Intermediate consumption/use of environmental protection products*	8.29						0.96	3.32	3.95	8.87	
Use of natural assets (depletion and degradation) by industries	5.67	0.66	0.19	2.57	0.00	0.12	0.42	1.18	0.53	6.07	
Final consumption of households and government	**71.67**									**76.69**	**Final consumption of households and government**
of which:											
Final consumption of environmental protection products	1.53						0.81	0.35	0.37	1.64	
Use of natural assets (depletion and degradation)	0.87	0.17	0.00	0.00	0.01	0.00	0.12	0.45	0.13	0.94	
Net capital formation	**29.66**									**24.48**	**Environmentally adjusted net capital formation** (Net capital formation adjusted for natural capital consumption)
of which:											
Gross capital formation on environmental protection equipment	1.67						0.51	0.54	0.62	1.78	
Exports	**31.93**									**34.17**	**Exports**
of which:											
Exported products for environmental protection	0.05									0.05	
Exports of natural resources	1.49	0.11	0.05	1.33						1.50	
Imports	**33.04**									**35.35**	**Imports**
of which:											
Imported products for environmental protection	0.56									0.59	
Imports of natural resources	0.34	0.17	0.12	0.05						0.36	

* Including environmental (depletion and degradation) cost of households.

minerals (2.57 per cent), biota (0.12 per cent), and degradation of land/soil (0.42 per cent), air (1.18 per cent) and water (0.53 per cent). These environmental costs are deducted from NDP in the derivation of EDP II;

(b) *Final consumption of households and government*: two of which elements are described, final consumption of environmental protection products (1.53 per cent of NDP) and use of natural assets by final consumers through the generation of wastes and emissions into air, land and water: 0.87 per cent of NDP. Note that adding this percentage to depletion and degradation by industries yields the total (6.54 per cent) shown in WS 10A;[26]

(c) *Net capital formation/accumulation*: environmentally adjusted capital formation decreases to 24.48 per cent of EDP from the conventional share of capital formation in NDP (29.66 per cent). Only fixed capital formation in EP equipment is identified as an of which element (1.67 per cent and 1.78 per cent). Capital formation, conventional and environmentally adjusted, is shown gross because no data are presented for consumption of fixed EP capital;

(d) *Exports and imports*: imports and exports of natural resources can be separately identified in conventional accounts. Imports may be indicative of depletion in other countries. Imports of timber (0.17 per cent), fish products (0.12 per cent) and minerals (0,05 per cent) are allocated, in the middle of the table, to (possible) depletion of forests, fish and minerals. The purpose is to show the dependence of the economy on the supply of natural resources from other countries. Similarly, exports of natural resources may be indicative of excessive use of natural resources to meet the demand from other countries. Total exports of natural resources is 1.5 per cent of NDP, four times larger than the share of imports over NDP, showing that the country under consideration is a relatively resource-rich country.

217. WS 10C is an example of how the analysis of WS 10B can be detailed for the different industries. The left-hand column of the table shows the percentage distribution of NDP by industries, and the right-hand column, the percentage distribution of EDP by industries and EVA/ NVA. As in WS 10B, the middle part shows the impacts of economic activities on natural assets, and economic responses to these impacts in terms of EP expenditures. The data in the middle part are expressed as percentages of the net value added (NVA) of each industry.

218. The contribution of forestry to NDP is 1.75 per cent while its contribution to EDP is reduced to 1.16 per cent. This is due to depletion caused by this industry, amounting to 38 per cent of value added. No EP expenditures were incurred during the accounting period by the forestry sector. In manufacturing, on the other hand, the costs of unabated environmental degradation amount to almost 3 per cent of NDP, with current EP expenditures[27] of about the same amount.

219. Further significant analyses of the data presented in the worksheets could be made for different time periods. For short- and medium-term analysis, structural change due to changing

Worksheet 10C. Contribution of industries to conventional and environmentally adjusted net product

		SNA	Economic transactions related to natural assets (percentage of net value added (NVA))				SEEA	
		percentage distribution of NDP by industries	Current environmental protection expenditures	Environmental taxes - subsidies	Gross fixed capital formation for EP	Use of natural assets	EVA/NVA (percentage)	percentage distribution of EDP by industries
Agriculture	Total	4.23				7.65	92.35	4.18
	Depletion					2.95		
	Degradation					4.69		
	Land					4.69		
	Air					0.00		
	Water					0.00		
Forestry	Total	1.75				37.95	62.03	1.16
	Depletion					37.95		
	Degradation					0.00		
	Land					0.00		
	Air					0.00		
	Water					0.00		
Fishing	Total	0.42				46.16	53.84	0.24
	Depletion					46.16		
	Degradation					0.00		
	Land					0.00		
	Air					0.00		
	Water					0.00		
Mining	Total	2.94				87.38	12.62	0.40
	Depletion					87.38		
	Degradation					0.00		
	Land					0.00		
	Air					0.00		
	Water					0.00		
Manufacturing	Total	27.26	3.02	-0.14		2.90	97.10	28.32
	Depletion					0.00		
	Degradation					2.90		
	Land		0.32			0.31		
	Air		0.97			2.05		
	Water		1.73			0.54		
Construction	Total	14.05	0.08	0.00		0.00	100.00	15.04
	Depletion					0.00		
	Degradation					0.00		
	Land		0.04			0.00		
	Air		0.04			0.00		
	Water		0.00			0.00		
Public administration and defence	Total	8.24				2.41	97.59	8.60
	Depletion					0.00		
	Degradation					2.41		
	Land					0.95		
	Air					0.55		
	Water					0.92		
Other industries	Total	41.12	17.24	-0.02		2.28	97.74	42.06
	Depletion					0.00		
	Degradation					2.28		
	Land					0.14		
	Air					1.40		
	Water					0.75		
thereof: Sewage and refuse disposal, sanitation and similar activities	Total		13.74					
	Depletion							
	Degradation							
	Land							
	Air							
	Water							
Total industries*	Total	100.00	8.29	-0.05	1.67	5.67	93.45	100.00
	Depletion					3.55		
	Degradation					2.12		
	Land		0.22	0.00	0.00	0.42		
	Air		0.65	0.00	0.00	1.18		
	Water		1.14	0.00	0.00	0.53		

*Excluding environmental (depletion and degradation) cost of households.

production and consumption patterns, environmental cost estimates and actual cost internalization could be usefully examined. Overall, time-series of EDP or environmentally adjusted capital accumulation could signal the sustainability or non-sustainability of economic growth, at least as far as natural capital consumption is concerned. Chapter V further elaborates on the use of SEEA results in assessing economic performance and growth, reforming economic policies and evaluating policy effects.

Notes

1. Note that transactions with the rest of the world are incorporated in the supply (imports) and use (exports) table, and the national income accounts (factor incomes, capital transfers and use of natural assets by other countries). Also, non-produced economic assets are distinguished from produced ones, owing to the different (from SNA) treatment of non-produced assets in the SEEA.

2. See, for example, Nestor and Pasurka (1998) for the use of input-output tables in compiling and analysing environmental protection expenditures and environmental employment.

3. Such deduction within an accounting system is questionable. The exclusion of defensive or any other undesirable activity from the economy would change the production boundary quite arbitrarily, since it is hardly possible to obtain consensus on what is desirable or regrettable in society. Moreover, simple deduction would not take into account the contribution of antecedent industries (for example, steel, cement, parts to waste treatment plants): deduction of indirect value added would require modelling that is outside the scope of environmental accounting.

4. Also, the net (value added) contribution of the EP goods and services industry to the economy cannot be measured with the data given in WS 2A, since the total intermediate consumption by this industry is not known in the present case, as indeed in most actual case studies. However, estimates could be made based on the number of employees, if available, or on ratios of average sales to value added by industry.

5. Such charges should be for environmental purposes, that is to say, to avoid depletion or degradation of natural assets, and are not to be mixed up with rents (in the SNA sense) or royalties from land/water use or the extraction of subsoil assets. These rents are property income paid to the owner of natural resources for the rights to exploit them (see 1993 SNA, paras. 7.128-7.133).

6. The existing classifications of individual consumption by purpose (COICOP), the Functions of the Government (COFOG), the purposes of the non-profit institutions serving households (COPNI) and outlays of producers by purpose (COPP) (1993 SNA, annex V, part I, sects. H-K) are currently further elaborated by the United Nations Intersecretariat Working Group on National Accounts. The revised versions show more detail on environmental protection expenditures (EPE) so that basic data will improve.

7. Actual experiments with input-output tables in the UNSD-supported projects did not provide useful results, as it was not possible to identify environmental protection outputs in the commodity classifications. However, in the United states of America an input-output framework was recently used to incorporate EP into the SEEA framework and to estimate indirect employment and value added attributable to the EP industry (Nestor and Pasurka, 1998). This is one of the methods recommended by Eurostat and the Organisation for Economic Cooperation and Development (Eurostat, 1998a; and Organisation for Economic Cooperation and Development, 1999).

8. The 1993 SNA and SEEA definitions of non-produced natural assets are further discussed below for

step 4, for non-produced economic assets, and in section D, for non-produced environmental assets.

9. Arguably, natural resources should include all assets that are currently exploitable, or likely to be so, for economic purposes, even if no explicit ownership or control is currently exerted over these resources (as, for instance, in the case of fish in the oceans or commercially exploitable timber in tropical forests). In practice, however, it can be assumed that the government will lay claim to any such assets, thus exercising more or less stringent ownership over all assets that are not privately owned. All these natural assets that may potentially provide economic benefits can thus be considered economic assets.

10. In the SNA, quality losses are treated as other economic disappearance of non-produced assets (1993 SNA, para. 12.33). The physical description of degradation of economic and environmental assets is typically part of systems or frameworks of environment statistics (see, for example, United Nations, 1984 and 1991). In order to facilitate linkage of environment quality statistics with environmental accounting data, the software developed for this manual introduces an additional worksheet (11) (see anex VI).

11. Note that depletion and degradation are not necessarily synonymous with losses of economic and environmental assets, respectively. Soil erosion, for instance, can be interpreted as a change in soil *quantity*, but can also be seen, and is here accounted for, as a change in the *quality* of agricultural land, in other words, land degradation. For reasons of simplicity, depletion is generally used here to mean the permanent loss of economic natural, non-produced assets, and degradation , the loss of environmental assets and asset functions.

12. Land reclamation is recorded as capital formation , in other words, as the result of a production process, in the SNA. For reasons of simplicity, land reclamation is included in other accumulation in the physical accounts of WS 4, but is shown separately as capital formation in the monetary accounts of WS 5. It is an open question whether such a treatment applies also to other non-produced natural resources, for example, in cases where forests increase as a result of reforestation. For the time being, net increase in forest volume is recorded as other accumulation in both physical and monetary accounts.

13. As the decrease in land quality is due mostly to nutrient loss, it has been suggested that soil erosion equals depletion of soil nutrient stock in full-fledged asset accounts for nutrients (Royal Tropical Institute and Food and Agriculture Organization of the United Nations, forthcoming).

14. Legal logging might be permitted in protected areas. In this case, forests should be treated as economic assets with environmental functions, as discussed above.

15. In Indonesia, a case study (Repetto and others, 1989) applied two measures of stock: (a) "volume over bark" (VOB) which is the volume from stump to crown point of the first main branch of all living trees more than 10 centimetres in diameter at breast height and (b) "volume actually commercialized" (VAC) which is the volume under bark of commercially logs exploitable actually extracted from the forest.

16. A Statistical Office of the European Communities (Eurostat) task force on satellite accounts for water is currently exploring the concept and measurement of potential water availability, taking into account hydrologic managerial constraints (Herrera and Bayo, cited in Møllgaard, 1997).

17. In-stream water use for purposes of transportation or recreation is dealt with as a form of land use (of "associated waters") (see step 4 (a) above).

18. In the SNA, capital formation and consumption are the consequence of shifting previously produced capital into production and consumption where it is gradually "consumed". Capital consumption is costed as the current prorated replacement value of physical wear and tear of the capital goods. For non-produced (natural) capital, such costing of the consumption of previously produced capital does not apply, and a more normative criterion of the long-term sustainability of production and income-generation has to be introduced (Bartelmus, 1998).

19. Note that there is an error in the heading X.D of the 1993 SNA (just above para. 10.120) which seems to classify acquisition less disposal of non-produced assets in capital formation by code No. P. 513, when indeed the correct code No. is K.2 (see 1993 SNA, annex V, part I.B.4).

20. Double counting could occur when maintenance costing was applied to an asset whose use might bring about erosion indirectly, for instance, through exposure of deforested land to wind and precipitation.

21. In some cases, a direct connection between an economic activity and a quantitative change of environmental assets can be made as indicated for forests (cleared) and species (captured or killed). The permanent loss of these assets could be valued in principle through maintenance costing (income forgone from forgoing the destructive activity). However, it is both conceptually and practically difficult to distinguish such activities and assets from economic depletion, as discussed in the preceding section, and this issue of quantitative change in environmental assets is not pursued further here.

22. See, for example, the theme indicators created in this manner by the Netherlands (NAMEA) (de Haan and Keuning, 1995). The problem with such indicators is that they are limited to particular policy themes and do not permit inter-theme comparison. Also, theme selection and definition will depend very much on a particular country s concerns and priorities.

23. In principle, a maintenance costing approach could be applied to the causing (pollution exporting) country.

24. It can be shown that under certain conditions, market values and maintenance costs are consistent and can be added and deducted from conventional indicators. Deduction of a hypothetical cost from observed market values is controversial, however (see, for a discussion of these issues and their relevance to environmental accounting, Bartelmus, (1998)).

25. Soil erosion is accounted as a degradation (of land quality) cost of agriculture, but is included as a depreciation cost of economic capital, affecting the productivity of agricultural land (cf. para. 181 above).

26. Cf. Chap. II, note 1, where the costing of pollution from consumption by households and government is explained.

27. No data on capital expenditures for EP were available or recorded during the accounting period.

CHAPTER IV

ACCOUNTS FOR SELECTED RESOURCES

A. Forest accounts

1. Environmental and economic concerns about forests

220. Environmental and economic concerns about forests have been expressed in numerous international forums and have given rise to various conventions, notably the International Tropical Timber Agreement (ITTA); the Tropical Forestry Action Plan (TFAP); the Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests (Forest Principles), (United Nations, 1993, resolution 1, annex III), adopted at Rio de Janeiro; the Agenda 21 (United Nations, 1993, resolution 1, annex II) action programme; the Convention on Biological Diversity (United Nations Environment Programme, 1992a); the United Nations framework Convention on Climate Change (document A/AC.237/18 (Part II)/Add.1 and Corr.1, annex I); and the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (document A/49/84/Add.2, annex, appendix II).

221. The main concerns are:

(a) *Economic:* linked to the sustainability of forests as a source of wood and non-wood products and economic activities that take place in the forest. The quantity and quality of forest resources decline because of forest logging, at levels greater than those of regeneration, for timber, fuel and fodder, and because of forest clearance to provide land for other uses;

(b) *Environmental* owing to the:

(i) Role of forests in the carbon cycle and the adverse consequences of large-scale deforestation on regional and global climatic balances;

(ii) Role of forests in the water cycle and soil erosion control: forest exploitation and clearance lead to various chains of interlinked problems, notably soil erosion and watershed destabilization;

(iii) Role of forests as a habitat and support of biodiversity: prevailing forest management practices contribute to a rapid loss of natural habitat diversity, species diversity and genetic diversity in forests, both natural and planted;

(iv) Degradation of forests due to acidification, fires, inappropriate forestry or logging practices;

(v) Recreational, aesthetic and cultural functions: the decrease of forests and the increasingly restricted access to forests impact particularly on communities that are dependent on forests for their livelihood and traditional cultural activities.

222. The increasing concern about sustainable forest use, either tropical, temperate or boreal, has led to the development of various instruments to monitor the health of the forest, changes in land use and the impact of forest on the national economy. These instruments include integrated environmental and economic accounting for forest, discussed in detail in the present section, and frameworks and lists of environmental statistics and indicators. Sections 2 through 4 provide an overview of the forests in the SEEA; section 4 deals with the implementation of its building blocks and section 5 discusses the step-by-step approach presented in chapter III.

2. Coverage of forests in the SEEA

223. The SEEA accounts for forest land and related ecosystems, biological assets (plants, animals and so forth) in the forest and other assets related to forests.

(a) Land

224. The SEEA reorients the SNA s land classification[1] towards environmental concerns. Wooded land is explicitly distinguished as a land category. Although excluded from SNA s economic assets, non-exploitable virgin forests are included in the SEEA classification of assets. Cultivated and uncultivated economic forest land is distinguished from non-economic (environmental) forest land. Table 2 shows the different classifications applied in country projects of environmental accounting.

225. Cultivated economic forest land corresponds to land over which ownership rights are enforced, and for which natural growth and/or regeneration of timber and other biological assets is under the direct control, management and responsibility of institutional units and is likely to produce economic benefits to the owner of the land. Plantations are typically cultivated forest land. In developed countries where native forests are rare, all exploitable forests are generally classified as cultivated economic forest land.

226. Uncultivated economic forest land corresponds to land over which ownership rights are enforced (including collective ownership by the government) but for which the natural growth and/or regeneration of timber and other biological assets is not under the direct control, management and responsibility of institutional units, although growth and regenaration are likely to produce economic benefits to the owner of the land. Land of tropical virgin native[2] forests that are exploited or exploitable in a foreseeable future is typically uncultivated economic forest land. Forest land used for provision of services, mainly recreation (that is to say, parks and so forth) is considered economic if the revenues generated from its use equal at least all of the costs of management, maintenance of access roads and the like.

227. Non-economic environmental forest land covers land of both protected and non-exploitable forests. It corresponds to forests, that are not exploitable for economic reasons (distance from markets, low productivity and accessibility and so forth), including virgin forests, and to forests where the exploitation of biological resources is severely restricted by virtue of the protection status.

Table 2. Forest classification in country projects

	CANADA	AUSTRALIA	THAILAND	GHANA	FINLAND	PHILIPPINES
Native forest (uncultivated)	**X**	**X**	**X**		**X**	
Of which non-exploitable	**X**	**X**		**X**		
For economic reasons (including "virgin" forests)	**X**					
For protection reasons (national parks, and so forth)	**X**			**X**		
Of which exploitable (for wood production)	**X**	**X**				**X**
Planted forests (cultivated)		**X**	**X**		**X**	
Of which for wood production (exploitable)		**X**			**X**	**X**
Of which for recreation						
Of which for protection (non-exploitable)						

(b) Ecosystems

228. Forest land, regardless of its classification (economic or environmental), may be categorized according to the associated ecosystems, for example, oak high forest or Mediterranean maquis and, within a certain category of ecosystem, further classified according to its state or health .[3] Despite progress made in the integration of new parameters by national forestry inventories (NFIs) (type of forests, management regimes, role in soil erosion and water cycle, biodiversity, health and so forth), no internationally agreed classification of ecosystems and their state is available at present.

(c) Biological assets

229. Biological assets are related to forest and other wooded land. They consist of animals and plants living in forests: trees and other flora of forests, fauna and so forth. Produced (cultivated) economic biological assets are distinguished from non-produced (wild or uncultivated) economic biological assets.

230. Produced economic biological assets related to forests are plants and trees growing in cultivated forests, either mature or immature, that yield products over which ownership rights are enforced and for which natural growth and/or regeneration is under the direct control, responsibility or management of institutional units. They are classified as:

(a) Fixed assets, when they yield repeat products (for example, trees for cork, gums, berries and so forth);

(b) Work-in-progress inventories, when they yield once-only products (for example, annual plants, trees of timber tracts and so forth).

231. Some animals living in cultivated forests can be considered cultivated (for example, livestock grown in forests, game introduced for replenishment in wooded areas for hunting and so forth). However, in general, fauna of forests is regarded as non-produced. The same applies to flora other than trees. By definition, the natural growth of a produced/cultivated biological asset, that is to say, the increase in value of an individual specimen during a given year as the result of biological development, is recorded as output in the production account and as gross capital formation or additions to inventories in the capital account of the corresponding economic activity - agriculture, farming, forestry.

232. Non-produced economic biological resources are animals and plants that yield products over which ownership rights are enforced but for which natural growth and/or regeneration is not under the direct control, responsibility or management of institutional units. Examples are trees in economic non-cultivated forests, wild fur animals, mushrooms, truffles, medicinal plants and so forth. Natural growth and offtake of non-produced biological assets as well as natural growth of non-cultivated biological resources and depletion of natural economic assets are recorded in the other changes in the volume of assets account in the SNA. In the SEEA instead, logging and other losses of timber due to economic uses (for example, loss of timber due to clearance of forest for agriculture) are classified under sustainable economic use and depletion . Depletion is defined as that part of the economic uses that exceeds the sustainable use, in other words, that impairs the long-term capacity of the forest to yield economic products. The same distinction applies to other non-produced economic biological resources. Accounting for non-wood products is usually difficult in practice because of lack of data.

233. Non-economic (environmental) biological resources are animals and plants living in forests. They do not yield products from which economic benefits are derived. They include trees in protected or inaccessible forests, fauna and flora without any commercial value and so forth. Biological resources, initially classified as non-economic, may change their classification from environmental to economic (for example, when illegal logging or hunting takes place in protected forests). In this case, one has to record first their economic appearance (in other accumulation) and then their depletion (non-sustainable use).

(d) Other assets related to forests

234. Other categories of assets related to forests include: produced assets such as forest roads and other structures, non-residential buildings, equipment for forestry and logging industries, accommodation for tourists or visitors and so forth when located in forest areas and used for forest-related activities and non-produced assets (for example, peat production).

3. Physical accounting

(a) Land and land-use accounts

235. Land accounting is an important aspect in the SEEA, as it is closely linked with several environmental concerns, including soil erosion, changes in land use, and so forth. In the absence of monetary valuation of environmental functions or uses of forests in the more practical versions of the SEEA and indeed the present manual, land accounting provides a measure of the changes in forest from which possible environmental consequences may be derived.

236. The SEEA includes accounts of areas under forest and wooded land, and matrices recording changes in classification of land during a given period. Through a classification of flows, these matrices of changes in land use can be related to economic activities and/or to natural causes. A typical forest account in area , as described in chapter III, worksheet 4, includes opening and closing stocks of forest land and all the changes therein. In order to describe in more detail forest areas and changes therein, such balances should be disaggregated by species, and types of forest (native or planted), as well as by the main categories of forest land (for example, economic cultivated, economic non-cultivated, protected, and so forth).

237. Forest balances measured in area are usually available from NFIs or land-use statistics. When official NFI or land-use statistics data are not available, estimates may be obtained from national or international research institutes or aerial and satellite photographs.

(b) Natural resource accounts for forests

238. As already described in chapter III, Worksheet 4, forest accounts show net changes in cubic metres of stocks of standing timber over time between the opening and closing stocks. Changes of stocks are due to natural growth, natural losses and gross removals. These accounts can be subdivided by species (conifers, broadleaves), age classes or other structural parameters. As far as possible, forest accounts should be compiled by species and type of forest (for example, cultivated, non-cultivated, high forest, coppice and so forth) and by age. The more detailed the breakdown of the classification is, the more accurate will be the linkage between area and volume data and physical and monetary data.

239. Forest accounts in volume are well known to foresters. They reflect, to a large extent, the information needed for forest resource management as they allow the relationships between stocks and flows to be monitored and evaluated. Forest accounts are also useful for establishing carbon balances and assessing carbon dioxide (CO_2) absorption.

240. Several country case studies (for example, those of Nordic countries, Thailand, the Philippines and Chile) have shown that the accounts are neither costly nor difficult to compile. Estimates of natural growth and natural losses are generally available through forest research projects or from international sources. Fellings can be assessed from production or external trade statistics. Other uses (charcoal, fellings for own account, and so forth), however, are more difficult to estimate.

(c) Commodity balances: uses of wood

241. Commodity balances correspond, although in a slightly different format, to the SEEA s physical accounts for the flows of products and raw materials. They show physical inputs and outputs of wood and wood products in the economy. The central part of the matrix, shown in table 3, depicts the raw material flows through wood processing industries. Table 3, extended to cover flows of residuals and specific uses (for example, energy uses), is highly informative and can be used for trend analysis regarding input coefficients in processing industries (material efficiency) and, combined with macroeconomic planning and forecasting models, for estimating future demand of forest products. The uses of forest products can be usefully examined for wood and non-wood processing industries. Table 4 shows a breakdown of the International Standard Industrial Classification of All Economic Activities (ISIC) up to 4-digits for wood processing industries.

Table 3. Commodity balance for wood products

(units: m^3)

	Products						
	Sawn logs	Firewood	Pulp wood	Sawn wood	Boards	Pulp	Paper
Net removals (from forests)	+	+	+				
+ Import	+	+	+	+	+	+	+
- Export	-	-	-	-	-	-	-
± Changes in inventories	+/-	+/-	+/-	+/-	+/-	+/-	+/-
= Total primary supply	=	=	=	=	=	=	=
- Uses by wood processing industries	-	-	-	-		-	
+ Total secondary supply	(+)			+	+	+	+
- Uses by non-wood processing industries	(-)	-		-	-		-
- Final uses	(-)	-					-

Note: Signs in parentheses reflect less important flows.

Table 4. Classification of wood processing industries

		ISIC classification	
Logging	part of 02		Logging and logging services activities
Sawing, etc.	20	2010	Sawmilling and planing of wood
		2021	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board and other panels and boards
		2022	Manufacture of builders' carpentry and joinery
		2023	Manufacture of wooded containers
		2029	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
Pulp industry	21	Part of 2101	Manufacture of pulp
Paper industry		Part of 2101	Manufacture of paper and paperboard
		2102	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
		2109	Manufacture of other articles of paper and paperboard

(d) Physical input-output table for wood

242. Mass balances by industry can be derived from physical input-output tables, applied to wood. These tables describe, for transformation processes of wood raw materials, the flows of main wood products entering the forest industries, energy use, output of by-products, and waste and emissions of wood-based residuals in a common denominator (1,000 metric tons of dry weight of wood content). The rows are the same as in the above sector/commodity balance. The columns, however, reflect the specific transformation processes of the raw and processed wood.

243. On the basis of the physical input-output table for wood, it is possible to show the total amount of wood used for energy, the total resource utilization rate and the wood-based emission volumes (notably organic matter emissions to water and biochemical oxygen demand (BOD)). The input-output tables complement the natural resource accounts and commodity balances for the study of carbon balances.

244. Numerous countries have drawn up, at least partially, natural resource accounts for forest: Canada, Finland, France, Ghana, Indonesia, Japan, the Philippines, the Republic of Korea, Thailand and United Kingdom, among others. Natural resources accounts are drawn up for 5- (or 10-) year periods (forest accounts), and for specific years in the cases of sector/commodity and industry mass balances.

4. Monetary accounting: valuation and aggregation

245. Monetary accounts are obtained by valuing the physical forest resource accounts, using the following valuation techniques. Table 5 shows valuation practices for selected countries.

Table 5. Valuation methods: country practices

	Finland	Canada[a]	Australia	Ghana	Philippines	Sweden
Timber						
Stumpage price[b]						
Discounted		**X**	**X**			
Non-discounted	**X**	**X**		**X**	**X**	**X**
Other[c]			**X**			
Land	**X**	**X**			**X**	**X**
Other biological						**X**

[a] Canada has experimented with several methods.
[b] Either observed on the market or calculated as a residual.
[c] Insured value for cultivated resinous forest in Australia.

(a) Valuation of land

246. Actual transactions of wooded land between institutional units are rather infrequent. Furthermore, in most cases, standing timber is sold together with the land, and it is difficult to separate the value of land from the value of the standing timber. By default, when such a separation is not possible, the composite asset should be classified in the category representing the greater part of its value (1993 SNA, para. 13.57). Countries with large forest areas that have no other significant market use than production of timber generally put a zero value on land (for example, Nordic countries).

247. If no market value is available or if it cannot be assessed indirectly from the observation of transactions on similar land, the value of the land has to be assessed by the discounted present value of expected future net returns, in other words, by the streams of economic rent on land over an infinite period. Economic rent on land is equal to net operating surplus/mixed income of productive activities carried out on the land less (imputed) interests on produced fixed assets engaged in the production and (imputed) compensation for non-salaried work.

248. Because the current market value of land can vary enormously according to location and the uses for which it is suitable or sanctioned, it is essential to identify the location and use of a specific piece or tract of land and to price it accordingly (1993 SNA, para. 13.56). A detailed classification of wooded land is thus necessary. This classification must refer to the capacity of land to generate income and economic benefits to its owner. This income-generation capacity depends not only on the species, dimension, age and uses of the wood, but also on the distance of the sawmill and the costs of logging and transportation, as well as on any present or potential other economic use of land, such as hunting, gathering of forest products, grazing of animals and future construction. The comparison between prices of land from actual transactions and the (calculated) sum of discounted streams of rent provides important insight into the meaning of prices and the validity of the discount rate in valuing standing timber.

(b) Valuation of standing timber

249. The SNA specifies the way standing timber must be valued. The value of cultivated standing timber is equal to the discounted future proceeds of selling the standing timber at today s prices after deducting the expenses of bringing the timber to maturity. The same method may be used with non-cultivated standing timber, in which case the expenses of bringing the timber to maturity are zero (1993 SNA, para. 13.49).

250. When calculating the discounted value of produced timber, one should ideally take into account the receipts and costs of thinning and so on, that is to say, the future receipts and costs of an optimal management of the forest. In practice, however, owing to the shortcomings of data, a simplified discounted value is generally used where the only receipt considered is that resulting from clear cutting of mature timber. A first valuation method therefore consists of calculating, according to the current age profile of the forest, the volume of standing timber that will arrive at maturity in future years, multiplying these volumes by stumpage price and then discounting the results. However, this method requires data on the current age profile of the forest and assumptions about the discount rate to be used.

251. A simplified method is often applied. Based on the assumption that the natural growth rate defines the internal rate of return to forestry and therefore offsets the need for discounting, the value of stocks is obtained by multiplying the volumes of standing timber by the stumpage price. Although timber is frequently sold while standing, the stumpage price may not be available. This is the case in particular when vertical integration of the forestry and logging industries with the pulp industry prevents the observation of prices for standing timber. The stumpage price has then to be inferred from data about the whole wood and pulp industry. Moreover, such integration and the oligopolistic structure of the market may result in prices that, although observable, are not representative of a true (free, competitive) market price.

252. By definition, timber standing in forests that are non-exploitable, either for legal or economic (inaccessibility and so forth) reasons, has a zero value. If the cost of logging, because of inaccessibility of the forest, is higher than the market price, then the resource rent will be negative. In that case, it is set equal to zero. Also, if the forest cannot be exploited because it provides other services (watershed protection, flood prevention and so forth), it could be assumed that the value of the resource is at least equal to the value of timber (Joisce, 1996). The SEEA, on the other hand, regards such non-exploitability, due, for example, to a logging ban, as transforming an economic asset into a non-economic one with zero economic value. Of course, any illegal logging beyond regrowth would have to be assessed as an economic depletion cost.

(c) Valuation of biological non-cultivated assets (other than timber)

253. Biological non-cultivated assets other than timber (wild fauna and flora) generally have no recognized market value as assets. Their value is included in the value of land or ecosystems. However, a value is recognized for the depletion (through harvesting, fishing or hunting) of these wild biota. Such a value is assessed from the value of corresponding goods on the market (furs, skins, meat and so forth). As previously indicated, in most cases this value is small and ignored in forest accounting. However,

in some cases (furs, truffles, mushrooms, wild animals and so forth) it may be important, and has to be estimated. This, of course, gives a supplementary value to the forest land.

(d) Segregation of SNA flows

254. For cultivated forest, transactions related to forests are already included in the conventional SNA and can be separately identified. Such transactions consist of:

(a) Output related to forest land;

(b) Costs related to the output: cost of plantations, access roads, fellings and so forth;

(c) Expenditures for protection of forest.

The segregation of the above flows allows assessment of the value of forest as timber and land, as well as the costs of the sustainable use of forests.

255. Output includes natural growth of cultivated forests, production of wood and non-wood products, fuelwood production, depletion of wild biota living in forests, and production of recreational services such as hunting. Environmental protection and management of forest activities include protection against fire, afforestation, protection against soil erosion, improvement of forest soils (reduction of acidification and so forth) and protection against game or insect attacks and so forth, as well as activities of control, monitoring and administration.

256. It would be useful, for policy purposes, to distinguish activities, that are carried out merely to increase forest exploitation (construction of access roads and so forth) from the activities of protection per se. Sources of financing public intervention could also be separately identified (Canadian forest management expenditure account) (Statistics Canada, 1997).

(e) Calculation of EDP

257. Two types of costs can be considered in the calculation of EDP:

(a) Environmental depletion and degradation costs at market value;

(b) Environmental costs at maintenance cost.

258. The conventional net domestic product is thus reduced by:

(a) The value of *depletion*, that is to say, that part of the value of the removals or losses of non-cultivated standing timber (and other forests non-cultivated biological assets) due to logging, harvesting, hunting and clearance of forest, which exceeds the sustainable use;

(b) The value of the decrease in the market value of land due to *degradation* resulting from forestry, logging or other forest-related activities and deforestation (clearance of forest land).

259. In order to calculate EDP at maintenance cost, the most efficient way to avoid the degradation of economic non-produced and environmental assets would have to be determined. In the case of forests, this would in most cases correspond to a limitation on logging, harvesting and clearance -- their reduction, to a level corresponding to sustainability and to the abatement of emissions which in turn have an impact on forests through acid rain. Therefore, maintenance costs correspond mainly to the abstention from or reduction in economic activities that attempt to relieve the pressures on forest areas.

260. The following would need to be assessed for such maintenance costing:

(a) The sustainable use of forests corresponding to different functions of the forest (carbon fixation, water retention capacity, prevention of soil erosion, protection of biodiversity, provision of recreational, cultural or aesthetic services and so forth);

(b) Corresponding (hypothetical) losses of income. These losses may be restricted to the value added directly forgone for the forestry and logging industry (when actual fellings are higher than the sustainable ones) or agriculture (when clearance of forests is made for agricultural land development purposes).

Alternatively, maintenance costs of forests could be interpreted as the imputed costs for monitoring protected areas, enforcing logging bans, protecting the forest from forest fires (mainly due to shifts in the use of land to agriculture) and so forth.

5. Implementation: a step-by-step approach

261. The present section discusses the step-by-step approach presented in chapter III as applied to forests.

(a) Adaptation of national accounts

STEP l: Compilation of the supply and use accounts

262. The objective of step 1 is to identify and separate, within the general supply-use tables, the transactions that are relevant for the description of forest assets and forest-related activities. Table 6 shows transactions of forest-related activities in separate columns of the industry classification. The main activities are forestry and logging, gathering of non-wood forest products, hunting and so

Table 6. Forest activities in the supply and use accounts

Worksheet 1

Assets balances by type of assets: **Produced Assets** (Standing timber, Other); **Non-produced economic assets** (Land, Standing timber, Other)

Supply and use accounts

Industries by ISIC

Output

Products by CPC	Agriculture	Forestry	Logging	Other	Total	Imports
Agricultural products	X	X				X
Natural growth		X	X		X	
Wood, logs			X		X	X
Other	X	X	X	X	X	X
Total	X	X	X	X	X	X

Intermediate consumption

Products by CPC	Agriculture	Forestry	Logging	Other	Total	Exports	Final consumption	Gross capital formation: Produced assets, Standing timber	Gross capital formation: Produced assets, Other	Gross capital formation: Non-produced, Land
Natural growth			X		X			X		-
Wood, logs				X	X	X	X		X	-
Other	X	X	X	X	X	X	X		X	X
Total	X	X	X	X	X	X	X	X	X	X

	Agriculture	Forestry	Logging	Other	Total
GDP	X	X	X	X	X
Consumption of fixed capital	X	X	X	X	X
NDP	X	X	X	X	X
Compensation of employees	X	X	X	X	X
Net taxes	X	X	X	X	X
Operating surplus	X	X	X	X	X

(Shaded) Cells corresponding to main forest-related products and industries.

forth, but also activities that result in deforestation (for example, agriculture, construction and so forth). With regard to those activities that produce emissions that endanger the forests (for example, through acid rain), their description is not specific to forest accounts but is developed in the emission accounts (steps 7 and 8 in chap. III).

263. Without disrupting the supply and use table, relevant transactions can be presented by adding columns for subclasses of the ISIC. Forestry is included, together with logging, in ISIC 02. As far as possible, transactions related to forestry and logging should be shown separately (see below). Forest-related products should also be shown separately, in particular natural growth of cultivated assets, wood in the rough and logs, non-wood products of forests and so forth.

264. Most national accounts do not yet follow the 1993 SNA requirement that natural growth on cultivated assets be recorded as output. For forest accounting purposes, it would be useful to assess the value of natural growth as output of the forestry industry, and to record natural growth less fellings as a change in inventories of cultivated standing timber (in other words, as gross capital formation, which includes work in progress on cultivated assets).

STEP 2: Identification and compilation of environmental protection expenditures related to forests

265. As indicated in section 4 (d), above, environmental protection expenditures related to forests include fire protection, afforestation, the improvement of forest soils (liming and so forth) and protection against game, insect attacks and so forth. As sustainable management of forest is increasingly becoming a current practice, forest environmental protection expenditure should also cover those actual extra costs that correspond to the sustainable use of forest , and all expenditures related to protected forest (control and so forth) and to forest monitoring (inventories).

266. Forest environmental protection expenditures are generally internal to the forestry industry. Except for some general government non-market output (fire protection, control and management of protected forests), they do not give rise to an output recorded as such in the general supply-use tables. Such expenditures may be described either in supplementary of which rows for forest environmental protection activities for the main transactions, that is to say, output, intermediate consumption, consumption of fixed capital, and so forth (see worksheet 2 in chap. III) or in a supplementary of which column.

STEP 3: Compilation of produced forest asset accounts

267. Produced forest assets consist mainly of inventories, that is to say, work in progress on cultivated assets. They correspond to the value of standing timber located on land cultivated for wood production. For the compilation of asset accounts for standing timber in cultivated forests, one has first to establish physical balances of standing timber, and then to value the volume by the respective price estimates. Table 7 shows the monetary asset accounts for produced forest.

268. As indicated in section 4, a simplified way for the valuation of stocks and changes in stocks of standing timber is to multiply the volume by the stumpage price , without discounting. Changes in inventories are the result of natural growth (that is to say, output of forestry) less fellings (that is to say,

intermediate consumption of logging). Other changes in volume are:

(a) Losses of standing timber due to forest fires and other exceptional events, as long as they are not included in fellings;
(b) Changes in economic uses or classification, as in the case, for example, where standing timber in a forest becomes protected during the accounting period.

Depending upon data availability, inventories in standing timber may be described at various levels of disaggregation (resinous, broadleaves and so forth). The revaluation item is the value of holding gains, in other words, the change in value of stocks of standing timber due to changes in (stumpage) prices.

Table 7. Cultivated forest accounts

	Produced assets					
	Inventories					Fixed capital (Orchards, cork oaks and so forth)
	Standing timber			Other	Total	
	Resinous	Broadleaves	Total			
Opening stocks	**X**	**X**	**X**	**X**	**X**	**X**
Capital formation	**X**	**X**	**X**	**X**	**X**	**X**
Gross fixed capital formation						**X**
Changes in inventories	**X**	**X**	**X**	**X**	**X**	
Consumption of fixed capital						**X**
Other changes in volume						
Forest fires, tempests	**X**	**X**	**X**		**X**	**X**
Other	**X**	**X**	**X**	**X**	**X**	**X**
Revaluation	**X**	**X**	**X**	**X**	**X**	**X**
Closing stocks	**X**	**X**	**X**	**X**	**X**	**X**

(b) Natural resource accounting

STEP 4: Compilation of physical forest accounts

269. Two main categories of non-produced economic assets (already described in the SNA) are detailed here:

(a) Economically used land (specifying forest land);

(b) Standing timber in economic non-cultivated (native) forest.

270. Table 8 describes in physical units (km^2) the area of *land*. In accordance with chapter III, only economic land is recorded in the table; protected land, land of unexploitable native forests, and so forth are accounted for in worksheet 6. The main changes that affect land areas and relevant for forest accounts are:

(a) Deforestation and afforestation: for example, change from forest land to agricultural land and land underlying buildings and vice versa;

(b) Transfers (gains): for example, from environmental (non-economic) forests to economic forests;

(c) Transfers (losses): for example, from cultivated (economic) forest for wood production to protected (non-economic) forest;

(d) Changes in classification: for example, conversion of a non-cultivated (native) forest to a cultivated forest;

(e) Quality changes, when land is classified according to quality classes.

Table 8. Physical non-produced economic asset accounts

	Economic non-produced assets				
	Non-cultivated standing timber (m^3)	Land economically used (km^2)			Other
		Forest	Other	Total	
Opening stocks	**X**	**X**	**X**	**X**	**X**
Economic use					
Sustainable use	-				-
Depletion	-				-
Other accumulation					
Natural growth	+				+
Deforestation	**(-)**[a]	-	+		
Afforestation		+	-		
Transfers (gains)	+	+	-		
Other volume changes					
Catastrophic losses	-				
Natural colonization		+	-		
Transfers (losses)	-	-	+	+/-	
Changes in classification	+/-	+/-	+/-	+/-	
Other					
Closing stocks	**X**	**X**	**X**	**X**	**X**

[a] Losses of timber due to land clearing (deforestation), when not included in "economic use".

271. The main changes that affect standing timber located on *non-cultivated* (native) *forest* are natural growth, sustainable use, depletion and catastrophic losses (for example, fires). Changes in stocks of standing timber may also be the counterpart of changes in land use (transfers and changes in classification). Other non-cultivated economic assets are mainly wild biota (flora and fauna) in forests.

STEP 5: Valuation of forests: compiling the monetary accounts

272. In step 5, a monetary value is given to stocks and flows related to non-produced economic assets. Table 9 shows the details for forest and land of the items already presented in WS 5. Valuation techniques applied to calculate the monetary accounts were discussed in chapter III and in section 4 of this chapter.

Table 9. Monetary non-produced economic asset accounts

	Economic non-produced assets				
	Non-cultivated standing timber	Land economically used			Other
		Forest	Other	Total	
Opening stocks	**X**	**X**	**X**	**X**	**X**
Acquisition less disposals		**(+/-)**	+/-	+/-	
Gross fixed capital formation		**(+)**	+	+	
Economic use					
Sustainable use	-				-
Depletion	-	-	-	-	-
Other accumulation					
Natural growth	+				+
Deforestation	**(-)**[a]	-	+		
Afforestation		+	-		
Transfers (gains)	+	+	+	+	
Other volume changes					
Catastrophic losses	-				
Natural colonization		+/-	-/+		
Transfers (losses)	-	-	-	-	
Changes in classification	+/-	+/-	+/-	+/-	
Other	+/-	+/-	+/-	+/-	
Revaluation	+/-	+/-	+/-	+/-	+/-
Closing stocks	**X**	**X**	**X**	**X**	**X**

[a] Losses of timber due to land clearing (deforestation), when not included in "economic use".

273. Stocks of standing timber on non-cultivated forest at the beginning and the end of the accounting period are valued by their respective stumpage prices. Natural growth and depletion, as well as the other changes that affect the volume of standing timber, are valued at average (beginning and ending) stumpage prices.

274. Economic land is recorded in the SNA monetary balance sheets at market prices. Although the SNA recommends that the value of forest land be separated from the value of standing timber, in practice this is not done. Therefore, one should pay particular attention to double-counting when compiling timber and forest land monetary accounts. Changes in the value of forest land may be due to decline in the productivity (defoliation and so forth) of the land. If it is possible to separately identify such changes from changes merely due to changes in prices, they should be recorded in a specific row for degradation (not reported in the table).

STEP 6: Compilation of physical environmental forest accounts

(c) Environmental degradation accounting

275. As shown in table 10, step 6 describes:

(a) All non-economic land, in other words, all the land that is not described in step 4, except forest land, and associated ecosystems;

(b) All non-economic forests (areas of forest land and volume of standing timber) and associated ecosystems;

(c) Other environmental, in other words, non-economic, assets: fauna, flora, water, air and so forth.

This step is necessary to complete the description of all stocks of forest land and standing timber and all changes that affect these stocks, including transfers between the various categories of forests (from the economy to the environment and so forth).

276. The comprehensive description of non-economic forests necessitates a classification of ecosystems (type of forest and so forth) and state of forest, from an environmental and ecological point of view, for example, level of defoliation, biodiversity and so forth.

Table 10. Physical environmental assets

	Environmental (non-economic) assets			
	Land and terrestrial ecosystems (excluding forest)	Forest and forest land (protected, unexploitable and so forth)		Other assets related to forests
	(km^2)	(km^2)	(m^3)	(various units)
Opening stocks	**X**	**X**	**X**	**X**
Economic use				
Deforestation		-	-	
Other accumulation				
Net natural growth			+/-	
Transfers (losses)	-	-	-	
Other volume changes				
Transfers (gains)	+	+	+	
Catastrophic losses and so forth			-	
Changes in classification	+/-	+/-	+/-	
Closing stocks	**X**	**X**	**X**	**X**

STEP 7: Compilation of emissions by economic sector

277. Step 7 refers to three main categories of emissions:

(a) Emissions by forestry and related industries;

(b) Emissions that affect forests;

(c) Absorption of carbon dioxide (CO_2).

As to the first category, there are few pollutants directly linked with forestry and logging. However, production of paper pulp and use of wood and paper products result in black liquids, and wood and paper waste, which it may be useful to describe (for example, for carbon balance purposes). Emissions that affect forests and forest ecosystems are mainly emissions of acid atmospheric pollutants.

278. Absorption of CO_2 by forests and carbon binding in wood are important aspects of the global warming problem. These effects counterbalance partially CO_2 emissions due to combustion of fossil energy. CO_2 absorption is a complex phenomenon, as CO_2 remains stored, for long periods of time, in wood products, forest soils and roots. Only the CO_2 absorbed through natural growth can be easily estimated applying existing coefficients.

STEP 8: Maintenance costing of environmental degradation

279. Maintenance costing results in the assessment of the extra cost for the maintenance of the state of forests from a quantitative and qualitative point of view. Maintaining the state of forest supposes:

(a) The definition of a sustainable use of forest, that is to say, a sustainable level of forest-related activities, mainly logging;

(b) The reduction to a sustainable level of the impact on forests of non-forest-related activities.

280. The level of sustainable use of forests has to be defined through modelling. This is a complex task, as the model depends on physical parameters, such as the age structure of forest, biodiversity of forest ecosystems, ecological functions of forests (carbon binding), soil and water conservation and social preferences. The sustainable level may be defined either in terms of a reduction of the level of forest-related activities (forestry and logging), in terms of supplementary costs (for example, extra costs for new management schemes, plantations and so forth) or through a combination of both approaches. The costs of the most efficient combination have to be retained as the maintenance costs for forest-related activities.

281. In order to maintain the quality of the forest ecosystems, it may also be necessary to reduce the maintenance level of non-forest-related activities or to take supplementary environmental protection measures in order to reduce the negative impact of these activities on the forest ecosystems. Generally these costs, for example, costs for the reduction of acid atmospheric emissions, have to be assessed globally, as they cannot be related to forest maintenance. However, some activities directly affect the state of forests. For instance, in developed countries, the introduction and proliferation of game for hunting may result in the destruction of young trees. Also agriculture extension has frequently brought about deforestation. In these cases, the direct impact of these activities may either be suppressed by their reduction to a sustainable level from the forest point of view, or mitigated by extra cost (plantation, protection and so forth). In both cases, maintenance costs of income forgone or imputed environmental protection costs could be calculated.

282. When assessing maintenance costs associated with a sustainable use of forests, one has to ensure that double-counting is avoided. When, for instance, sustainable use is to be achieved through a reduction of fellings, maintenance costs may be roughly estimated by the corresponding reduction of the value added of logging. The value of the depletion allowance calculated in step 5 has therefore to be reduced accordingly.

B. Subsoil assets

283. The present section outlines the concepts and methods for the compilation of subsoil asset accounts, as recommended in the 1993 SNA and in the SEEA. It follows closely the methodology described in chapters II and III, but develops in further detail the issues related to the compilation of subsoil assets and reviews country practices. So far, no international agreement has been reached on concepts and methods for the accounting of depletion in general, nor for the compilation of subsoil asset accounts in particular. Nonetheless, several developed and developing countries have compiled accounts for subsoil assets and certain commonalities can be identified in these approaches.

1. Physical accounts

(a) Definition of stocks

284. Subsoil assets are defined in the 1993 SNA (p. 309) as proven resources of mineral deposits located on or below the earth s surface that are economically exploitable, given current technology and relative prices. ... Subsoil assets consist of coal, oil and natural gas reserves, metallic mineral reserves and non-metallic mineral reserves ... The SEEA adopts the same definition as the SNA. Some countries prefer a broader definition of reserves (see table 11 below) for two reasons: (a) data are usually reported for broader categories of reserves and (b) proven reserves are considered too limited for the long-term assessment of sustainability and for macroeconomic decision-making.

285. Subsoil assets are classified according to:

(a) The degree of geologic certainty;

(b) The degree of economic feasibility of the reserves.

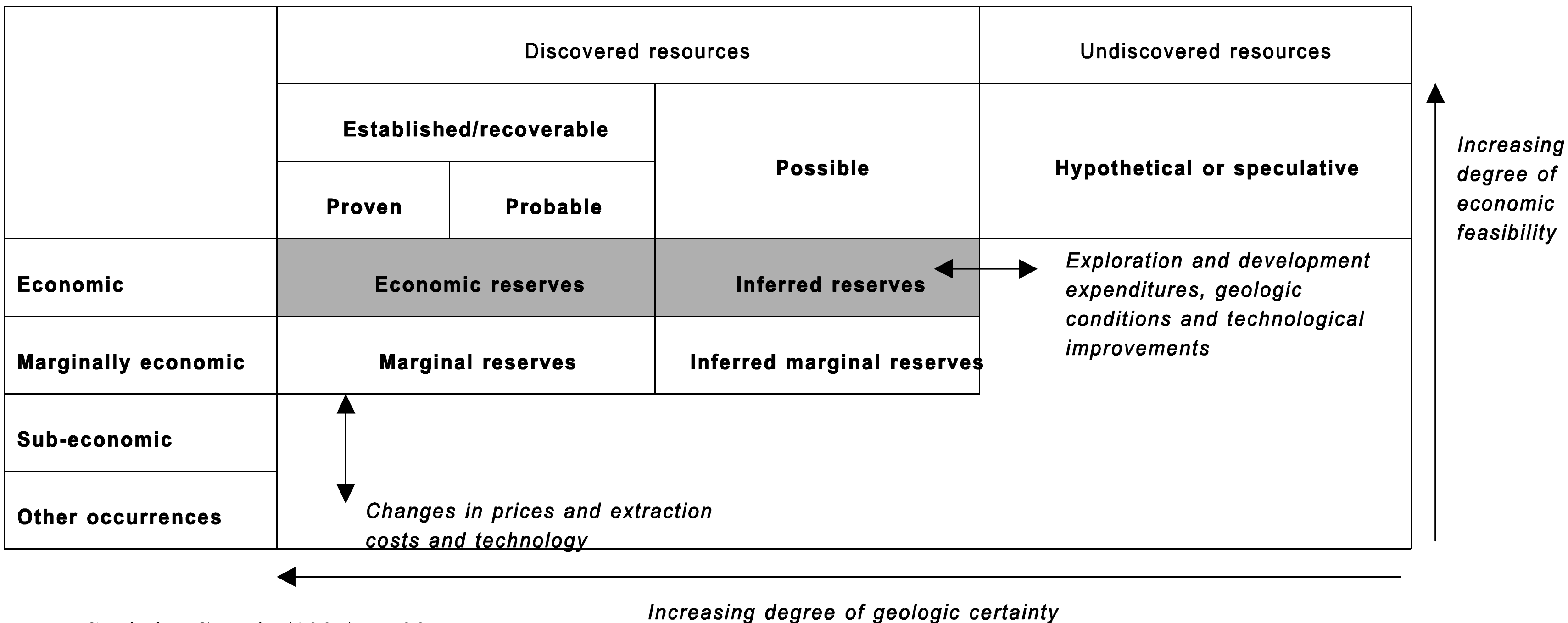
The McKelvey box of figure VIII illustrates the classification of subsoil resources with respect to economic feasibility (vertical axis) and geologic certainty (horizontal axis). The degree of geologic certainty categorizes resources as discovered (proven, probable and possible) or undiscovered. The boundary between discovered and undiscovered fluctuates as a result of exploration and development, differing geologic conditions and technological improvements. The degree of economic feasibility on the other hand categorizes the resources under economic, marginally economic and sub-economic according to the relationship between prices and extraction costs and technological exploitability.

286. The part of the resources that, from an economic point of view, is feasible to exploit and that has been measured with some degree of geologic certainty is defined as an economic reserve . This categorization of economic reserves (represented as shaded areas in figure VIII) is based on a certain probability of extracting the resources at profit. Different probabilities are used for weighting different categories in different definitions of economic reserves, as shown in table 11.

(b) Fixed assets or inventories

287. Subsoil assets are different from the stocks of both fixed assets and inventories, the major difference being that they have not been created by processes of production. Although they are neither fixed assets nor inventories, they present characteristics of both. The 1993 SNA assumes that all receipts generated from the use of natural assets can be recorded as income, specifically as part

Figure VIII. McKelvey box



Source: Statistics Canada (1997), p. 32.

Table 11. Economic reserves: definition and weights

	Proven	Probable	Possible	Undiscovered
Australia	X (1)	X (1)		
Canada	X (0.95)	X (0.90)		X (only physical)
Chile	X (0.)			
Korea, Republic	X (1)			
Netherlands	X (w)	X(w)	X(w)	
Norway	X(w)	X(w)	X(w)	X(w)
Philippines	X (0.81 -	X (0.71 -		
United Kingdom	X (1)	X (1)	X (1)	X (average between upper and lower boundaries)
United States	X (1)	Not included due to lack of data, but planned for inclusion in		

Sources: Australian Bureau of Statistics (ABS) (1997), Statistics Canada (1997), Banco Central de Chile and Servicio de Geología y Minería (SERNAGEOMIN) (1997), Kim and others (1998), Pommée (1998), Statistics Norway (1998), Domingo (1998), Vaze (1996) and United States Bureau of Economic Analysis (1994).

Note: The numbers in parentheses represent the probabilities of extracting the asset, at profit, from the reserves; *w* is the unspecified probability of recovering the resource.

of operating surplus. The implicit assumption is that assets are not exhaustible and therefore no deduction from the receipts is necessary. Some argue that there is a strong similarity between natural assets and fixed assets. Therefore depletion should be treated in a similar way to depreciation and deducted from NDP (United States Bureau of Economic Analysis, 1994; Hill and Harrison, 1994; Hill, 1998). Others treat depletion as withdrawals from the stocks of natural assets, similarly to inventories. Therefore, the whole value of the rent should be considered intermediate consumption and therefore deducted from GDP (Vanoli, 1997).

2. Valuation

288. The preferred method for valuing assets in the SNA are prices based on market transactions. However, in the case of subsoil assets, there may not be enough transactions to establish a meaningful market price. In this case, the SNA indicates that the value of the reserves are usually determined by the present value of the expected net returns resulting from the commercial exploitation of those assets, although such valuations are subject to uncertainty and revision (1993 SNA, para. 13.60).

289. Chapter III provides an overview of the valuation techniques commonly used and the assumptions underlying each method. The preferred method for the valuation of economic reserves is the net present

value, though it has to make use of discount rates (see below). On the other hand, empirical analysis has shown that the net price method, while circumventing the use of a discount rate, tends to overestimate the market value of the subsoil assets. The assumption of the Hotelling model, that, under perfect competition, the rents would rise in line with the rate of interest, may not hold in reality. Economic subsoil assets are, practically speaking, not finite, as additions to the assets, through discoveries or reclassifications, have been frequently larger than extractions. Moreover, world prices of minerals and quantity extracted are not governed by perfect competition.

290. The calculation of the net present value (see chap. III, box 6) for valuing subsoil assets involves the estimation of the resource rent, the choice of discount rate and the estimation of a normal return to capital. The life-length of the resource, that is to say, its availability under anticipated discovery and exploitation rates, also constitutes an important variable in the calculation of the net present value.

(a) Resource rent calculation

291. The resource rent represents the net return to the subsoil assets. It is usually estimated, as indicated in chapter III, as the difference between the revenue generated from selling the asset and the costs of extraction, including costs of materials, labour and a return to the produced capital but excluding taxes, royalties and other costs not directly related to the extraction process, or as net operating surplus plus specific taxes minus a return to capital.[4] The calculation of the net present value requires the estimation of future extractions and resource rents. It is usually assumed, because of lack of direct information, that current annual rates of extraction as well as resource rents remain constant for the remaining life of the reserves. In the case of several ores coexisting and mined together, there is a risk of double-counting the extraction costs in the calculation of the resource rent. In such cases, total costs have to be allocated to the different products on the basis, for example, of their contribution to the net revenue of the mine.

292. The values of subsoil assets are particularly volatile, as they are very sensitive to changes in prices, discount rate and assumptions about the normal return to capital. Such volatility may not necessarily affect the behaviour of mining companies, as the resource may be considered uneconomic, generating negative rents in the short term (say, in one particular year) but is deemed commercially viable in the long term. To obviate this problem, some countries choose to use a moving price average (Australian Bureau of Statistics (ABS), 1997). Negative rents may also occur because of estimation problems, as the rents are estimated residually and, more importantly, because of the occurrence of transfer pricing (that is to say, essentially wrong corporate accounting to avoid or reduce rent capture by Governments). Negative resource rents are set equal to zero and reported in the asset accounts, as indicated in chapter III.

(b) Choice of the discount rate

293. The SNA recommends using a rate of discount based on transactions in the particular type of asset being valued, rather than a general rate of interest such as yield on government bonds. The discount rate expresses the time preference of an asset s owner for income today rather than in the future as well as the risk associated with future returns. The time preference varies depending on the ownership. In general, individuals and businesses will tend to demand a quicker return from resource ownership than the government. A typical private discount rate might be in the range of 7 to 9 per cent annually. A

government or social discount rate is usually a few percentage points lower, in the range of 3 to 6 per cent. Table 12 shows different discount rates used in calculations of net present value.

Table 12. Discount rates

	Discount rate	Comments
Australia	13.1 per cent or 8.6 per cent (real)	Bank lending rates to large corporations less change in percentage points in producer price index (13.1 per cent) or consumer price index (8.6 per cent)
Canada	4 per cent (real)	Average provincial government real borrowing over 30-year period. It represents pure time preference with risk factor of zero
Korea, Republic of	Net price (no discount rate)	
Netherlands	8 per cent (nominal)	Moving 10-year average of the long-term nominal interest rate on government bonds. A discount rate of 4 per cent (real) has also been suggested
Norway	7 per cent (real)	
Philippines	Net price method and user cost (discount rate = 5 per cent and 10 per cent)	
United Kingdom	6 per cent 3 per cent	Social rate of time preference Proxy for a 3 per cent increase in the reserves
United States	3 per cent (real) 10 per cent (real)	Approximates the long-term real rate of time preference Approximates the long-term real rate of return of business investment

Sources: Australian Bureau of Statistics (ABS) (1997), Statistics Canada (1997), Banco Central de Chile and Servicio de Geología y Minería (SERNAGEOMIN) (1997), Kim and others (1998), Pommée (1998), Statistics Norway (1998), Domingo (1998), Vaze (1996) and United States Bureau of Economic Analysis (1994).

(c) Normal return to capital

294. The calculation of a normal return to capital in resource rent estimation presents practical difficulties. The problem is how to separate total returns into those relating to fixed assets and those relating to the resource. Net operating surplus, estimated as the difference between the revenue generated from the sale of asset, the costs of labour and materials and consumption of fixed capital, includes the return to all the capital assets of an enterprise, that is to say, the return to produced and non-produced capital, and to human capital. The rate of return applied to fixed capital is larger than the rate of discount because of the risk associated with future return of the industry and of the fact that the capital to be remunerated is larger than fixed capital. The Statistical Office of the European Communities (Eurostat) task force on subsoil assets (Eurostat, 1998b) suggested using a rate derived from actual data from manufacturing industries or the rate of return to company shareholders. It supposed such a rate would be in the range of 8 to10 per cent.

295. The normal return to capital should include all forms of capital involved in the production process

except the return to natural capital. In the absence of information on the return to different types of capital, the rate of return to capital is usually calculated only for produced capital and is estimated as the ratio of the net operating surplus to the value of the stock of fixed capital for the mining or manufacturing industry. Table 13 below shows the different rates of return to capital used in the calculation of net present value and net price.

Table 13. Normal rate of return to capital

	Rate of return to capital	Comments
Australia	8 per cent for metal mining 12 per cent for oil and gas	Derived using mining companies estimates of capital stock and operating profit on average returns
Canada		Nominal interest rate based on long-term industrial bond rates
Chile	At present, no monetary valuation	
Korea, Republic of	10 per cent	
Netherlands		No estimation, as it assumes that net present value is approximately equal to the value of expected specific revenues by the Government from the extraction of the asset
Norway	8 per cent	Based on cost-benefit analysis for projects with a certain degree of risk (Norwegian government report)
Philippines	5 per cent	Opportunity cost on the money invested in the fixed assets used in extraction and exploration
United Kingdom	15 per cent	Rate safeguarded under United Kingdom s oil and gas regime
United States	6 per cent	45-year average real rate of return to investments in corporate bonds and equities

Sources: Australian Bureau of Statistics (ABS) (1997), Statistics Canada (1997), Banco Central de Chile and Servicio de Geología y Minería (SERNAGEOMIN) (1997), Kim and others (1998), Pommée (1998), Statistics Norway (1998), Domingo (1998), Vaze (1996) and United States Bureau of Economic Analysis (1994).

(d) Life length of the resource

296. The life length of the resource has usually been estimated as the ratio of the stock at the beginning of the period to the quantity of the resource extracted in the year. This practice, however, ignores the effects of discoveries. To obviate this problem, the suggestion has been made to: (a) divide the sum of the stock at the beginning of the period and additions to the stock during the period by the extraction or (b) divide the stock at the beginning of the period by the net extraction (that is to say, extraction less discoveries) (Organisation for Economic Cooperation and Development (OECD), 1998).

(e) Valuation of stocks and changes in stocks

297. The value of opening and closing stocks is obtained by applying the net present value (or net price) method as explained above and in chapter III. Changes in stocks are brought about by depletion, discoveries and reclassification of the reserves due to changes in prices and technology. They are valued by multiplying a per-unit average asset value by the respective physical quantities. The per-unit average value is calculated by dividing the present value of the stock by the physical stock size, at the beginning and end of the accounting periods, and averaging the two values. Revaluation is calculated residually as explained in chapter III.

C. Accounting for soil degradation

1. Introduction

298. Among the various natural resources, land, combined with soil and water, is of specific importance for policy makers dealing with agriculture and food. The intense and increased pressure on land leads to its degradation and pollution, which may result in a partial or complete loss of its productive capacity. The Global Assessment of Soil Degradation (GLASOD) study estimates that, of the 8.7 billion hectares of agricultural land, pasture land, forest land and woodland, nearly 22.5 per cent has been degraded since mid-century. According to the UNEP *World Atlas of Desertification* (1992b), every year, nearly 6 million hectares of previously productive land in arid, semiarid and dry sub-humid area loses its productive capacity to produce food. In terms of income lost, this destruction of productive capacity costs the world in 1990 prices some US$ 42.3 billion each year ... In terms of area, Asia suffers the worst ravages of desertification, with 1,312 million hectares of degraded drylands. In terms of severity of degradation, however, North America and Africa are by far worst off, with 76 and 73 per cent of their dryland degraded .
An overview of the situation is given in table 14.

Table 14. Main causes of soil degradation by region in susceptible drylands and other areas

(Millions of hectares)

Region	Aridity zone	Deforestation	Overgrazing	Agri-cultural	Over-exploitation	Bio-industrial	Total degraded	T o t a l
Africa	Susceptible	18.6	184.6	62.2	54.0	0.0	319.4	1,286.0
	Other	48.2	58.5	59.2	8.7	0.2	174.8	1,679.7
Asia	Susceptible	111.5	118.8	96.7	42.3	1.0	370.3	1,671.8
	Other	186.3	78.5	107.6	3.8	0.4	376.6	2,584.1
Australia	Susceptible	4.2	78.5	4.8	0.0	0.0	87.5	663.3
	Other	8.1	4.0	3.2	0.0	0.1	15.4	218.9
Europe	Susceptible	38.9	41.3	18.3	0.0	0.9	99.4	299.6
	Other	44.9	8.7	45.6	0.5	19.7	119.4	650.8
North	Susceptible	4.3	27.7	41.4	6.1	0.0	79.5	732.4
America	Other	13.6	10.2	49.1	5.4	0.4	78.7	1,458.5
South	Susceptible	32.2	26.2	11.6	9.1	0.0	79.1	516.0
America	Other	67.8	41.7	51.9	2.9	0.0	164.3	1,251.6
Total		578.6	678.7	551.6	132.8	22.7	1,964.4	13,012.7

Source: World Atlas of Desertification (United Nations Environment Programme, 1992b).

299. To make the users of such resources aware of the dangers of inappropriate management, a system of up-to-date information on the current status and problem areas of land resources in an accessible format is required. The information system should be easily accessible and capable of storing detailed information on natural resources so that data can be combined, updated and analysed. Such a system would also strengthen the capacity of national soil/land resources institutions to deliver reliable information which is a prerequisite of the efficient use of these resources and of the implementation of development programmes. Two actions are needed to this end. First, development of a system (as included in the SEEA) that provides a macro-view of the current status of soil degradation in relation to the total economic situation of the country/region. Second, detailed disaggregated information needs to be compiled for in-depth analysis. To meet the second requirement, it is necessary to link databases on agro-climatic conditions, landform-soil relationships, water resources and hydrology, land cover and land use with socio-economic databases of the economy included in the SEEA. The present section presents illustrations for compiling aggregates relating to the soil degradation included in SEEA. It also introduces readers to the Global Soil and Terrain Database (WORLD-SOTER) and the GLASOD (Oldeman, 1996), which deal with the concepts and definitions of soil inventories and status of degradation, useful for formulating action plans. Linkage of the two databases will enhance the analytical capability of the system.

2. Soil degradation process

300. Soil degradation can be described as a process by which one or more of the potential ecological functions of the soil are harmed. These functions relate to biomass production (nutrient, air and water supply, root support for plants), filtering, buffering, storage and transformation (for example, of water, nutrients, pollutants), and to biological habitat and gene reserves. Soil degradation is defined as a process that lowers the current and/or future capacity of the soil to produce goods and services. Two categories of the soil degradation process are recognized, namely, displacement of soil material (for example, soil erosion by water forces or wind forces) and insitu soil deterioration covering chemical or physical soil degradation. Classifications of soil degradation by types and sub-types are shown below. The relevant definitions are given in Food and Agriculture Organization of the United Nations (FAO) and others (1994a).

W: Water erosion
- Wt: Loss of topsoil
- Wd: Terrain deformation/mass movement
- Wo: Off-site effects
  - Wor: Reservoir sedimentation
  - Wof: Flooding
  - Woc: Coral reef and seaweed destruction

E: Wind erosion
- Et: Loss of topsoil
- Ed: Terrain deformation
- Eo: Over-blowing

C: Chemical deterioration
- Cn: Loss of nutrients and/or organic matters
- Cs: Salinization

- Ca: Acidification
- Cp: Pollution
- Ct: Acid sulphate soils
- Ce: Eutrophication

P: Physical deterioration

- Pc: Compaction, sealing and crusting
- Pw: Waterlogging
- Pa: Lowering of water table
- Ps: Subsidence of organic soils
- Po: Deterioration from other physical activities such as mining and urbanization

3. Degradation of biological activity

301. Land/soil degradation can be the result either of natural hazards, or of unsuitable land use and inappropriate land management practices. Natural hazards include land topography and climatic factors such as steep slopes, frequent floods and tornadoes, high-velocity wind, high-intensity rains, strong leaching in humid regions and drought conditions in dry regions. Deforestation of fragile land, overcutting of vegetation, shifting cultivation, overgrazing, unbalanced fertilizer use, lack of soil conservation and over-pumping of groundwater (in excess of capacity for recharge) are some of the human activities that cause soil erosion. Causes of soil erosion need to be identified for imputing environmental cost in the SEEA, as only the changes in quality caused by economic activities are recorded as production costs.

4. Soil degradation in the SEEA and the 1993 SNA

302. In the 1993 SNA, as well as (more explicitly) in the SEEA, soil is defined along with land. The total area of land for any country is usually fixed and can be changed only through land reclamation, for political reasons or, in rare cases, because of natural disasters. Total land area is divided in the SEEA into three components: (a) soil, (b) area of land under economic uses such as land underlying buildings, land under cultivation, recreational land and forest land and (c) non-economic land areas with connected ecosystems. For the compilation of flows connected with soil degradation, let us consider only agricultural land or, more specifically for the present discussion, the soil connected with land used for agricultural activities. As to the SEEA (see WS 4 and 5 in chap. III), two items are particularly relevant, land improvement and quality changes accounted as gross fixed capital formation, and economic disappearance as defined in the 1993 SNA.

303. *Gross fixed capital formation (P.51)*: this item includes expenditure on improvement of land and cost of transfer of land ownership. The cost of improvement of land covers, besides land reclamation from the sea and forest clearance, expenditures on soil conservation measures. Soil conservation includes two types of expenditures, namely, (a) expenditures incurred by Governments (and sometimes corporate bodies) on construction of flood and wind barriers to protect the land and associated soil from water and

wind erosion, and on the laying down of irrigation and drainage channels and so forth and (b) expenditures incurred by individual landowners (households, corporations, Governments) directly on the owned land itself, which may include items such as making bunds, terracing or creating drainage channels. Generally, both items are included in the compilation of national accounts. However, a specific item that needs further consideration is the cost of growing green manure crops (and forgoing production) which improves the soil quality (productivity). The cost of cultivating such crops, including the imputed cost of labour, could also be included in the expenditure on land improvement. Some impacts of cultivation practices like crop rotation are accounted indirectly in the following item.

304. *Other economic disappearance of non-produced assets (K.62):* this item consists of two components: (a) quality change in non-produced assets due to changes in economic uses, consisting of decreases (or increases) in the value of land, that are the counterpart of changes in land use - for example, transfer of land under cultivation to communal grazing land - recorded as changes in classification and (b) degradation of non-produced assets due to economic activity, covering all degradation of land from economic (agricultural) activity. As shown in chapter III, land-use changes are accounted as other accumulation , and land degradation as environmental cost in the SEEA. The degradation may be ordinary, recurring from economic activity, or less predictable erosion and other damage to land from deforestation or improper agricultural practices (1993 SNA, paras. 12.32 and 12.33). Occasional land degradation of substantial magnitude due to natural hazards is more of the nature of capital loss and is accounted as other volume changes in both the SNA and the SEEA.

305. Estimation of the first item (P.51) is generally based on data collected from farm owners in the form of a census or sample survey, and from details of government expenditure. In developing countries, such data are available for benchmark years and can be estimated for other years using indicators on the area under cultivation and the wage rate for rural labour. Construction works undertaken by farmers are labour-intensive with an average life of two to three years and high repair and maintenance cost, which is often imputed.

306. It is not possible to separate each type of soil degradation as an individual event. Thus, to quantify human-induced soil degradation for the purpose of compiling the SEEA categories, three aspects should be assessed, namely, the degree of soil degradation, the relative extent of soil degradation, and the causative factors of soil degradation, and then the quantity and value of the degradation should be estimated. This is discussed further in the following section.

5. Measurement of soil degradation

307. The effects of soil erosion are complex. Some can be reversed by suitable soil conservation programmes and improved cultivation practices. However, other types of degradation are irreversible. Irreversible impacts include land lost by gulling and cases of severe sheet erosion, where the soil cover has been removed to a great extent. Where degradation is reversible, it is generally difficult to assess the actual extent and impact of land degradation, as farmers may convert their land to less demanding uses or may increase the level of inputs.

Box 8. GLASOD and WORLD-SOTER projects

The United Nations Environment Programme (UNEP) formulated a project proposal for the Global Assessment of Soil Degradation (GLASOD) in 1987 which developed methodologies to create soil and terrain databases. The main objective of the GLASOD project was to strengthen global awareness of policy and decision makers of the dangers resulting from inappropriate land and soil management. One of the prime products of this project was to make available to the potential users information (in the form of digitized maps) on soil and terrain resources in non-technical terms.

The GLASOD maps, by assessing not the vulnerability of land resources to the soil degradation process but rather the status of degradation, assists policy makers and resource managers in identifying priority areas of intervention.

To assess soil vulnerability, a comprehensive information system of soil and terrain resources is needed. For this purpose, the Global Soil and Terrain Database (WORLD-SOTER) was developed. This is an internationally endorsed land resource information system that can store, at different levels, detailed soil and terrain attributes in such a way as to ensure that these data can be assessed, combined and updated, and easily analysed from the point of view of potential land use, in relation to food requirements, environmental impact and conservation.

308. Methodologies for prediction of soil erosion have been developed since the early 1930s. This work generally addressed different types of soil erosion. For example, conceptual work for universal soil erosion, predicting sheet and rill erosion by water, was done by Cook (1936) and updated by Wischmeier and Smith (1978). The method uses rainfall erosivity, a soil erodibility factor, length and steepness of the slope and so forth to measure average annual soil loss. Similar work was done for the measurement of soil erosion by wind (Woodruff and Siddoway, 1965). However, a systematic effort to assess the nature and extent of land degradation at regional or global scales was made only in the 1990s. The most important studies on land degradation include the GLASOD mapping exercise by Oldeman, Hakkeling and Sombroek (1990) and a comparative study of drylands by Dregne and Chou (1992). Box 8 describes current activities on the development of soil databases. Studies like GLASOD provide global status estimates that are generally based on qualitative expert estimates. In recent years, some work has been done to assess soil degradation on the basis of actual collection of data. Some of these methods are described in the illustrations contained in annex IV by way of examples extracted from different sources.

309. In making economic assessments of the impact of degradation, various approaches have been used. Degradation costs[5] have been measured as: (a) the value of the defensive expenditure on soil conservation works, drainage and irrigation systems, terracing and so forth, required to prevent land degradation; (b) the value of the lost yield;[6] (c) the replacement costs of lost soil nutrients, where the cost of additional inputs (fertilizer and so forth) needed to maintain the same level of yield is taken as a measure of the cost of soil degradation; (d) the taking of an income allowance whereby an estimate is made for reinvestment of a share of the income from the land to maintain the same level of income (Lutz and El Serafy, 1988); and (e) the cost of rehabilitating the plot back to its former productive condition. Each of these methods measures soil degradation from a different angle. Some can be used only for a particular type of degradation, whereas others can be used universally.

310. It is not sufficient to value the cost of installing soil conservation measures alone, followed by improved land management techniques, because in spite of those measures one may still be left with depleted soil. In the maintenance valuation approach, when the soil is to be restored to the condition prevailing at the beginning of the accounting period, it is necessary to take into account three cost components in order to estimate depletion and degradation of soil: (a) the cost of replacing nutrients through additional inputs to maintain the level of productivity; (b) the cost of replacing soil organic matter and thereby restoring the original structure of the soil (for example, allotting part of the land to a green manure crop and forgoing production); and (c) the cost of replacing the eroded soil. The first two components are relatively easy to estimate. The third component usually cannot be applied in practice, as natural processes would replace eroded soil very slowly and would often require that the land remain fallow. This would lead to very high costs. One should pay particular attention to double-counting when calculating the maintenance cost.

311. For compiling comprehensive estimates of soil degradation for a given area (country/ region/subregion), in practice the maintenance cost estimate may be made by taking into account the fall in productivity and causative factors of soil degradation. Compilation of this cost may require the use of soil maps to classify the total area by groups according to the principal causes of soil degradation.[7] To account for the cost required for replacing soil nutrients and so forth, the area may be further subdivided according to the degree of soil degradation, and for each subdivision average productivity data may also be compiled. Such data can generally be compiled by retabulation of results of crop estimation surveys (Narain, 1995). Such surveys can at the same time also collect some minimum data on soil characteristics (Food and Agriculture Organization of the United Nations (FAO), 1995a). With the help of such a tabulation, it may be possible to make a more precise estimate of per unit value of replacing soil nutrients. Details of area affected by the principal causes of soil degradation will also provide a basis for estimating the cost of soil conservation measures required for protecting the soil from further degradation. The total cost can be apportioned between different years, depending upon the estimated life of the asset created for soil conservation. This component can be taken in place of the third component, namely, the cost of replacing eroded soil, for sustainable use of land.

6. Conclusions

312. Annex IV provides a number of illustrations that can be broadly classified into: (a) methods that use actual data collected from the field and (b) methods based on expert judgements (GLASOD). Reliable estimates may be obtained cost-effectively through a combination of both types of methodologies. The data available in GLASOD could be used for the stratification of land, which in turn could be used for the collection of data on actual soil loss. It might also be possible to collect data through already existing surveys such as farm management surveys or crop estimation surveys. GLASOD s maps and data are based on estimated evaluations of degradation provided by local scientists, rather than on measured values. It is suggested that the concepts recommended by GLASOD be adopted for the collection and compilation of data. These data, together with a GIS database, data on use of agricultural inputs and information on soil conservation practices like crop rotation, could be used to construct a sound information system.

313. Soil degradation accounts provide estimates of the cost of maintaining soil in near-natural conditions by minimizing soil erosion/depletion. In order to use information on type and magnitude of erosion for policy-making, it would be desirable to obtain information on possible land improvement measures necessary to avoid/reduce the different types of soil degradation.

D. Economic accounting for renewable aquatic resources

1. Introduction

314. The present section discusses environmental accounting for renewable aquatic resources, including fish, molluscs, crustaceans and other living organisms, living wild in oceans, lakes, ponds and rivers, as well as cultivated animals kept in captivity by aquaculture establishments. It does not cover other uses of the resource, for example, recreational activities or other uses, which are often very important although difficult to value. The concepts presented below were discussed at a United Nations Statistics Division/FAO Joint Workshop held in New York in June 1999 (United Nations and Food and Agriculture Organization of the United Nations, 1999) and are further elaborated in the forthcoming guidelines on the System of integrated Environmental and Economic Accounting for Fisheries (SEEAF) (United Nations, Food and Agriculture Organization of the United Nations and United Nations University, forthcoming).

315. Knowledge about renewable aquatic resources varies greatly. Many aquaculture establishments are usually able to provide reliable estimates of the size of the stocks, which they control. The knowledge of the size of some wild stocks is, however, often unreliable because they are more difficult to monitor. This is, among other things, due to natural variations in environmental factors, species interaction and uncertainities in the input to stock assessment models (for example, the size of catches, discards and so forth).

316. In most parts of the world, the fishing capacity has reached the level where unrestricted fishing would result in overexploitation, with smaller catches and smaller economic benefits than would be possible were the exploitation managed. In extreme cases, there exists the risk of extinction of some fish stocks, with impacts on the ecosystem. The fisheries managers have to act upon the information available to maximize economic benefits from the use of renewable aquatic resources. In many cases, this information is far too limited and uncertain. Economic accounting for renewable aquatic resources should be seen as a means to improve the informational basis for fisheries management.

317. The control over renewable aquatic resources varies significantly. Aquaculture stocks are privately owned and traded in markets, making it possible to value these assets on the basis of market prices. In some countries, access to fishing in lakes, ponds and rivers is privately owned and the access rights are traded and hence have a market value. This is the case not only for fish stock that stays in the land where the fishing rights are in place, but also for fish that travels over large areas and can be caught by others (for example, salmon caught by anglers and fish in ocean ranching).

318. Since the introduction of 200 miles of exclusive economic zone (EEZ) in the 1970s and 1980s, most commercially important aquatic stocks have been under the jurisdiction of some country/countries.

Some wild stocks do migrate between EEZs belonging to different countries, some stocks migrate between EEZs of countries and international waters, and some stocks live completely in international waters. Efforts have been made, within the United Nations framework, to make the countries that exploit these stocks behave in an environmentally responsible manner.

319. The United Nations Convention on the Law of the Sea (United Nations, 1983), the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (United Nations, 1995) and the Code of Conduct for Responsible Fisheries (FAO, 1995b) created a legal framework for fisheries management. Countries were able to set rules for fishing within their EEZs to prevent overfishing. In some cases, international bodies have been set up to manage fishing out of stocks that straddle between EEZs of different countries and in some cases it has been possible to reach agreements on the management of fishing out of stocks in international waters.

320. Methods for managing fisheries vary greatly. In some cases, fishing is largely free but the authorities make efforts to diminish fishing capital through decommissioning (purchasing) of vessels. In other cases, fishing effort is controlled by closing the fisheries for a number of days, establishing regulations on the types of gears and/or requiring a licence for the participation in the fishery. Management through catch quotas is common. In most cases, quotas are allocated to fishermen with very limited or no possibility of trading these rights. In a few cases, the quotas are freely tradable and market-based prices for the quotas are well established, providing good estimates of the market valuation with respect to accessing the fish stocks.

2. Fisheries accounting

(a) Production boundary

321. The production boundary of the 1993 SNA includes all activities carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transfer inputs of goods and services into outputs of other goods and services. In the case of fisheries, natural growth of fish stocks in open seas is not counted as production, as the process is not fully managed. On the other hand, the growth of fish in fish farms is treated as a process of production. The fish harvested in open seas from commercial or recreational fishing counts as production regardless of whether it is sold in the market or used for own consumption.

322. The production boundary of the SEEA is essentially the same as that of the 1993 SNA. In the case of aquaculture production, there is no difference. The output of an aquaculture establishment should be recorded as being produced continuously, that is as work in progress, by distributing the value of the slaughtered fish in proportion to the costs incurred in each period (1993 SNA, para 6.96).

323. In the case of fishing from wild fish stock, all landed fish should be recorded as production including, data permitting, that part of the catch that fishermen use for feeding their families and the landings of catches from recreational fishing even if not sold in the market. The catches used for own consumption should be valued at the basic prices at which they could be sold if offered for sale in the market.

324. There are some potential problems once a nation sells (trades or gives away) part of or its entire quota. The question arises whether the activity of harvesting the fish should be included in the asset-owning nation s production or in the production of the nation to which the fishing fleet belongs. In theory, the production occurs within the national boundary of the asset holder and could be counted as that country s output. The 1993 SNA suggests that, if the fishing activity by another nation s fleet is not prolonged in a country s EEZ, then the activity need not be recorded as production by that country. In effect, the ship and the activity that takes place on it are within the national boundary of the ship-owning nation. This treatment would be more desirable, unless there is some special arrangement made by the fish asset owner to contract out the harvesting of its asset. Even in this case it does not seem advisable to attempt to measure the fishing activity as part of the asset-owning nation s production. The sale of the quota seems to be the sale of an asset. A nation that owns quota rights to another nation s fish assets could record a claim, valued at the price actually paid or the residual value of the quota.

325. It is important that all catches be duly recorded for estimations of the stock sizes and their productive potential. This means that not only all landings, legal and illegal, by commercial and recreational fishermen, but also all fish that is discarded at sea,[8] should be recorded. The discarded fish should not be counted as part of the production, but should be recorded as part of other volume changes, as discussed in chapter III.

(b) Asset boundary

326. The 1993 SNA asset boundary includes all assets owned by a unit and from which economic benefits may be derived. In the case of fisheries, it includes fish raised in aquaculture establishments (produced assets) and fish in the open sea (non-produced economic assets), provided that effective ownership rights, individual or collective, are exercised. As mentioned earlier, the degree of management of fish stocks varies greatly, and it may be difficult to decide, in practice, what effective management entails. The SEEA and the SEEAF adopt a pragmatic approach whereby all fish stocks within the EEZ of a country is considered an economic asset and therefore included in the asset boundary. The SEEA further extends the asset boundary of the 1993 SNA to include environmental assets, for example, marine and freshwater ecosystems, biodiversity and so forth.

327. A pragmatic approach to the determination of the boundary between produced and non-produced assets is to follow the FAO definition of aquaculture according to which farmed fish stocks would qualify as produced assets, while all types of wild, enhanced and ranched fish stocks would be recorded as non-produced economic assets, if available data allow them to be physically accounted.

328. The SNA records changes in the value of naturally occurring assets, for example, depletion (harvest) and growth, resulting from deliberate management activities or from environmental factors, in the accumulation account, outside the production account. Therefore, rebuilding of a depleted wild fish stock by forgoing catches in the current period for the benefit of future higher harvests would not be recorded as capital formation and hence would not be included in GDP.

329. The SEEA suggests separately identifying depletion, defined as the value of the catches above the sustainable yield, and changes in non-produced natural assets due to other economic decisions (for example, stock rebuilding through fisheries management). The former is treated as cost of production and deducted from the net value added of the fishing industry. The latter is classified in the separate category Other accumulation , outside the production account. This has the advantage of providing information to policy makers about the relationship between fisheries management expenditures and benefits in terms of creating the potential for higher catches in the future.

(c) National boundary

330. The 1993 SNA recommends that the accounts be compiled for resident institutional units. Residency status determines the limits of domestic production and affects the measurement of GDP. The concept of residency is based on the location of the centre of economic interest of the operation. The great mobility and versatility of fishing vessels can at times make it difficult to decide their residency and hence in which country s production accounts the vessel s production should be recorded. Possible criteria for the determination of the centre of economic interest in the case of fisheries are the length of stay and the regularity of fish harvesting in a country s EEZ by a foreign fishing vessel. In those cases where a foreign flagged vessel stays for an extended period of time (for example, one fishing season or one year) in a country s EEZ or returns for a substantial part of a year on a regular basis, it might be assumed that its centre of economic interest lies with the host country. Other criteria could include the location at which the harvested fish is landed and/or processed.

331. Although the approach described above is preferred for accounting purposes, data availability may not allow its practical implementation, especially in the case where data on output of foreign flagged vessels are incomplete, thus preventing the allocation of their production to the host country s fisheries GDP. A vessel fishing in international waters that lands its catches regularly in a foreign port and buys its inputs in that country is operating similarly to a quasi-corporation in the country. If the owner of the vessel pays taxes, is obliged to return a financial statement to the authorities and reports on its catches in the country where it lands its catches, its centre of economic interest should be recorded in that country. If, on the other hand, the vessel s owner pays taxes and reports the establishment s financial outcome and catches in the country where the enterprise resides, it may be difficult in practice to identify the actual centre of economic interest of the vessel. For pragmatic reasons, the centre of economic interest could be considered to be in the country where the enterprise resides.

332. Another difficult case for deciding where the establishment (vessel) has its centre of economic interest occurs when the owner of a fishing vessel is resident in one country, the vessel is fishing in the EEZ of a second country and the place of landings is in the owner s country. In some cases, the fishing vessel may be engaged in this kind of fishing during the whole year, while in other cases it may engage in such fishing during a short period of time. According to the SNA, the centre of economic interest of the vessel lies in the host country. In practice, however, as the vessel pays taxes and returns financial statements about its operations to the owner s country, the production is recorded as occuring in the owner s country.

3. Physical accounts for renewable aquatic resources

333. Physical accounts for fish produced by fish farming is calculated as the number (weight) of fish at the beginning of the accounting period plus natural growth, minus fish (number or weight) harvested and minus natural death. This information is generally available and can be obtained through surveys.

334. For wild fish stock, basic data include landings, effort and estimates of the size of the stock at certain points in time. The data on the size of the stocks are usually subject to large errors, making the estimates of the changes in the stocks very unreliable. Subtracting the estimated catches from the estimated changes in the stocks would give a residual, covering recruitment, natural growth and mortality.

(a) Definitions and measurements of wild fish stocks

335. A stock is a group of individuals of a specific species that is functionally separated from other individuals of the same species, usually by the fact that spawning takes place in different areas. In some cases, different stocks spawning in separate grounds may mix and be subject to exploitation in common feeding grounds. For management purposes, such stocks could be considered one stock. It is often common to use the term *stock* when referring to an exploited or management unit and *population* when referring to a biological unit.

336. Definitions of stocks for use in measuring stock sizes have to be adapted to the availability of data. For many species, the biologists estimate the size of the stock in terms of the weight of those cohorts that do appear in the catches. This means that the total stock may be defined as the weight of all cohorts aged *y* years or older, where *y* is the age of the youngest fish in the catch. The reason for this is that too little is known about the cohorts that are younger than *y*. Separate assessment of the youngest age groups are often made, however, in order to assess the recruitment potential to the exploited part of the stock. This is also important information for management purposes. The sexually mature part of the stock (the spawning stock) is frequently estimated, as it is believed that these estimates give an indication of the growth potential of the stock and the probability of a collapse.

337. Like all living creatures, wild fish form a part of a complicated ecological system where some fish are predators and others are prey. To be able to understand the dynamics of the biological system, estimate its productive potential and avoid serious overfishing, it is important to gather information on stocks and catches of each species.

338. Physical data on stocks are usually compiled by biologists, who use different methods to estimate the size of the stocks. The virtual population analysis (VPA) is usually the most reliable method. It uses data on catches from different cohorts of the same stock, together with data on catch per unit effort. This method can be used to estimate the size of the stock only of those species that are relatively long-lived and where data on the proportions of the different cohorts in the catches are available. When this information is not available, biologists rely on other models, which relate the size of the stock to the availability of fish, estimated by catch per unit effort. These methods are often very imprecise, partly because it is very difficult to estimate the volume of effort in homogeneous units. A special case occurs when fish gather into schools, for example, pelagic species, thus making it possible to use observations from echo integrators, instruments that use sound waves to observe the fish in the water so as to estimate the size of the total stock. Stocks of bigger aquatic animals like seals and whales can be estimated by direct counting of the number of animals in randomly sampled areas.[9]

339. In most cases, the biologists estimates of the fish stocks are very imprecise. In addition, the variability in the recruitment to the stock and the effects of environmental factors affecting the growth of the individual fish and the rate of natural death from accidents, sickness, old age and predators, makes it very difficult to estimate the productive potential of the fish stock. Therefore, when a fish stock declines, it may be difficult to identify, whether this decline was caused by overfishing and should be recorded as depletion, or by adverse environmental factors and should be recorded as other volume changes (see chap. III).

340. When using the VPA method for estimating the size of fish stocks, the biologists must include estimates of the natural mortality of the stocks. In some cases, these estimates may involve the size of some predator stocks. Moreover, the VPA method provides improved estimates of the stocks at some specific point in time, as more information becomes available about individual cohorts. For this reason, the size of some fish stock at the beginning of the period is more precisely estimated at the end of the period than at the beginning of the period. On the basis of the data obtained with the VPA method, it is possible to obtain consistent estimates of the size of the stock at the beginning and at the end of the accounting period and all flows explaining the change in the stock, for example, catches, recruitment, increases in weight and losses because of sickness, accidents and predators. Even in this case, the biologists have rarely found it useful to present this physical information in accounting format, because of the lack of reliable data, in particular the natural mortality rates.

(b) Definitions of sustainable exploitation and physical depletion

341. A renewable resource is taxed (exploited) in a sustainable way, if the amount taken away (the catch) is equal to the growth of the resource so as to maintain the size of the stock at the end of the period. If we allow for uncertainties concerning the rate of growth of the resource during the period, the definition of sustainable exploitation has to be reformulated in terms of probabilities and expected values.

A renewable resource is taxed in a sustainable way if the expected size of the stock at some given future point in time is equal to the present size and the likelihood of extinction is equal to zero.

342. Sustainability is a concept that has been used for a long time in the economic theory of fisheries and other renewable resources. It has been shown that there is not one sustainable way to tax a resource, but many -- infinitely many, in fact. At small stock sizes, the resource s ability to grow is small and it can be sustainably exploited only by taxing it a little, while the same resource can give large catches without risking decline in the stock when the stock is larger and more productive. In these circumstances, sustainability gives an ambiguous reference point for managers of a renewable resource and for the statisticians accounting for it. The objective of the managers must be to manage the resource so that it is sustainably exploited and able to bring maximum benefits to society. This optimal sustainable exploitation is the reference point that the national/environmental accountants should use.[10]

4. Monetary valuation of aquatic natural resources

(a) Produced assets: aquaculture

343. Fish farmed in aquaculture establishments are produced assets. These assets are privately owned and can be traded in the market. In most cases, market prices are easily obtainable and can be used to estimate the value of live fish owned by these aquaculture establishments.

344. Given physical data on the number and weight of fish owned by some aquaculture establishment and the market prices of the different categories of fish, the fixed price estimates of the volume of these assets can be estimated. The estimation can be made either directly, by multiplying the physical data on the volume of fish in the different categories by the prices observed during some base year, or indirectly, by first calculating a price index for these assets and then using the index and the estimate of the current value of the fish stock to estimate the fixed-price values of the fish.

(b) Non produced economic assets: wild fish stocks

345. Monetary valuation of wild fish stocks is more complicated, as the fishing rights are rarely treated as property rights. Direct and indirect valuation methods are discussed below.

(i) Monetary valuation on the basis of observed prices of access rights

346. When fishing rights are freely traded, the value of the natural resource can be estimated from the market prices of these entitlements. In many cases, where the State hands the access rights to fishermen, trading in theses access rights is prohibited and therefore there is no directly observable market valuation. In some cases, fishing rights may be tied to some asset (often fishing vessels and, in some cases, land) that is freely traded. In these cases, it may be possible to infer market valuation of the access rights by comparing the prices of such assets when fishing rights are attached to them with prices of similar assets that do not have any such rights.

347. If the fishery is managed with individual transferable quotas (ITQs) and/or individual transferable share quotas (ITSQs), the market value of all ITQs is equal to the value of the use of the fish stock. This value should be equal to the rent. The value of all permanent ITSQs, measured at market price, gives the market's valuation of the fish stock. It should reflect the discounted expected profits that the fishing firms expect to obtain from using ITSQs.

348. In most of those cases where ITQs and ITSQs are used to manage fisheries, these access rights are, as property rights, not as secure and legally binding as those that exist for capital or natural resources, such as land or mineral deposits. It should also be noted that the introduction of property rights in a fishery often occurs when there exists considerable excess capacity in the fishing industry. In such cases, the price of the annual ITQs is determined by the short-run rather than the long-run, marginal profits of the fishing, thus overestimating the total profits from the exploitation of the fish stock.

349. The profitability of the fishing industry, and therefore the price of the fishing rights, depends crucially on the efficiency of the fisheries management. If the managers are unable to prevent serious overfishing, then the profits of the fishing firms will be small and the prices of the access rights will be low. If the managers are able (or the fishermen believe that they will be able) to manage the fishery so as to bring high profits to fishing firms, then the prices of the access rights will be high.

(ii) Monetary valuation: present value of future rents

350. When appropriate prices, that can be used for the valuation of fisheries resources are not available, the 1993 SNA recommends the estimation of the value of the resource by calculating the present value of the expected net returns resulting from the exploitation of the asset. In many cases, uncertainty and lack of data on the biological and economic relevant factors make last year s rent (or the average rent during past years) the best estimate of future rents from exploiting the fish stock (stocks), hence the present value of net returns is equal to last year s rents divided by a discount rate.

351. In some cases, it may be possible to obtain better estimates of future rents by forecasting future stock sizes, catches, prices and costs[11] than by using realized profits in past years. This should be the case when the fish stock is far below its historical level. It is important to note, however, that biological systems are often quite complicated and the knowledge of these systems, and their productive possibilities, are often limited.

352. The fact that fisheries frequently target more than one species makes it very difficult to obtain data on the cost of fishing for each species. The joint production character of the production process creates special complications for the estimation of the cost of fishing for each species.

353. The interactions between different stocks add to the complications of estimating the value of the fish stocks. For example, the size of the catch, and therefore the value, of some prey stock depends on the size of some predator stock. If the predator stock has little commercial value, it may pay to catch from it so as to increase the catches from the valuable prey stock. In this case, the value of the predator stock can become negative when the stock is big, as it then does more harm then good. The interactions between the different species are certainly important but they are usually poorly understood and difficult

to quantify.

354. On the basis of bio-economic theory, it is to be expected that the net price method, a simplification of the net present value (see chap. III), rarely approximates accurately the present value of future rents from the exploitation of some aquatic stock. More generally, it is to be expected that the relationship between the value of the stock and the physical size of the stock is not proportional and most often it is not linear.

355. In some countries, the fisheries may be managed so as to bring benefits other than maximum economic benefits to society. Considerations of employment issues, regional issues and sometimes the protection of a certain way of life, enter frequently into decisions on fisheries management. In these cases, the present value of future rents (and the market prices of the access rights) underestimates the social value of the natural resource.

356. Subsidies, specific resource taxes, the cost of managing the fishery, the habitat protection cost and possible enhancement costs should be taken into account when estimating the value of the fish stock on the basis of discounted future rents. Negative rent estimates may occur in practice. The convention in the SEEA is to record them as zero.

357. A change in the value of an aquatic stock may be brought about by: (a) a change in the physical size of the stock; (b) a change in technology which allows increases in the production of fish with the same inputs and same physical stock; (c) a change in prices of the products (landings) and/or of the inputs used in the industry exploiting the stock. In practice, it is difficult to separate the changes in the price of outputs and inputs from the other changes in the value of the stock. The present value method, estimated by the present value of rents using constant prices of output and input and constant technology, is desirable. This method should also be applied when the access rights are freely tradable and it is possible to estimate the monetary value of the stocks on the basis of market prices.

358. The changes in the value of some stock reflect not only the cost of using up the resource but also other changes due to management and environmental factors. It is therefore not possible to use decreases in the value of some wild fish to estimate the cost of depletion, not even in those cases where the value of the fishing rights can be estimated from market data.

(c) Shared stocks

359. In those cases where no control exists over the exploitation of an aquatic resource (because it lives in international waters or because the States that exploit it have not managed to organize proper management of it), it should be recorded as an non-economic environmental asset, as discussed in chapter III.

360. In those cases where the control over the exploitation of a fish stock has been established and the access rights have been shared out among the States, it is possible to record these stocks (migrating and straddling stocks and stocks that complete their life cycle in international waters) as economic non-produced assets. In those cases, the international agreements that form the basis for the management of the resource should make it possible to determine the share of each State in the common resource. In some instances, these international agreements state explicitly the share of total catches that should be allocated to each State. It is sometimes the case, however, that the fishing vessels of the states concerned have different likelihoods of catching the share that has been allocated to them, making it necessary to estimate the share in the resource from the share in the actual catches rather than the share stated in the agreement. However, the fact that international agreements are frequently changed leads to changes in the share of catches allocated to the countries sharing the resources.

361. In those cases where there are reliable data on the share of the country in the commonly exploited stock, this share can be used to determine the portion of the total stock that should be recorded in the country s asset accounts. Monetary valuation of this share in the stock can then be estimated, either from data on access rights to this stock if they are freely traded, or from the present value of estimated future rents, as discussed above.

E. Air emissions

1. Introduction

362. Air emissions can be defined as pollutants released into ambient air from stationary and mobile sources that may either harm human beings, animals, vegetation or material, or act as precursors to ozone, smoke or acidification of precipitation. They can be natural, that is to say, generated by natural processes, or human made. The SEEA focuses on the linkage of the human-made emissions to the causing economic activities.

363. Chapter III discusses degradation accounts in the SEEA and explains how emissions can be valued using maintenance cost valuation. The present section focuses on problems encountered when linking emissions, obtained by environment statistics databases, to the causing economic sector.

2. Classification issues

364. In the SEEA, emissions are linked to the economic sectors (industries, government and households) that cause degradation as a result of their production process or of their final consumption.

Figure VII in chapter III shows how emissions are linked to the economic accounts. The linkage of emissions, in physical terms, to the production accounts has been advocated in the NAMEA, discussed in chapter II. The SEEA goes a step further, attempting to value the emissions at maintenance cost. Such costs represent the cost that the polluter would have to incur to meet environmental regulations were they put in place and enforced.

365. The economic accounts are compiled for resident units. A unit is said to be resident within the economic territory[12] of a country when it maintains its centre of economic interest in that territory, that is to say, when it engages, or intends to engage, in economic activities indefinitely or over a long period of time, usually interpreted as one year, in the economic territory of that country (1993 SNA, paras. 1.28 and 2.22). This implies that some of the production/consumption of the resident unit may take place abroad and vice versa, that is to say, some of the production/consumption, taking place within the country, may be attributable to foreign units.

366. Integrating emissions and their value in the SEEA framework entails following the specifications given above that flows of residuals from the causing industry be generated by activities of resident units. This implies that emissions by non-resident units, that is to say, foreign tourists or trucks, airplanes and locomotives owned by a foreign country, should be linked to the value added of the industries of the country owning the machine and not to the domestic product of the country in which they are generated. Emissions generated by foreign resident could be reported in the environmental accounts of the country in which they are physically generated as transfers from the rest of the world in the generation-of-income account, thus affecting NNI (net national income) rather than NDP.[13]

367. Emissions are usually estimated indirectly from energy use data collected in energy statistics, state-of-the-environment databases, national or international emission inventories, for example, of the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change, 1995) and so forth. These data measure national emissions, that is to say, emissions stemming from the national territory, regardless of whether they are generated by resident or foreign units, and may not be comparable with the definitions and classifications of the1993 SNA and SEEA. They would thus require reclassification of the environment statistics data.

368. The different definitions used in the national accounts and in environment statistics are closely related to the concept of cost caused and cost borne, discussed in chapter I, with the SEEA addressing the issues of impact caused and environment statistics being more concerned with impacts borne. Both types of data are relevant for policy formulation, as the former addresses regulation and control policy and the latter measures the impacts of emissions on the national territory.

369. The SEEA permits the reconciliation of the different definitions and classifications used in the SNA and the SEEA and environment statistics. An extension of WS 7 and 8 to a matrix form would allow the recording of the emissions stemming from national economic activities in the national territory as well as of the emissions from national economic activities in another country.

370. Emissions caused by transportation and tourism constitute typical examples of the above issues and are discussed in some detail below.

(a) Emissions caused by transportation (mobile sources)

371. Environment statistics inventories include a subcategory for mobile sources. Mobile sources include highway vehicles, that is to say, vehicles registered to use public roadways (for example, cars, trucks, buses, motorcycles and so forth), aircraft and locomotives. Linking emissions from mobile sources to the economic accounts entails the allocation of the emissions to the causing sector, for example, industries (by ISIC) including the government, households and the rest of the world.

372. Emissions generated by vehicles, aircraft or locomotives as part of the production process, and not of final consumption, should be allocated to the resident industry (including the government), regardless of whether the emissions take place on the national territory or abroad. Thus, emissions caused by airplanes, buses and railways that provide transport services between two or more countries should be allocated to the transportation industry of the country of residence of the transportation operator, that is to say, the industry generating the value added.

373. The case of households is slightly different, as the emissions caused by households are linked to the final consumption of the country where they actually take place, regardless of the residence of the households. In the SEEA, their value is shifted in the production accounts as described in WS 9. The case of emissions by non-resident households, visiting a country for tourism, is discussed below.

374. The allocation of the emissions to the various sectors presents considerable practical difficulties. Information on fuel purchased, types of vehicles and distance driven may be used for estimating the share of emissions of each sector. Two examples of difficulties in linking existing environment statistics to the economic accounts are presented in annex V. Both examples are extracted from Gravgård (1998).

(b) Emissions caused by tourists

375. Emissions caused by tourists[14] can be generated by consuming and producing activities. Moreover, these activities may be undertaken by resident or non-resident units[15] of the country in which the emissions are generated. The concept of residence of the tourist or the tourism industry plays the key role in the allocation of emissions among countries.

(i) Resident units

376. Although tourists may be either residents or non-residents (in the 1993 SNA sense) of the country they visit, the services they use, namely, hotels, car rentals, taxis, restaurants and so forth, are characteristic of the tourism industry and are often resident units of the country visited. Emissions caused by tourists using the services provided by the tourism industry are actually emissions caused by the industry and not by the tourists as consumers.[16] Therefore the emissions should be allocated to, and the value of the emissions should be deducted from, the value added of the resident industry causing degradation, that is to say, from the tourism industry.

377. The emissions of resident tourists, in other words, leisure tourists and business travellers in their leisure time travelling in their country of residence, should be allocated to the final consumption of households.

(ii) Non-resident units

378. Tourists who travel for business in their country of residence generate environmental degradation. Emissions caused by the productive activities of these tourists should be allocated to the industry employing the traveller, that is to say, to the industry generating the value added.

379. Business travellers who work on the installation of exported machinery or a consultancy project for less than one year are considered tourists, according to the World Tourism Organization definition, as their activity is remunerated from the country of origin. At the same time they are non-resident individuals employed by non-resident producer units, according to the SNA. In this case, emissions caused by the productive activity of the business traveller (for example, driving to reach a plant where a machine needs to be installed and so forth) should be allocated to the non-resident industry for which the person is working in the originating country, that is to say, to the industry generating the value added.

380. Non-resident tourists or business travellers during their leisure time, in other words, when they behave as consumers and not as producers, not only use the services of the tourism industry but also consume other products not characteristic of the tourism industry. Emissions caused by tourists as consumers of products should be allocated in the SEEA to the final consumption of the country where the tourists reside.

381. From a practical point of view, it may not to be feasible to distinguish emissions according to the categories enumerated above. Simplifying assumptions could be made, taking into account the particular situation in each country as well as the net balance between emissions caused by resident and those caused by non-resident units. One suggestion is to treat all emissions by tourists, except the ones by resident units that should be allocated to households consumption anyway, as caused by the tourism industry, even though, in some cases, the tourism industry is not responsible for causing the degradation, the underlying assumption being that the emissions by non-resident consumers and producing units are small or that the net balance of emissions caused by resident and non-resident is close to zero.

382. Alternatively, Eurostat (1998a) suggests that emissions from non-national (non-resident) entities (including tourists) should not be included as part of emissions caused by national (resident) economic activities (p. 3, point 1), but should be included in the accounts of the country of origin of the tourists. The proposal is based on the assumption that non-resident tourists contribute an important share to all emissions caused by tourists. An attempt should be made to estimate the share to the emissions caused by non-resident units if the net balance of emissions caused by resident and non-resident units is significantly large.

Notes

1. The 1993 SNA distinguishes four categories of land: land underlying buildings and structures, land under cultivation, recreational land and associated surface water, and other land and associated surface water.

2. Native forests are those forests that do not result from a plantation or whose natural growth is not under the effective control of an institutional unit, although they may be protected and somehow managed .

3. In chapter III, forest ecosystems consist of environmental forest land only. This has been done to avoid double-counting. Economic forest land, including quality indicators, is reported, in physical terms, in worksheet 4 and could be further classified according to the associated ecosystems.

4. When the Government is the owner of the subsoil assets, resource rent could be estimated directly as the total fees, taxes and royalties collected by the Government from the companies involved in the resource extraction.

5. For a more comprehensive discussion of methods for the valuation of soil resources, refer to FAO and others (1994).

6. This method is widely used, as it is simple and applicable to all types of land degradation. In this method, crop yields or other output net of costs of intermediate inputs and consumption of fixed capital, are estimated for the non-degraded and degraded soil and then priced. The difference measures the value of lost production. If this value was considered a permanent loss, it would have to be extrapolated and discounted to obtain the total loss from soil erosion during the accounting period.

7. For a comprehensive description of the degree, the relative extent and causative factors of soil degradation, refer to L. R. Oldeman (1993).

8. Landings are defined as catches less discarded fish (fish thrown dead back to the sea), that is to say, the weight of the catch landed at the wharf.

9. For further information about stock assessment methods see Hilborn and Walters (1992), King (1995) and Sparre and Venema (1992).

10. For further information about fisheries economics and optimal exploitation, see Clark (1990), Cunningham, Dunn and Whitmarsh (1985) and Hannesson (1993).

11. Estimation of the monetary value of cod, shrimp and capelin in the Icelandic EEZ can be found in Danielsson and others (1997).

12. The economic territory of a country may differ from the national boundaries. It includes: (a) airspace, territorial waters and continental shelf lying in international waters over which the country enjoys exclusive rights (for example, mineral deposits of oil and natural gas in international waters operated by a resident unit) ; (b) territorial enclaves in the rest of the world; and (c) any free zones (1993 SNA, para. 14.9).

13. The valuation of transboundary flows presents methodological as well as data problems and is not further discussed here (see chap. III, para. 203 and note 23).

14. A tourist or visitor, as defined in *Tourism Satellite Accounts* (World Tourism Organization, 1998), is any person travelling to a place other than that of his usual environment for less than 12 months and whose main purpose of trip is other than the exercise of an activity remunerated from within the place visited. This definition includes both tourists for leisure purposes as well as business travellers. Note, also, that tourists may be residents or non-residents of the country they visit.

15. See para. 365 above. Also, the 1993 SNA (para. 4.16) elaborates the concept of residence for individuals and corporations, thus distinguishing between tourists as individuals and tourists as business travellers, employed by non-resident producing units.

16. Tourism services may include the services of produced assets (namely, car rentals, hotel, taxi services and so forth). In the 1993 SNA, a consumer purchasing such services has the right to use the asset for the time specified by the contract. The value of the services includes the consumption of the fixed capital of the asset (namely, car, hotel, taxi and so forth), the interest costs as well as any other cost incurred by the owner to operate the asset. In line with this, the imputed cost of emissions caused by the use of the asset represents a cost to be incurred by the asset owner and should therefore be allocated to the tourism industry.

CHAPTER V

POLICY APPLICATIONS

A. Introduction

383. The present chapter illustrates potential policy applications of the System of integrated Environmental and Economic Accounting (SEEA). Case studies of SEEA implementation have so far offered few examples of how such accounting can improve policy-making. This, together with the perceived negative political and economic consequences of such accounting, tends to discourage its implementation. This chapter aims to show possible ways in which environmental accounts can assist in policy-making while alleviating concerns over its perceived risks.

384. The chapter consists of five sections. Sections B and C illustrate how information from integrated environmental and economic accounting (IEEA) can be applied to economic and environmental policies, respectively. These two sections are structured so as to facilitate policy application of environmental accounting data by a range of different users of integrated accounts. Section D describes how the accounts can serve to develop or reform the policy-making process, and so improve the policy outcome. The fact that environmental accounting is often regarded as only an accounting exercise neglects the effects that stakeholders participation in the exercise can have on the ways in which policies are made. Section D identifies those effects. Section E offers conclusions.

385. As this chapter refers frequently to the worksheets of the SEEA used in chapter III, a list of those worksheets is provided in box 9 for easy reference.

Box 9. List of worksheets of SEEA implementation

WS 1	1993 SNA: supply, use and asset accounts
WS 1A	Supply and use table
WS 2, 2A	Environmental protection expenditures
WS 3, 3A	Monetary asset accounts: produced assets, including natural assets
WS 4, 4A	Physical asset accounts: non-produced economic assets
WS 5	Monetary asset accounts: non-produced economic assets
WS 5A	Market valuation of non-produced economic assets
WS 5B	Monetary asset accounts: non-produced economic assets
WS 5C	Allocation of depletion costs to economic activities
WS 6	Physical asset accounts: non-produced environmental assets
WS 7	Emissions by economic sector
WS 8	Maintenance cost of emissions by economic sector
WS 9	Integrated environmental and economic accounts
WS 10A	Comparison of conventional and environmentally adjusted aggregates
WS 10B	Percentage distribution of conventional and environmentally adjusted indicators
WS 10C	Contribution of industries to conventional and environmentally adjusted net product

Source: Chapter III

B. Application to economic policy

386. IEEA information is intended for improving both economic and environmental policies. Information support to economic policy which in the past has been based on conventional national accounts data is particularly important. It is, in fact, the focus of the conventional accounts on market transactions to the exclusion of environmental impacts and their social costs that has triggered work on environmental accounting. Major results from such accounting are thus environmentally adjusted aggregates that can be used for making economic policies.

387. The present section focuses on how SEEA data can improve economic policy-making and promote economic growth. It demonstrates that accounting for the depletion and degradation of natural assets is an intrinsic part of economic analysis. Social factors should also be considered in the design of economic policy; however, they are not discussed here because they are not part of the SEEA.

388. Information from IEEA may contribute to improved economic policy in several ways:

(a) Assessing economic performance;

(b) Reforming economic policies;

(c) Evaluating policy effects.

1. Assessing economic performance: use of SEEA aggregates

389. Economic policy-making often starts by assessing economic performance in the recent past. Gross domestic product (GDP) has traditionally been used to indicate the gross value added created by the economy during an accounting period. Net domestic product (NDP), which is GDP net of consumption of fixed capital, is a better indicator of economic sustainability than GDP, although in practice NDP is seldom estimated. These overall aggregates give a general indication of whether the economy is growing or not. Complemented by other economic indicators such as unemployment, fiscal deficit, trade deficit, debt and inflation, they are used to set the direction of economic policies for the future. For example, if GDP growth has been slow in the past, policy makers may consider reducing the interest rate to encourage investment; however, decisions on promoting economic growth are conditioned by indications of inflationary pressure.

390. Environmentally adjusted aggregates change the information base for assessing economic performance. WS 9 aggregates the monetary values of natural asset depletion and degradation and deducts them as production costs from NDP to arrive at environmentally adjusted NDP (EDP) as the sum total of environmentally adjusted value added. EDP represents net value created by an economy during an accounting period after deducting the consumption of both produced assets and non-produced natural assets. It provides more accurate information on economic performance. In the example given in WS 9 and 10A, EDP amounts to 203,214, compared with NDP, which amounts to 217,454. The difference

represents the value of natural asset depletion and degradation, which amounts to 14,240, or 6.5 per cent of NDP.

391. The use of EDP helps to integrate environmental-economic concerns into the heart of conventional economic policies. If EDP was used as an indicator of genuine economic growth, and macroeconomic and sectoral policies were designed to maximize it, then they would have to treat non-produced natural assets in the same way as produced assets. They would then aim to maintain both the income-generating capacity and the environmental services provided by all assets. In contrast, designing economic policies to maximize conventional aggregates such as GDP and NDP could result in the reduction of EDP. Using EDP in place of GDP or NDP might compel policy makers to include the economic role of natural as well as produced assets when choosing activities to promote economic growth.

392. Policy makers sometimes express concern about perceived negative economic and political implications of using EDP instead of GDP as an indicator of economic performance.[1] These concerns stem from international comparisons of GDP for three major purposes: (a) to assess the relative economic strength of economies, (b) to allocate development aid and (c) to identify investment opportunities. In essence, they have to do with the image of a country or its government and flows of finance and investments into the domestic economy.

393. These concerns are unwarranted. First, at the present stage of environmental accounting, international comparisons of EDP are hampered by a proliferation of different approaches, including valuation techniques and different coverage of natural assets.[2] Second, when it becomes possible to compare the EDP of a greater number of countries, any particular level of EDP will be seen as relative to the EDP of other countries, most of which will experience a downward adjustment from GDP. This will avoid any unfair comparison of one country s EDP with other countries GDP. Third, a comparison between EDP and GDP of a country or across countries indicates the amount of total capital (including natural capital) consumption, and a comparison of EDP and NDP indicates the amount of natural capital consumption. Even though the gaps estimated in these comparisons may be larger in one country than another, the very effort to estimate such gaps can serve to demonstrate the government s commitment to conserving the natural assets of its economy. Any possible negative consequences in terms of image, domestically or internationally, are likely to be offset by such commitment. In fact, such commitment may attract international financing to reduce the gaps, now that they have been identified.

394. It must be cautioned, however, that although environmentally adjusted aggregates have policy advantages over conventional aggregates, they are by themselves inadequate to indicate the full environmental, social and economic dimensions of sustainable development. Although the comparison of EDP and NDP can help identify environmental costs, EDP will not include information on unemployment, social equity or a wide range of environmental costs that cannot be quantified and monetized. EDP growth should not, therefore, be the primary objective of economic policies, even though in relative terms an increase in EDP is more economically sustainable than an increase in GDP. To broadly assess sustainable development, environmental and social indicators in non-monetary terms as well as other economic indicators should be used in conjunction with EDP so as to change the primary economic policy objective from economic growth, adjusted or otherwise, to the improvement in the quality of human life.

2. Reforming economic policies

395. Environmental accounts data can be used to factor the economic costs of natural asset depletion and degradation into economic policies. If the concern is economic or income sustainability, economic policies can be designed to have the users of natural assets pay for the depletion of natural assets. Such payment could be based on the user cost or the net price method as shown in WS 5A.[3] For example, in WS 5B the total depletion cost of coal is estimated using the net price method (67 monetary units) and user cost (43). If the policy concern is ecological sustainability, in other words, maintaining a given standard of natural assets, then the appropriate payment by users of these assets is identified by the maintenance cost method, as is done in WS 8. For example, the cost per 1,000 metric tons of sulphur dioxide (SO_2) emission is estimated at 0.907.

396. A number of market instruments use these valuation concepts in the design of policy tools intended to force households and enterprises to internalize their environmental costs and help achieve economic and environmental sustainability. Such instruments include user fees, effluent charges and tradable pollution permits, as well as reduction or removal of environmentally harmful subsidies. Of course this initial cost assessment by economic agents may not necessarily be borne by the same agents. The ultimate incidence of environmental costs would have to be modelled with appropriate assumptions about production and consumption technologies and market behaviour (Bartelmus, 1998, p. 22). Such modelling would reveal the resulting change in production and consumption patterns and its implications for policy objectives of income distribution and structural change.

397. The revenues from the application of market instruments could be used in different ways depending on policy objectives. If the aim is to achieve overall macroeconomic sustainability, the proceeds should be invested in assets that contribute to the maintenance of at least the current level of national income. Conceptually, the investment could also be made in human capital and institutional capital insofar as these non-conventional yet important assets contribute to income- generation. Where ecological sustainability is the primary objective, tax rates should be set to recover the maintenance cost, and revenues should be invested to maintain the total stock of natural assets or protect their environmental and economic functions.

398. Environmental accounts information can also contribute to the development of environmental

industries. Environmental investment opportunities can be identified using data on environmental protection expenditures (WS 2A). For example, the total output of environmental protection goods and services amounts to 23,877, which indicates the magnitude of the environmental industry. WS 2A also provides information on the import and export of environmental protection goods and services, indicating the potential of environmental business opportunities across countries. For example, the value of imports of environmental protection goods and services amounts to 1,209 and the value of exports of such goods and services is 101. Further information on environmental expenditures by government, households and non-profit institutions can indicate the level of public support for environmental protection. From WS 2A, we can see that the problem of waste has received the highest public attention (1,036), whereas protection against radiation (126) and noise abatement (139) has received low attention in terms of actual expenditures.[4] This type of information will enable businesses to better target their environmental investments.

399. Information on environmentally adjusted net value added by sectors sheds new light on the relative importance of industries in the economy. For example, WS 10C shows that the contribution of the forestry sector to EDP is 1.16 per cent, whereas that contribution constitutes 1.75 per cent of NDP. In mining, these proportions drop from nearly 3 per cent in conventional accounts to 0.4 per cent in the environmental accounts. With this information, policies can be better designed to enhance the economic contributions of certain sectors. The data also highlight the need to use sectoral policies to reduce, for instance, the net depletion of forest resources, in order to maintain and strengthen the role of forestry in the economy.

400. Structural and sectoral adjustments, promoted by international financial and development institutions, are a major instrument for macroeconomic management in many developing countries. These programmes can use environmental accounts to integrate conservation of natural assets into the reform of fiscal, monetary, exchange-rate and trade policies. For example, we can see how domestic prices may be kept artificially low because of competition with cheap imports paid for with revenues from the unsustainable export of natural assets. Were such hidden subsidies in the export sector eliminated, we might find that domestic inflationary pressure would rise significantly. Similarly, currency overvaluation can result from the export of artificially cheap natural resources. As the external demand for such resources is high, domestic currency will experience an upward pressure. An overvalued exchange rate based on export of underpriced resources leads to the so-called Dutch disease, where resource extraction activities compete with non-resource based exports that face relatively disadvantageous terms of trade. (El Serafy, 1997).

401. To achieve the broad societal objective of sustainable development, economic policies should be designed in light of both a set of social and environmental considerations, and the economic functions of natural assets. Policy makers should consider information from physical accounts of non-produced environmental assets (WS 6), industrial emissions (WS 7) and information on asset distribution that can be found when industrial classification (ISIC in figure VII) is linked to the produced and non-produced asset accounts in physical and monetary terms. Such information sheds light on the central issue of sustainable development and inter-generational equity, providing a basis for setting policy on how much natural wealth should be left to future generations. The measurement of environmental costs (WS 5A, 5B and 8) is designed to ensure that future generations will have the necessary capital at their disposal to derive from it at least the benefits obtained during the current accounting period.[5]

3. Evaluating policy effects

402. The effectiveness of reformed economic policies can be assessed by observing the growth rate of EDP. An increase in EDP represents an increase in the value added created by an economy, allowing for the cost of undermining its natural asset base for future growth.

403. Comparisons between EDP and NDP over time can demonstrate the effectiveness of reformed economic policies in preserving the value of natural assets. A shrinking gap between the two aggregates indicates the effectiveness of these policies in protecting natural assets, creating net value added or both. A comparison of the value of natural asset depletion and NDP, expressed as the ratio

(NDP - EDP I) / NDP

(3.9 per cent in WS 10A), indicates depletion per unit of unadjusted NDP. A comparison between the sum of depletion and degradation and NDP, expressed as the ratio

(NDP - EDP II) / NDP

(6.5 per cent in WS 10A), indicates total environmental cost per unit of NDP. In WS 10C, these ratios are calculated at the sectoral level, in terms of environmentally adjusted net value added (EVA) divided by conventional net value added (NVA). A time-series of these ratios can indicate changes in the environmental impacts of economic activities over time.

404. Other ratios are also policy-relevant. When we compare the ratios of final consumption to NDP, with final consumption to EDP II (C/NDP = 71.7 per cent, and C/EDP II = 76.7 per cent in WS 10A), we can identify the extent to which we are living off natural assets. A time-series of these ratios can indicate the effectiveness of economic policies with respect to changing consumption behaviour.[6]

405. When environmentally adjusted net capital formation (ECF), which is largely equivalent to the genuine saving indicator advanced by the World Bank (1995), is compared with EDP (24.48 per cent in WS 10B) over time, the extent of investment in natural assets can be evaluated. When such information is compared with the conventional ratio (29.66 per cent in WS 10B), the relative significance of negative natural capital accumulation for economic performance can be assessed.

406. The effect of policies to improve the efficiency of capital, including non-produced economic (natural) assets, can be evaluated by comparing EDP I with the stock of total capital. The EDP I/CAP I ratio (5.0 per cent in WS 10A) measures the environmentally adjusted net value added per unit of capital (including natural economic capital). It can be compared with conventional NDP over produced capital (30.5 per cent), indicating dramatic changes in capital productivity due to the inclusion of natural assets in the analysis. The incorporation of natural assets will decrease capital productivity, which conventional indicators tend to overstate. Wide variations of productivity among different industrial sectors can be expected, suggesting different sectoral investment policies.

407. The effects of exchange-rate and trade policies can be evaluated by using information from the external accounts. Further analysis (modelling) could assess the influence of potential environmental cost internalization on the terms of trade and import/export structures. Possible changes in the trade balance might bring about changes in real trading positions and international creditworthiness as a result of maintaining the productivity of natural assets.

408. Other economic parameters can also be environmentally adjusted, or compared with EDP as a ratio, in order to facilitate broad assessment of economic policies. Fiscal deficits, for example, will be underestimated if the environmental costs of public sector economic activities are not recorded. By comparing an environmentally adjusted fiscal balance time-series with the conventional one, we can assess government efforts to internalize public sector environmental costs. When a conventional indicator of the public sector deficit is compared with EDP instead of GDP, the problem can be seen as more serious owing to the measurement against the true net value added, which is the fundamental base of tax revenue. Debt and debt service can also be compared with EDP in a similar fashion to gauge the real economic strength that can sustain a particular level of debt and debt service.

409. Tracing the potential repercussions of the environmental adjustment of economic parameters throughout the system requires assumptions about economic behaviour such as price elasticities and technological conditions of production and consumption. Simple comparisons of conventional and environmentally adjusted aggregates therefore cannot provide adequate insight into the ultimate effects of introducing environmental parameters into the economic system. Those effects need to be modelled, for example, in input-output or general equilibrium analyses. Compared with direct statistical data interpretation, these models suffer from sometimes unrealistic behavioural and technological assumptions, but have the advantage of presenting explanations, predictions and alternative policy scenarios in a transparent and analytically rigorous fashion.[7]

C. Application to environmental policy

410. Just as economic policies must be designed in light of their environmental impacts, so too must environmental policies take into account their economic implications in order to be sustained. Although their immediate objectives differ, both environmental and economic policies aim ultimately to support sustainable development, or the improvement in the quality of human life within the carrying capacity of supporting ecosystems.

411. The present section describes how the information contained in the common framework of the SEEA can facilitate the formulation of integrated environmental policies. Data from environmental accounts can be used as inputs into preliminary environmental policy-making; final formulation of environmental policies should take place in a broader context. It should be noted, however, that such information may be inadequate, as it is often difficult to quantify and monetize environmental processes such as pollution and its effects on natural systems and human beings. Although certain environmental data can be and have been linked to national accounts in both physical and monetary terms, environmental policies should rely on a wider range of environmental statistics and indicators. Moreover, apart from

economic implications, social impacts of environmental policies should also be considered, though such impacts are not fully reflected in environmental accounts and are not further discussed here.[8]

412. Environmental accounts provide information that can be applied to environmental policies in many ways, namely, in:

(a) Identifying environmental priorities;

(b) Tracing pressure points;

(c) Designing environmental policies;

(d) Evaluating policy effects;

(e) Facilitating international environmental management.

1. Identifying environmental priorities

413. Physical data on non-produced economic and environmental assets and on pollution can facilitate the identification of environmental priorities. Non-produced economic assets (WS 4) are those over which ownership rights are enforced and that provide economic benefits to their owner, notably land and soil, forests, fisheries, and water resources. Non-produced environmental assets (WS 6), in contrast, are not commercially exploitable: ownership rights may not be enforced and no direct economic benefits can be obtained from their use. Environmental assets include, in particular, terrestrial and aquatic ecosystems, rare and endangered species and air. Pollution and waste discharges are described in WS 7, which tabulates emissions by industry, government, households and the rest of the world.

414. With such information, we can appreciate the extent and evolution (with time-series) of major environmental problems and relate them to the economic activities that cause them. The purpose may be to set up environmental standards and targets, on the basis of the relative importance of the problems, and to set priorities for resolving them. The limitations on aggregating and comparing physical stocks and stock changes will make it necessary to construct monetary accounts, so as to facilitate priorities-setting among a broad range of environmental assets and asset changes.

2. Tracing pressure points

415. The supply, use and asset accounts (WS 1) use International Standard Industrial Classification of All Economic Activities (ISIC) codes to identify industries that are mainly responsible both for the depletion and degradation of natural assets and for environmental protection activities. When the ISIC is linked to physical accounts of non-produced economic and environmental accounts (WS 4 and WS 6, respectively), and to emissions by economic sector (WS 7), environmental problems can be traced to their sources through the input-output framework of the SEEA. The monetary accounts, on the other hand,

allow us to measure the contributions of particular industries to the overall environmental costs generated during the accounting period. Economic and non-economic causes of environmental problems are separated in WS 4 and 5, facilitating the formulation of targeted policies with an element of the precautionary principle.

416. Environmental pressure points can also be traced to their sources by examining the conversion of natural assets -- the change from their serving environmental functions to their serving economic ones. Time-series of physical accounts of non-produced environmental and economic assets can be linked so as to trace the decrease in environmental functions of an asset and the increase in its economic functions, for example, the drainage of a wetland and the corresponding increase in agricultural land. The environmental assets of WS 6 can also be linked to WS 3, which includes information on the monetary value of produced natural assets such as livestock for breeding, orchards, plantation and timber tracts. The loss of environmental functions of a particular natural asset, say, a forest in the wilderness, can then be related to the increased value of a newly generated produced asset, such as a plantation in the forestry sector.[9]

3. Designing environmental policies

417. Information from environmental accounts can be used in determining the costs of environmental policies. The maintenance cost of industrial emissions (WS 8) indicates the cost of the most efficient technologies available to maintain economic and environmental functions of natural assets (see box 2 of chap. II). The availability of such information serves not only to promote the use of these technologies for environmental protection, but also to indicate the financial requirements for meeting environmental objectives. When we link these data to the environmental expenditure accounts of industry, government, and households (WS 2), we can compare the imputed cost of best available technologies with actual environmental expenditures, to estimate additional financial requirements by sector to implement environmental policies.

418. As discussed above, information from environmental accounts can facilitate the application of both regulatory and market-based instruments for environmental protection. One regulatory instrument that can benefit from environmental accounting data is environmental impact assessment (EIA), commonly used to evaluate development projects. EIA regulates the identification of environmental impacts. Emission estimates by sector (WS 7) usually rely on coefficients that relate emissions to inputs and outputs of the production process. These coefficients can also be used to determine the pollution generated by development projects. Ecological sustainability standards are applied in the depletion measurements of the physical asset accounts. In WS 4A, for example, the levels of sustainable use of forest, fishery and water are indicated and the levels of current depletion identified. The standards and the current use levels can be used as benchmarks for assessing the environmental impacts of development projects. Dose-response information from EIA can also feed back into the estimates of coefficients and sustainability standards for the purpose of environmental accounting. To evaluate environmental impacts of projects, the net price, user cost and maintenance cost methods presented in steps 5 and 8 of chapter III can also be used.

419. Environmental accounts can also contribute to the analysis of property ownership patterns, and thus contribute to efforts towards reforming tenure systems which is central to environmentally sound management of common-access resources. By linking data on produced and non-produced natural assets (WS 3, 4, 5 and 6) to ISIC codes, the distribution of national assets and asset use among various sectors can be assessed. This is a first step in the establishment of property rights over common-property assets, which will create an incentive for better environmental care and economic use in the interest of their owners.

420. Environmental accounts provide the basic data and frameworks with which to model the system-wide impacts of environmental policy. For example, the decision to enlarge a forested national park could produce a chain of effects, many of which could be identified using environmental accounting data. Depending on national park management policies in effect, this decision might:

(a) Increase the acreage of protected forests in the wilderness (WS 6);

(b) Reduce the depletion of rare and endangered species (WS 6);

(c) Reduce soil erosion (WS 4 and 6);

(d) Increase the quality and availability of water (WS 4 and 6);

(e) Improve the quality of air (WS 11, in SEEA software);

(f) Reduce the acreage and asset value of land in its economic functions (WS 4 and 5) with negative implications on agricultural yields;

(g) Reduce the amount of standing timber for economic use (WS 3 and 4) with implications for the employment of loggers;

(h) Reduce the asset value of livestock for breeding, orchards, plantations, and timber tracks (WS 3).

4. Evaluating policy effects

421. The system-wide effects of environmental policies, and in particular their effectiveness and efficiency, can also be evaluated by linking environmental protection expenditure (EPE) data (WS 2) to environmental indicators. When EPE and environmental state indicators show an inverse relationship over time, analysis can and should be carried out to find the obstacles to the attainment of environmental targets. Based on the evaluation of policy effects and information of the evolving state of the environment, new environmental priorities can be developed.

422. A comparison between environmental indicators and environmental protection expenditures over time can also yield information on the efficiency of environmental policies. Such information can be used

to encourage use of least-cost technologies and of economic instruments in order to change the level and pattern of consumption and production.

423. EPE can also be used to help assess the effects of environmental policies on international competitiveness of an economy. These expenditures represent economic costs incurred by businesses and society to make up for environmentally damaging production and consumption. They are essential in analysis of whether environmental controls actually harm international competitiveness. The international or intersectoral comparison of maintenance cost per unit of output may also provide an indicator of "environmental comparative advantage", that is to say, of which countries or sectors can produce at lowest environmental cost.

5. International environmental management

424. Environmental accounts information can also be used to facilitate international control of transboundary flows of pollutants and wastes. WS 7 includes information on residual flows between a country and the rest of the world (43,000 metric tons of SO_2 from, and 85,900 metric tons to, the rest of the world). These flows are not estimated in monetary terms. Were these flows valued, they would be presented as negative transfers in figure VII, and flows of residuals out of the country would increase the value of environmentally adjusted national income (ENI), whereas incoming flows of residuals would reduce it.[10] Physical and monetary information on transboundary pollution will be essential to developing international strategies that address this problem and assessing financial compensation of receiving countries by polluting ones.

D. Implications for policy-making

425. In a narrow sense, environmental accounting is a statistical process of data compilation and dissemination. It involves identification of data sources and gaps, collection and processing of data, preparation of accounts in physical and monetary terms, computation of environmentally adjusted accounting aggregates, and the dissemination, electronically from a database or as a statistical report. As an accounting process, the task is deemed complete when integrated accounts and aggregates are presented for a particular accounting period.

426. In a broad sense, however, environmental accounting is also a policy process that runs throughout the accounting phase and beyond. Although accounting per se is carried out by specialized institutions, discussions of environmental accounts, particularly at the initial stage of its implementation, typically involve collaborative efforts by different government agencies, non-governmental sectors and external (international) organizations. These different interested parties or stakeholders collectively undertake a range of tasks; in particular, they:

(a) Identify priority environmental problems;

(b) Determine the scope and coverage of the environmental accounts;

(c) Provide data and raise policy questions to be answered through environmental accounts;

(d) Interpret and disseminate the results;

(e) Debate and promote policy measures to be taken;

(f) Evaluate the effectiveness of such measures.

427. In a typical environmental accounting exercise, there is a lead institution, governmental or non-governmental, assisted by a group of stakeholders and a technical team. The function of the lead institution is to plan, organize, coordinate and report on the project. The technical team is composed of staff from the lead institution itself and/or stakeholder institutions. Unlike technicians who focus on the accounting procedures, the stakeholders are mainly concerned with policy applications of the accounting results. Because it involves this broad stakeholder process (discussed in further detail in chap. VI), environmental accounting can change how policy is made in several ways, namely, by:

(a) *Fostering participation:* an environmental accounting project is usually designed and implemented with the participation of government agencies, non-governmental organizations, the private sector and external organizations. An organized group of diverse stakeholders can facilitate communication between these groups and policy makers in the congress, parliament, State council and ministries of finance and economic planning. Traditionally, these policy institutions focus on conventional economic objectives. The broad group of stakeholders can help broaden that focus by organizing and presenting its views on environmental, social and economic concerns;

(b) *Facilitating prioritization:* an organized group of stakeholders can facilitate identification of the most pressing environmental-economic problems to be accounted for and addressed. Many countries face a host of such problems, but financial resources for addressing them are limited. Through consultation among a balanced group of stakeholders and use of existing environmental and economic indicators, countries may be able to reach consensus on policy priorities. When priorities are identified, an environmental accounting project can be more focused and policy makers are in a better position to devise and implement targeted policy measures with limited financial resources;

(c) *Enabling integration:* stakeholders are expected to include environmental and economic institutions, as well as affected groups such as trade unions. Dialogue among these stakeholders can bring out connections among environmental problems and between environmental and economic problems. The identification of connections can facilitate a more comprehensive and integrated search for solutions. For example, the problem of salinization is often related to upstream deforestation. When the ministry of water resources, the ministry of forestry and the loggers association work together in a stakeholder group, causal relationships can be discussed and identified. A coordinated treatment of salinization can be found and reflected in the sectoral activities of environmental accounts. Such interactions among stakeholders can also lead to policy recommendations that maximize complementarity and minimize conflict between environmental protection and socio-economic development;

(d) *Raising environmental awareness:* environmental awareness can be achieved in three ways. First, environmental accounting requires the collection of basic environmental data. Stakeholders are expected to contribute to the data-collection efforts. This process of data collection can raise environmental awareness within the stakeholder institutions themselves. Second, as environmental data become available, environmental indicators can be compiled and publicized beyond the range and process of environmental accounting. Third, when the environmental accounts become available, stakeholders can disseminate the results through their respective networks, reaching targeted audiences;

(e) *Strengthening capacity:* throughout the environmental accounting process, stakeholders can strengthen their capacity to spot key policy issues, analyse statistical data, develop integrated policy proposals, promote the use of environmental accounts in policy-making, and advocate policy and institutional reforms. As these capacities are enhanced, stakeholders will be in a stronger position to enter into direct dialogue with policy makers.

E. Conclusions

428. This chapter looked at environmental accounting both as an accounting and as a policy process. The accounting process generates a host of information that can be used to facilitate the formulation of economic and environmental policies. This information can be used to assess economic performance, reform economic policies and assess the effectiveness of reformed policies. It can also help identify environmental problems and priorities, trace environmental pressure points, design environmental policies, determine international arrangements to control transboundary pollution, and evaluate the effects of environmental policies.

429. As a policy process, environmental accounting can improve the ways in which policies are made. It builds stakeholder participation into policy-making, facilitates the identification of environmental priorities, fosters an integrated approach to identified problems, raises environmental awareness, and strengthens the policy engagement capacity of civil society groups. For these goals to be achieved, the formation of a stakeholder group for the implementation of environmental accounts is indispensable.

430. The potential of environmental accounting to build engagement in the policy process has yet to be fully realized through its broad implementation. Countries implementing environmental accounts stand to benefit from these applications by improving their image based on the commitment to protect natural assets. Moreover, such programmes will show the potential for new business opportunities resulting from a more sustainably managed natural resource base in a world of increasing scarcity. The present manual attempts to encourage an increasing number of countries to foster environmental accounting by demonstrating its feasibility and usefulness in policy-making.

Notes

1. Note that gross domestic product (GDP) is often mistakenly used as an indicator of welfare or social progress.

2. However, the System of Integrated Environmental and Economic Accounting (SEEA) issued by the United Nations as an interim version and the ongoing process of its revision represent important steps towards further standardization of concepts and methods, which have already been developed in consistency with the procedures and definitions of the world-wide adopted 1993 SNA (chap. XXI, sect. D).

3. As described in chapter II and box 5 of chapter III, the method of such valuation is based on the net present value of total net income generated from the potential use of the asset; in practice, however, simplifications of this method, notably the net price and user cost valuations, are frequently applied.

4. For a more accurate assessment, these figures would have to be supplemented with gross capital formation expenditures which are available only as a total (for government and industries) of 752 for waste disposal, surpassed by 1,340 for waste water management.

5. Another concept of environmental debt would have to assess the value of environmental costs, accumulated over the past in expanded financial accounts (Bartelmus, 1998, box 5). However, such accounts are not yet established in the SEEA.

6. Of course, consumption can be financed by income transfers from abroad, included in the concept and definition of national income. Also, the measurement of changes in consumption patterns would require a more detailed analysis of different consumption categories.

7. Input-output models have the double advantage of (a) being consistent - via make-use matrices of the supply and use accounts - with the national accounts framework and (b) facilitating the linkage between monetary economic variables and physical environmental indicators (see sect. 1, above).

8. Questions of income distribution and the allocation of environmental cost to social groups could be addressed by extending environmental accounts into social accounting matrices, incorporating environmental impacts, as, for example, in the Netherlands Social Accounting Matrix including Environmental Accounts (SAMEA) (Keuning and de Haan, 1998).

9. Assuming that the transfer of an environmental asset has resulted in the replacement of a non-produced asset (a forest in the wildness) by a produced asset that was generated within the production boundary of the national accounts (a plantation) (1993 SNA, para. 10.6).

10. Actual commercial shipments of wastes to and from the rest of the world are already accounted for as exports and imports in the conventional accounts, increasing GDP by an excess of exports over imports, or decreasing it by an excess of imports over exports.

CHAPTER VI

INSTITUTIONAL AND RESOURCE REQUIREMENTS

A. Elements of a national programme of environmental accounting

431. Both the United Nations Conference on Environment and Development (Earth Summit) held at Rio and the United Nations Statistical Commission recommended that the System of integrated Environmnetal and Economic Accounting (SEEA) be implemented by Governments as a satellite system of the revised 1993 SNA. This latest version of the SNA already specifies key features of the SEEA in consistency with the central accounting framework (1993 SNA, chap. XXI, sect. D). The SEEA handbook (United Nations, 1993a) further elaborates and extends these features. The current worldwide effort to assist countries in the implementation of the 1993 SNA thus provides an opportunity to launch environmental accounting while establishing the central SNA framework.

432. Even though experience with such coupling of SNA and SEEA implementation is still lacking, it might be useful to relate a planned environmental accounting project to the six phases of SNA implementation,[1] before deciding on the scope, coverage and institutionalization of the project. For instance, countries that have not yet implemented phases 1 (basic indicators of GDP) and 2 (gross national income and other primary indicators) should probably refrain from implementing the SEEA as part of their official national accounting programme. Research institutes, on the other hand, might usefully embark on some experimentation with selected aspects or modules of the SEEA until progress in SNA implementation has been made by the national accountants. As has already happened in some countries, the experience gained in these more experimental pilot projects can be successfully transferred into the official statistics system.

433. At the outset of a national programme of integrated environmental and economic accounting, there should be a clear perception of the status of national accounting, in the country, of the objectives and priorities of environmental and economic policy, and of data availability, especially on environmental conditions. Such an assessment of statistical capacities, environmental conditions and political priorities facilitates the formulation of a work plan and effective coordination of data gathering by different agencies. Elements of an implementing strategy could include pilot, benchmark and annual compilations, as well as special studies. Ideally, a national programme of environmental accounting should be long-term, since the statistics required take a long time to develop and the analysis of some environmental effects requires long time-series.

1. Pilot compilation

434. A national programme of environmental accounting could be initiated by a pilot project. The objective would be to explore the need for and capabilities of conducting environmental accounting in the country. A pilot compilation of environmental accounts would typically start with the development of the accounting framework. The flexible building-block structure of the SEEA (see chap. II, sect. B) permits the selection and modification of modules so as to suit the conditions and priority concerns of a particular country. When determining the scope and classifications of such a framework, data availability and analytical objectives should be taken into account. Data availability should not, however, be the most restrictive factor, as the framework should be designed for long-term analysis, allowing for improvement in the database. The initial pilot compilation would be based on existing statistics. Considerable data

gaps can be expected at the start of the programme, requiring estimates that should be replaced by more reliable data in later compilations.

435. However weak in terms of data, a pilot compilation serves important purposes. It familiarizes national staff with the concepts and methods of integrated accounting, assists in setting up coordination mechanisms of data collection and guides future data development. At the end of the pilot phase, data reliability, compilation methodology and coordination mechanisms should be assessed, and a course of action set for future work. Box 10 is a summary of lessons learned from a pilot study of integrated environmental and economic accounting (IEEA) in the United States of America.

436. Based on past experience, it is suggested that the pilot compilation be carried out as an interdisciplinary research programme in which the statistical office or the institution responsible for the compilation of national accounts and/or a particular research institute play(s) key roles. Two years are usually required, in a developing country, to conduct a national pilot study of integrated accounting. Depending on the scope, coverage and data availability, the project costs ranged between US$ 100,000 and US$ 200,000.

Box 10. Lessons learned from integrated economic and environmental accounting in the United States of America

The following summarizes the lessons learned from a case study of integrated environmental-economic satellite accounting, focusing on mineral resources:

(a) Consistency with the existing economic accounts is a prerequisite of the use of environmental accounts;

(b) A new environmental accounting project should be built upon past national and international experience to avoid reinventing the wheel ;

(c) Adapt (b) to national concerns;

(d) Present a range of estimates in cases of alternative methodologies applied and corresponding uncertainties;

(e) Publish information on data sources and estimation methods to make data, methods and assumptions transparent;

(f) The focus on environment-economy interactions permits the use of a market approach consistent with market valuations of the conventional accounts.

Source: Landefeld and Howell (1998).

2. Annual compilations

437. To date, practical experience is generally limited to the first phase of environmental accounting, the pilot project. Given the costs of comprehensive benchmark compilations which can be assumed to be at least as great as those of a pilot project, it is proposed that annual compilations in a reduced format be conducted. Reduced-format compilations would introduce aggregated environmental costs into summary economic accounts for the adjustment of key economic aggregates.

438. The compilation software attached to the present manual has been designed to allow reductions in the breakdown or classifications of aggregates while maintaining system consistency. This is achieved by means of built-in formulae, reflecting accounting rules and identities.

3. Benchmark compilations and data collection

439. Benchmark compilations would be similar to pilot compilations in scope and coverage, but would be carried out, not at the beginning, but in the course of the long-term programme, possibly every 5 or 10 years. Their purpose would be to develop and update the economic-environmental database for time-series and detailed structural analyses. Benchmark compilations would thus make use of extensive data sets that accumulated over time and would incorporate the results of special, more detailed environmental accounting studies (see below).

440. Data development and collection are key ingredients of benchmark compilations. Since economic data, for example, of production, trade and investment, are usually well established, the focus of data development should be on environment statistics. Frequently such statistics are compiled for the purpose of environmental policy and management and not necessarily for IEEA. There is a distinct need to link physical data collection and environmental accounting to determine data sets that satisfy purposes of both (physical and monetary) environmental accounting and the compilation of environmental statistics and indicators.[2]

441. Case studies of SEEA implementation have faced major data gaps. They had, therefore, to resort to using special and partial studies, for example, of a specific local ecosystem or particular aspects of a natural resource, as the basis for nationwide estimates. A recent international conference, focusing on country experience with environmental accounting, found major data gaps on environmental protection goods and services, pollution, ecosystem health and transboundary flows of wastes and pollutants (Uno and Bartelmus, 1998). On the other hand, the accounting framework permits the incorporation of partial data sets and their expansion in consistency with related economic variables such as intermediate consumption of materials or output. In this manner, administrative data and special studies that were not developed for purposes of environmental accounting could be used. For instance, emission data can be derived from a combination of technical knowledge of production and consumption processes and statistics on inputs or outputs used or produced during the accounting period.

4. Special accounting studies

442. Once the framework for environmental accounting has been established, it can also serve in implementing particular economic sector or asset accounts. One type of accounts could provide the information for in-depth analyses of particular natural resources such as mineral deposits, forests and water. Other accounts could focus on industries causing environmental depletion and degradation, dealing either with one specific aspect of depletion or degradation across all industries, or with different kinds of impacts of a specific industry. Chapter IV describes the concepts and methods of such sectoral accounting.

443. The use of the SEEA framework ensures comparability of sectoral accounts and avoids the risk of non-compatibility with national accounting concepts and procedures. The latter has been a major drawback of ad hoc studies which disregarded national and international statistical standards. It is sometimes argued that, given the lack of experience with environmental accounting and serious financial constraints, it might be useful to embark on selected special studies only, before attempting full implementation of the SEEA. As discussed in chapter I, such a selective approach can provide useful information for the management of a particular environmental asset or concern but would not be useful for the policy analysis of overall environment-economy interaction.

444. Environmental accounting could also be undertaken at a more restricted geographical level. Such an area could be an ecological zone of particular interest or value, or an administrative entity (province, State) in which the sustainability of development is at a particularly high risk. There is an advantage in compiling environmental data at the local/regional levels which might be offset, however, by lack of information on consumption, production and capital formation in the region and on detailed transboundary flows, usually unavailable at subnational levels. The study of selected regions might provide useful information for local-level planning and strategies. On the other hand, comprehensive regional accounting for the whole country would yield comparative information about regional disparities in environmental impacts and non-sustainabilities of economic activity for regional planning by the central Government. The feasibility of such accounting at the regional (province) level is currently being explored by the United Nations Statistics Division in the Philippines.

B. Implementation of a pilot project

445. New methodologies are always difficult to launch, especially in the context of the official statistical system. Selected country experience can be found on the web site: <www.panda.org/resources/publications/sustainability/mpo/accounting/studiesindex.htm>. A review of selected case studies is presented in Uno and Bartelmus (1998).

1. Setting up the project: national seminar and project formulation

446. The broad interdisciplinary nature of environment-economy interaction is described in chapter I. This characteristic applies to data collection from disparate sources of information, as well as to data use and users. Data producers and users are in fact frequently identical, for instance, when line ministries and research institutes generate and use their own data sets. Bringing data producers and users together in a broad-based national seminar serves thus several purposes:

(a) Identification of environmental and economic concerns and priorities;

(b) Presentation of the SEEA, describing concepts and methods, data needs, resource requirements and the analysis and policy use of the accounting results;

(c) Agreement on a collaborative work programme, including mechanisms of supervision, coordination and implementation.

447. The identification of environmental and economic concerns determines the scope and coverage of the project. These concerns need to be reflected in classifications that figure prominently in the worksheets presented in chapter III. The main substantive classifications of environmental protection expenditures and non-financial assets are reproduced here as annexes II and III. Extensions or modifications of classifications will have to be made to capture particular national environmental, economic and social conditions and policy priorities.

448. Effective organization and coordination of a large number of data-collection and processing activities require the participation of high-level representatives of the key institutions involved. This is to ensure the cooperation of these institutions, especially for data release, and to foster better understanding of the results of environmental accounting. At the outset, a national seminar could be convened to launch the project and assign responsibilities for its implementation.

449. The lead agency should be the one responsible either for environmental matters or for statistical data collection and accounting. Given the experimental nature of a pilot project, a research institute is sometimes charged first, while the more conservative governmental offices may take a wait-and-see attitude. However, if environmental accounting is to become a more permanent feature, it has to be transferred to the official statistical system, preferably to the institution responsible for the conventional national accounts rather than to those responsible for largely physical environmental statistics and indicators. The reason is that national accountants usually find it easier to familiarize themselves with extensions of the accounting system into the environment than environmental statisticians who are usually less familiar with economic accounting.

450. All participating institutions should commit themselves to providing the knowledge and data in their domain. This is typically facilitated by a supervisory committee, problem-solving task forces, and working groups implementing particular sectors or modules of the accounting framework. Recurrent meetings of these stakeholders (see chap. V) are needed to ensure the consistency of concepts and methods used, monitor progress, educate potential data users at all stages of the project and provide directions to the further implementation of the programme.

451. If outside support from donor agencies and/or substantive (technical) institutions is needed, some type of agreement on the objectives, activities and outputs of the joint venture needs to be drawn up. This could be done in the form of a Memorandum of Understanding between the donor agency and its partner. An example of such an agreement is presented in annex VI. Attention is drawn to the list of activities contained in the Memorandum. The identification, confirmation or modification of these activities should be one of the main results of the project-launching national seminar. Most of these or similar activities are in fact described in some detail in chapter III.

2. Human resource requirements: training, workshops and distribution of work

452. Training seminars, workshops and on-the-job instructions are needed to familiarize staff with the concepts and methods of environmental accounting, not only within the lead agency but also in the cooperating data-producing institutions. Even if staff is familiar with particular environment statistics, the requirements for processing these data into the different cells of the accounting framework are usually not widely known. This is the case in particular with staff from non-statistical agencies who have never before worked with accounting concepts and methods, be they conventional or environmental in nature. On the other hand, national accountants and economic statisticians are usually unfamiliar with "scientific" environmental data that are generated by monitoring stations rather than from administrative records or questionnaires.

453. The United Nations regional commissions, regional development banks and international training institutes can play a major role in building national capacities for IEEA. All the regional commissions have organized training workshops in environment statistics and accounting. The pioneering efforts of the Munich Centre for Advanced Training in Applied Statistics for Developing Countries could be a model for similar courses in regional statistical training institutes. The Centre has now held its first courses on Statistics for Environmental Policy in both English and French. In addition, regional city groups might be an effective way of sharing experiences in different fields of applied statistics, including environmental accounting.

454. A first familiarization with the structure and contents of the SEEA is usually provided in workshops convened immediately after the national seminar. More detailed technical workshops on particular natural resources and environmental impacts should be conducted thereafter. These workshops will bring together the expertise for the assessment of particular areas. For instance, the modelling of fish stocks and their sustainability needs to be related to the (national) accounting concept of depletion in physical terms and for monetary valuation. In this manner, socio-economic concerns and environmental impacts and repercussions are discussed extensively to the mutual benefit of all parties involved. As indicated in chapter V, this kind of collaboration and information exchange is a most useful aspect of environmental accounting, beyond the immediate outcomes of the accounting project.

455. The data identified and categorized in "dummy" tabulations or worksheets need to be processed and transmitted to the executing agency for further processing and introduction into the consolidated accounts database. At this time, the reconciliation of data from different sources is crucial. For example, forest data obtained from the forest industry through the national accounts questionnaire may differ significantly from the data collected by the Ministry of Forestry. The worksheets, described in chapter III, are the basic tool in compiling the SEEA. It is difficult to generalize about how much data processing should be done at the executing agency or at the participating data sources. It all depends, of course, on the respective knowledge about environmental accounting, acquired by the different institutions, their data-processing capacities and their human and financial resources.

456. Typically an environmental accounting project will require a core group of permanent staff, supported by inter-agency working groups. For example, in the Philippine pilot project, 8 full-time consultants worked with 30 part-time staff of the National Statistical Coordination Board (NSCB) and a technical working group of 10 representatives from collaborating agencies. A core group of NSCB staff

provided overall guidance, while the consultants and the technical working groups actually compiled the tables and accounts.[3]

3. Evaluation, analysis and institutionalization

457. After the accounts have been compiled, a draft report is prepared. The report is drafted to present the accounts and to describe the data gaps, and the problems encountered, solved or deferred. The report can be the basis for a second national seminar to discuss the results, to present further analysis and interpretation of the results, and to make recommendations for follow-up programmes. Recommendations may include the allocation of a more permanent responsibility for recurrent environmental accounting to a particular agency. As suggested above, the agency dealing with the compilation of the national accounts (such as the National Statistical Office or the Central Bank) is probably the best place for harbouring a regular programme of integrated environmental and economic accounting. However, broader cooperative programmes could be set up to allow for full participation of data producers and users. Box 11 is an illustration of such a broader set-up in the Philippines.

Box 11. Institutionalizing the Philippine Economic-Environmental and Natural Resource Accounting System

After two years of piloting natural resources and environmental accounting in the country, using the SEEA framework, Executive Order (EO) 406, institutionalizing the Philippines Economic-Environmental and Natural Resources Accounting (PEENRA) System, was signed by the President in March 1997. The EO authorized the creation of PEENRA units in three agencies: (a) the National Statistical Coordination Board (NSCB), the compiler of the national accounts, (b) the National Economic and Development Authority (NEDA), the economic planning agency, and (c) the Department of Environment and Natural Resources (DENR), the agency responsible for the management and protection of natural resources and environment. The EO mandates these agencies to conduct activities leading to the regular compilation of the environmental accounts as a satellite of the Philippines System of National Accounts (PSNA); it also requests the integration of the results of environmental accounting in planning and policy formulation. A Steering Committee on PEENRA was created to provide directions for the PEENRA units. The Committee is headed by the Director-General of NEDA, with the other agencies represented at the level of Under-secretary.

458. Follow-up activities could include:

(a) A programme of data development to close the most glaring data gaps discovered in the pilot study. This could be part of a broader programme of environment statistics, include the establishment of a network of monitoring stations, or simply focus on the improvement of existing databases in the different cooperating institutions;

(b) Training on the uses of environmental accounting in policy-making;

(c) A research programme for the assessment of the direct policy or managerial uses of the accounts, on one hand, and the more indirect uses through filters of modelling and further analysis, on the other hand;

(d) Extended physical accounts such as material/energy balances or input-output tabulations;

(e) Feasibility/pilot studies of regional (subnational) environmental accounts;

(f) Special-sector accounting for selected environmental concerns (natural resources or environmental impacts);

(f) Training workshops and capacity-building through technical cooperation.

459. As elaborated in chapter V, the analysis of policy applications of the results of integrated accounting is essential for convincing the user community of the need for recurrent compilations of such accounts. Typically, statisticians are reluctant to get involved in analysis of the statistics produced. The reason is that they are intent on maintaining their reputation as producers of objectively observed data, which might be impaired by getting involved in data interpretation and modelling. However, much knowledge about the quality, validity and definition of statistics and indicators becomes lost in this manner. At the same time, users are hesitant to accept any modifications of well-established economic aggregates such as gross domestic product (GDP), cost or capital. As pointed out above, user involvement right from the beginning of the project and national seminars with full participation of data producers and users are probably the best way to tap the knowledge of the statisticians and to educate the user community, ensuring wide acceptance of environmentally adjusted accounts and indicators.

Notes

1. The six phases or milestones were proposed by the Intersecretariat Working Group on National Accounts to provide countries with a framework for formulating their individual SNA implementation plans and with an instrument for characterizing the levels of national accounts development. The milestone approach was endorsed by the United Nations Statistical Commission at its 29th session in February 1997.

2. See, for a discussion of such linkage between SNA/SEEA, physical natural resource accounts and the Framework for the Development of Environment Statistics (FDES), Bartelmus (1997).

3. Information provided by E. Domingo, National Statistical Coordination Board, the Philippines, and leader of the pilot project on SEEA implementation.

ANNEX I

SEEA implementation: steps and activities[a]

Step 1: Compilation of the supply and use accounts

Step 2: Identification and compilation of environmental protection expenditures

Step 3: Compilation of produced natural asset accounts

- 3.1 Identify industries with cultivated natural assets
- 3.2 Estimate the value of fixed asset/inventory stocks at the beginning of the accounting period
- 3.3 Incorporate national accounts data on gross fixed capital formation, changes in inventories and capital consumption
- 3.4 Assess other volume changes due to natural disasters or other destruction and uncompensated seizures by authorities and so forth
- 3.5 Estimate the value of the fixed asset/inventory stocks at the end of the accounting period

Step 4: Compilation of physical natural resource accounts

- 4.1 Land and soil accounts
- 4.2 Subsoil asset accounts
- 4.3 Forest accounts (economic functions)
- 4.4 Fishery resources and other biota accounts
- 4.5 Water accounts

Step 5: Valuation of natural resources: compiling the monetary accounts

- 5.1 Determine the market prices of different natural resource outputs
- 5.2 Assess the total production cost per unit of resource output
- 5.3 Assess normal return to capital
- 5.4 Determine net operating surplus
- 5.5 Calculate the net price as the difference between 5.1 and (5.2+5.3) or as the difference between 5.4 and 5.3
- 5.6 Use market value or apply net price at the beginning of the accounting period to the physical opening stocks of non-produced economic assets
- 5.7 Apply average net price to volume changes of non-produced economic assets
- 5.8 Use market value or apply net price at the end of the accounting period to the physical closing stocks of non-produced economic assets
- 5.9 Calculate revaluation item as balance between opening and closing stocks and all other asset changes

5.10 Enter environmental (depletion) cost into the SEEA for calculation of EVA I, EDP I and so forth
5.11 Establish the discount rate
5.12 Estimate the lifetime of the resource at current exploitation rates
5.13 Calculate the user cost allowance, apply the discount rate and lifespan established above to the current net return
5.14 Enter user cost allowance into the SEEA for alternative EVA I and EDP I calculation

Step 6: Compilation of physical environmental assets accounts (optional)

Step 7: Compilation of emissions by economic sector

Step 8: Maintenance costing of emissions

8.1 Assess the minimum cost activities for avoidance/restoration of environmental degradation
8.2 Apply minimum unit costs to emissions
8.3 Enter environmental costs in an alternative version of the SEEA (for calculation of EVA II, EDP II and so forth)

Step 9: Aggregation and tabulation

Step 10: Comparison of conventional and environmentally adjusted indicators

Notes

a. The steps represent building blocks of the SEEA and could be implemented selectively according to country priorities and data availability.

ANNEX II

Classification of Environmental Protection Activities (CEPA)[a]

1. Protection of ambient air and climate

1.1 Prevention of air pollution through in-process modifications
- 1.1.1 For the protection of ambient air
- 1.1.2 For the protection of climate and ozone layer

1.2 Treatment of exhaust gases and ventilation air
- 1.2.1 For the protection of ambient air
- 1.2.2 For the protection of climate and ozone layer

1.3 Measurement, control, laboratories and the like

1.4 Other activities

2. Waste-water management

2.1 Prevention of pollution through in-process modifications

2.2 Sewerage networks

2.3 Waste-water treatment

2.4 Treatment of cooling water

2.5 Measurement, control, laboratories and the like

2.6 Other activities

3. Waste management

3.1 Prevention of pollution through in-process modifications

3.2 Collection and transport

3.3 Treatment and disposal of hazardous waste
- 3.3.1 Thermal treatment
- 3.3.2 Landfill
- 3.3.3 Other treatment and disposal

3.4 Treatment and disposal of non-hazardous waste
- 3.4.1 Incineration
- 3.4.2 Landfill
- 3.4.3 Other treatment and disposal

3.5 Measurement, control, laboratories and the like

3.6 Other activities

4. Protection of soil and groundwater

4.1 Prevention of pollutant infiltration
4.2 Decontamination of soils
4.3 Protection against soil erosion
4.4 Measurement, control, laboratories and the like
4.5 Other activities

5. Noise and vibration abatement (excluding workplace protection)

5.1 Noise from road and rail traffic
 5.1.1 Preventive in-process modifications at the source
 5.1.2 Construction of anti-noise/anti-vibration facilities
5.2 Air traffic noise
 5.2.1 Preventive in-process modifications at the source
 5.2.2 Construction of anti-noise/anti-vibration facilities
5.3 Industrial process noise and vibration
5.4 Measurement, control, laboratories and the like
5.5 Other activities

6. Protection of biodiversity and landscape

6.1 Protection of species
6.2 Protection of landscapes and habitats
 6.2.1 protection of forests
6.3 Rehabilitation of species populations and landscapes
6.4 Restoration of cleaning of water bodies
6.5 Measurement, control, laboratories and the like
6.6 Other activities

7. Protection against radiation (excluding nuclear power stations and military installations)

7.1 Protection of ambient media
7.2 Measurement, control, laboratories and the like
7.3 Other activities

8. Research and development

8.1 Protection of ambient air and climate
 8.1.1 Protection of ambient air
 8.1.2 Protection of atmosphere and climate
8.2 Protection of ambient water
8.3 Waste
8.4 Protection of soil and groundwater
8.5 Abatement of noise and vibration
8.6 Protection of species and habitats

8.7 Protection against radiation
8.8 Other research on the environment

9. Other environmental protection activities

9.1 General administration of the environment
9.2 Education, training and information
9.3 Activities leading to indivisible expenditure
9.4 Activities not elsewhere specified

Notes

a. Based on United Nations, Economic Commission for Europe (1994).

ANNEX III

Classification of Non-Financial Assets (CNFA) in the 1993 SNA and the SEEA

CNFA		SNA (rev.)
1	**Produced assets (CC 3.1)**	AN.1
1.1	Man-made assets (3.1.1.1)	
1.1.1	Fixed assets	AN.11-part
1.1.1.1	Tangible fixed assets	AN.111-part
1.1.1.1.1	Dwellings	AN.1111
1.1.1.1.2	Other buildings and structures (including historical monuments)	AN.1112
1.1.1.1.3	Machinery and equipment	AN.1113
1.1.1.2	Intangible fixed assets	AN.112
1.1.1.2.1	Mineral exploration	AN.1121
1.1.1.2.2	Other intangible fixed assets	AN.1122, AN.1123, AN.1129
1.1.2	Inventories	AN.12-part
1.1.2.1	Materials and supplies	AN.121
1.1.2.2	Work in progress (except on natural growth products)	AN.1222
1.1.2.3	Finished goods	AN.123
1.1.2.4	Goods for resale	AN.124
1.1.3	Valuables	AN.13
Memorandum item Consumer durables (3.1.2)		AN.m
1.2	Cultivated natural growth assets (living biota) (3.1.1.2)	
1.2.1	Cultivated fixed natural growth assets	AN.1114
1.2.1.1	Livestock for breeding, dairy, draught and so forth	AN.11141
1.2.1.1.1	Livestock (except aquatic animals)	
1.2.1.1.2	Fish stock and stock of other aquatic animals in fish ponds and farms	
1.2.1.2	Vineyards, orchards and other plantations of trees yielding repeat products	AN.11142
1.2.2	Work in progress on natural growth products	AN.1221
1.2.2.1	Livestock raised for slaughter	AN.12212
1.2.2.1.1	Livestock (except aquatic animals)	
1.2.2.1.2	Fish stock and stock of other aquatic animals in fish ponds and farms	

1.2.2	Crops and plants of cultivated forests	
1.2.2.2.1	Crops and other produced plants, not yet harvested (work in progress)	
1.2.2.2.2	Trees of timber tracts	
1.2.2.2.3	Other plants of cultivated forests	
2	**Non-produced assets (3.2)**	
2.1	Non-produced natural assets	AN.2
2.1.1	Wild biota (3.2.1)	AN.213
2.1.1.1	Wild animals (except of wild aquatic animals)	
2.1.1.2	Wild fish and other aquatic animals	
2.1.1.3	Wild plants (except of uncultivated forests)	
2.1.1.4	Trees and other plants of uncultivated forests	
2.1.2	Subsoil assets (proved reserves) (3.2.2)	AN.212
2.1.2.1	Fossil subsoil assets	AN.2121
2.1.2.1.1	Coal and lignite, peat	
2.1.2.1.2	Crude petroleum	
2.1.2.1.3	Natural gas	
2.1.2.2	Metal and other ores	AN.2122
2.1.2.2.1	Uranium and thorium ores	
2.1.2.2.2	Metal ores	
2.1.2.3	Non-metallic mineral reserves	AN.2123
2.1.2.3.1	Stone, sand and clay	
2.1.2.3.2	Other minerals	
2.1.3	Land (with ecosystems and soil) (3.2.3)	AN.211
2.1.3.1	Soil (3.2.5.1)	
2.1.3.2	Cultivated (economically used) land areas (with connected ecosystems) (3.2.5.2)	
2.1.3.2.1	Land underlying buildings and works	AN.2111
2.1.3.2.2	Agricultural land	AN.2112
2.1.3.2.3	Forests (timber tracts) and other wooded land	
2.1.3.2.4	Recreational and other open land for economic purposes	AN.2113-part
2.1.3.2.5	Areas of artificial watercourse or water impoundment	AN.2119-part
2.1.3.3	Uncultivated land areas (with connected ecosystems)	AN.2113-part, AN.2119-part
2.1.3.3.1	Wet open land	
2.1.3.3.2	Dry open land with vegetation cover	

2.1.3.3.3	Open land with or without insignificant vegetation cover	
2.1.3.3.4	Water areas (except areas of artificial watercourse or water impoundment)	
2.1.4	Water (3.2.3)	AN.214
2.1.4.1	Groundwater	AN.2141
2.1.4.1.1	Aquifers	AN.21411
2.1.4.1.2	Other groundwater	AN.21412
2.1.4.2	Water of lakes, rivers and so forth	
2.1.4.2.1	Water in water reservoirs, artificial watercourses and water impoundments	AN.2142
2.1.4.2.2	Other	AN.2149
2.1.4.3	Coastal water	AN.2149
2.1.4.4	Ocean water	AN.2149
2.1.5	Air (3.2.4)	
2.2	Intangible non-produced assets (leases, goodwill and so forth)	AN.22

ANNEX IV

Illustrative examples of soil assessment

Illustration 1: The universal soil loss equation (source: Lal and Pierce (1991)): the equation as presented by Cook (1936) has remained valid until today. Average annual soil loss A is given by:

$$A = RKLSCP$$

where R is rainfall erosivity, which is a function of climate; K is the soil erodability determined by soil particle size, percentage of organic matter in the soil, soil structure and so forth; L is the slope length factor; S is steepness of slope; C is the cover management factor; and P is the supporting practice factor. This technique has been discussed in detail by Wischmeier and Smith (1978).

Illustration 2: Nutrient replacement cost approach (source: Norse and Saigal (1993)): the central focus of the study is to provide a systematic method for assessing the economic costs of land degradation (particularly soil erosion using Stocking s (1986) approach based on the highly significant relationship between soil loss and losses of nitrogen, phosphorus and organic carbon). The study attempts to classify, document and analyse soil loss data collected by Stocking for 1970-1976. The raw data consisted of sludge measurements taken from the collecting tanks on erosion plots, which gave records of nutrient concentration in percentages for nitrogen, phosphorus and organic carbon. These data were used to compile the loss of nutrients for a given level of erosion, using regression analysis. The agricultural land was divided into commercial and communal lands and further subdivided into grazing and arable lands. The results were used to project national totals and convert them into monetary value using current fertilizer prices. The study obtains US$ l.5 billion per year (at 1985 market fertilizer prices and rate of exchange) as the total nutrient loss on the mineral-fertilizer-replacement basis.

Two major limitations for this study should be mentioned, namely: (a) it is questionable whether monetary costs can be quantified with sufficient accuracy by the equivalent cost of nutrient replacement. The reason is that, as the supply of nutrients to plants is different depending on whether inorganic fertilizers are applied or natural processes are assessed and (b) the methodology does not establish any relationship between the loss of nutrients and the loss of production.

Illustration 3: The yield-input relationship (source: Parikh (1991)): in this approach the yield is taken to be the product of a function of inputs and of another function of soil quality. The soil quality index is determined by a set of inherent physical and chemical properties of the soil, namely, soil type (sand, loam, light clay, heavy clay), soil colour (black, gray, yellow), soil depth (less than 1 foot, 1 to 3 feet, more than 3 feet), soil salinity (nil, moderate, poor), surface drainage (good, moderate, poor) and rate of percolation (high, moderate, low). The study used data collected in the Fertilizer Demand Survey conducted for two consecutive periods, 1975-1976 and 1976-1977, over all parts of India and covering some 21,500 farm households. The study constructed a soil quality index using regression analysis. For estimating depreciation or appreciation in land quality, sampling data on soil properties can be used in the following equation:

$$\Delta V = \sum_{t=1}^{\infty}(Q_t - Q_{t+1})\frac{Y_{t+1}}{(1+r)^t}$$

Where Q_t is the soil quality index at the beginning of period t, Y_t is net value of output in period t, ΔV is the change in value of soil between period *t* and period *t*+1, and *r* is the discount rate. This approach was applied to India. Using cross-section data, soil quality functions were estimated for different States by Parikh (1991).

Illustration 4: Soil erosion in soils of Costa Rica using sedimentation data (source: Aguirre (1997)): the author applied a simple method for estimating soil erosion, using data on sediments suspension in 70 major rivers. Compilation of soil loss was done in two phases:

Phase 1: (i) Estimates of the sediments in suspension on the 70 major rivers during a year was obtained from Instituto Costarricense de Electricitad (ICE) (1995);

(ii) Sediments were then converted into the equivalent weight of a hectare of soils at 20 centimeters with a bulk density of 0.95;

Phase 2: (i) The average nutritive value of Costa Rican base soil was estimated;

(ii) The total nutrients lost were estimated.

Relevant data extracted from the study are given in table A.2.

Table A.2. Nutrient loss and cost in Costa Rican soils

Nutrient	Nutrient in soil (kilograms/ hectare)	Total loss[a] (hectare equivalents)	Price/kilogram	Total value (US$)
Nitrogen	3,791	168,437,921	0.451	75,965,502
Phosphorus	24	1,066,344	0.400	426,538
Potassium	3l9	14,173,489	0.610	8,645,828
Calcium	4,320	191,941,920	0.093	17,850,599
Magnesium	648	28,791,288	0.480	13,819,818
Total				116,708,285

a. Figure in Nutrient in soil column multiplied by nutrient loss coeffcient (44,431).

ANNEX V

Air emissions

A. Economic activities and air emissions

The following examples are reported from Gravgård (1998).

Example 1: SO_2 emissions related to national activities

Most European countries prepare SO_2 (and other) emission inventories, in connection with the Atmospheric Emission Inventory for 1990 (CORINAIR) database and reporting to the Economic Commission for Europe 1979 Convention on Long-range Transboundary Air Pollution (United Nations, Economic Commission for Europe, 1996). Thus, totals for the SO_2 emissions exist for many countries, and these totals can, with more or less difficulty, be allocated to different industries and subsequently linked to the national accounts.

Before doing so, it is necessary, however, to look at the activity data and energy use lying behind the CORINAIR SO_2 emissions, especially for transport activities.

As the primary aim of the CORINAIR/ECE inventory is to describe contributions to acidification on a national level, the emissions of SO_2 from planes, ships and cars include, emissions from:

- Planes: all planes (all nationalities) flying below 1,000 meters (corresponding to the so-called landing and take-off (LTO) cycles);
- Ships: all ships (all nationalities) sailing between one national port and another national port;[a]
- Cars: all fuel used in the country.

This definition is made without respect to definitions of economic activities (and related physical activities) in the national accounting sense.

Table A.3 shows, in the case of Denmark, 1990, rough estimates of the energy use and SO_2 emissions related to ships, estimated from national accounting activities on the one hand and CORINAIR activities on the other hand.

If we take the economic activity related to Danish shipping companies (Danish resident units) as it is described in the national accounts for 1990, we find that the corresponding physical activities involved a bunkering of 12 petajoules fuel (13,000 metric tons SO_2) in Denmark and of 118 petajoules (204,000 metric tons SO_2) in other countries. Thus, the total quantity of energy bunkered by ships owned by Danish shipping companies was 130 petajoules (217,000 metric tons SO_2). The fuel bunkered in Denmark is used for sailing both inside and outside Danish territory, while most of the fuel bunkered in other countries is used outside Danish territory.

The CORINAIR inventory accounts for 8 petajoules (7,000 metric tons SO_2) used for Danish and foreign ships sailing between Danish ports.

The difference between the activities for ships based on national accounting principles and those based on CORINAIR principles is substantial. The numbers can be compared with reference to the fact that, according to CORINAIR, the total energy used in Denmark in 1990 was 679 petajoules and the corresponding total SO_2 emissions were 189,000 metric tons. This means that the figure for SO_2 emissions related to Danish ships bunkering abroad according to the national accounts was larger than that for the total Danish emissions according to the CORINAIR inventory.

Table A.3. National activities by ships, Denmark, 1990

Accounting principle	Energy use		SO_2 emissions
		Petajoules	Metric tons
National accounts	Bunkering in Denmark	12	13,000
	Bunkering abroad	118	204,000
	Total	130	217,000
CORINAIR, ECE	Energy used: Danish port to Danish port	8	7,000

While there is little doubt that the 130 petajoules and 217,000 metric tons SO_2 reflect the energy use and SO_2 emissions related to the economic activities of Danish shipping companies (resident units in Denmark), there is also little doubt that the 8 petajoules energy use and the 7,000 metric tons of SO_2 are more relevant when it comes to a description of the effect on the Danish environment of (Danish and other) shipping activities in Denmark. Therefore, whether it is correct to combine CORINAIR data for SO_2 with those of the Danish national accounts will depend on the purpose of the combined economic and environmental account.

Example 2: CO_2 emissions related to national activities

National CO_2 statistics are often compiled according to the International Panel on Climate Change (IPCC) guidelines, which support the United Nations Framework Convention on Climate Change (A/AC.237/18 (Part II)/Add.1 and Corr.1, annex I) signed by about 150 countries in Rio de Janeiro in 1992. While the CORINAIR/ECE guidelines for national SO_2 emissions focus on the pressure on the national environment, the IPCC guidelines for CO_2 emissions focus on national responsibility for the global CO_2 problem. Therefore, in the case of transportation/mobile sources, the national CO_2 inventory according to the IPCC guidelines[b] is based on emissions from the following sources:

- Planes: all domestic landing and take-off (LTO) (under 1,000 metres) and all domestic cruise (over 1,000 metres). Domestic traffic is defined as traffic between two national airports, without respect to route or final destination. Planes belonging both to national and to foreign airline companies are included;

- Ships: all ships (all nationalities) sailing between one national port and another national port;

- Cars: all fuel sold in the country.

Table A.4. shows, in the case of Denmark, 1990, rough estimates for the energy use and CO_2 emissions related to planes (exclusive of defence) as they can be estimated from the Danish national accounts on the one hand and IPCC reporting on the other hand.

Table A.4. National activities by planes, Denmark, 1990

Accounting principle	Energy use	Petajoules	CO_2 emissions 1,000 Metric tons
National accounts	Planes owned by Danish airline companies	25	1,800
IPCC, United Nations Framework Convention on Climate Change	Domestic traffic	1	72

The economic activity by Danish airline companies is accompanied by an energy use of approximately 25 petajoules (1,800,000 metric tons CO_2). This energy use takes place in connection with landing and take-off and cruise by Danish planes in Denmark, other countries and international territories.

In contrast, the Danish use of energy for planes according to the IPCC guidelines is 1 petajoule (72,000 metric tons CO_2) or approximately 4 per cent of activity according to the national accounting principles. Some energy use by foreign airline companies is included in the IPCC figure; however, that this energy use is rather small is of course related to the fact that the geographical extension of Denmark and the number of Danish airports and thus also the domestic LTO and cruise by planes -- are rather limited --.[c]

So, once again, we find that there is a substantial difference between the energy use and emissions calculated on the basis of national accounting activities and energy use and emissions calculated using national environmental statistics/IPCC accounting. In the latter case, both the IPCC approach and the national accounting approach focus on the effect of national activities (more or less from a responsibility/cost-caused point of view), but the definitions of national activities are quite different in the two approaches, and so are the results.

Notes

a. By this definition, it follows that traffic from Copenhagen to the nearby Malmoe City in Sweden is neither Danish nor Swedish national traffic, while traffic from a Russian port in the Baltic Sea, through the North Sea, and the English Channel, around Portugal and Spain through the Mediterranean Sea and through Bosporus, to a Russian port in the Black Sea is national Russian traffic.

b. The IPCC reporting instructions also include emissions from international traffic, but these emissions are not included in the national totals.

c. It should be observed, however, that according to the IPCC guidelines, Greenland and the Faeroe Islands are part of Denmark while in the Danish national accounts, these part of the Danish kingdom are regarded as part of the rest of the world.

ANNEX VI

Memorandum of Understanding

between

the Government Agency of ... the (donor/cooperating agency)

A. Background

The present Memorandum of Understanding is to set out the terms of reference for joint cooperation between the Government of ... and the (donor/cooperating agency). The project is designed to contribute to the implementation of the recommendations of the United Nations Conference on Environment and Development, requesting that Member States establish the System of integrated Environmental and Economic Accounting (SEEA) with the support of the United Nations Statistics Division and other international organizations.

B. Objectives and approach

The general objective of the project is to assist the Government of ... in preparing a first presentation of integrated environmental and economic information, using a framework for environmental accounting based on the SEEA. The SEEA has been designed as a satellite system of the 1993 SNA which facilitates the implementation of the SEEA in conjunction with the conventional economic accounts of the SNA.

The economic growth of [name of the country] has been relying heavily on its natural resource base to drive its industrialization. In many sectors, natural resources (such as forests, oil, coal and so forth) provide important inputs for development. Nevertheless, the country has not recorded resource depletion under its conventional national accounts system. This omission can now be corrected with the introduction of natural resource accounting under the SEEA. Furthermore, degradation of natural assets from soil erosion and the pollution of environmental media of air, water and land have become major concerns in the country. The costs to society of these environmental concerns are also assessed by the SEEA and allocated to the economic activities causing the environmental impacts.

In addition, certain public and private expenditures are either directly or indirectly induced in response to environmental changes. For example, safe drinking water is provided through the enhancement of sewerage systems or the control of soil erosion and can be considered environmentally related. Those expenses can be readily identified in conventional accounts. However, the costing of consequential effects (and related expenses, for example, for medical treatment) on human health and well-being is more difficult to conceptualize and measure. Those indirect costs are therefore not further explored in the present project but could be assessed in follow-up studies.

The main objectives of integrated environmental and economic accounting in (name of the country) can thus be specified as:

(a) Segregation and elaboration of all environment-related flows and stocks of traditional accounts, permitting the separate estimation of the total expenditure for the protection or enhancement of the environment;

(b) Linkage of physical resource accounts (which record the total stock or reserves of natural resources and changes therein) with monetary environmental accounts and balance sheets;

(c) Assessment of environmental costs and benefits from the depletion of natural resources in production and final demand, and changes in environmental quality resulting from pollution and other impacts of production, consumption and natural events on the one hand and environmental protection and enhancement on the other hand;

(d) Accounting for the maintenance of tangible wealth through net capital accumulation (discovery, increase and use/consumption) and the assessment of stocks (reserves) of natural and produced assets;

(e) Elaboration and measurement of indicators of environmentally adjusted product and income. This involves consideration of the costs of depletion of natural resources and emissions for the calculation of macro-aggregates, notably an environmentally adjusted net domestic product (EDP).

The basic approach to compiling environmental-economic accounts in (name of the country) will be to use the existing national accounts data for the benchmark years 1990 and 1995 (years in which full input-output tables were compiled) and make appropriate adjustments for the depletion and degradation of environmental assets and the identification of environment-related expenditures. For 1990 and 1995, full integrated accounting systems and tabulations will be established. For the intervening years and following years, reduced format accounts will be compiled.

The process of linking the SNA with environmental and natural resources accounts is achieved in the SEEA by the incorporation of produced and non-produced (natural) assets in the 1993 SNA. Produced and non-produced assets are integrated into supply and use, and asset accounts. This approach permits integrated environmental-economic analysis, required for integrated planning and policy-making, and will be the basic approach to implementing the SEEA in the country.

C. Activities and outputs

To assist the Government in the task of preparing a first presentation of environmental information, within the framework for integrated accounting of the SEEA, different "activities" will be carried out, grouped into the following five programme elements:

(1) Elaboration of the SEEA framework for the country;
(2) Compilation of pilot integrated economic and environmental accounts for 1985-1992;
(3) Evaluation of project results;
(4) Training of national staff;
(5) Finalization of project reports.

Each of these programme elements (PE) comprises the following activities (estimated period of implementation in brackets):

PE 1 Elaboration of SEEA frameworks for (name of the country)

Activity 1.1 Design of the accounting framework and related data tabulations [June 1999].

PE 2 Compilation of pilot integrated economic and environmental accounts for 1985-1992

Activity 2.1 Identification of major data sources [June-July 1999];
Activity 2.2 Adaptation of national accounts (SNA) data for environmental analysis [July 1999]:

(i) Compilation of supply-use table;

(ii) Identification of production and expenditure data on environmental protection;
(iii) Compilation of produced assets accounts;

Activity 2.3 Compilation of natural assets accounts in physical terms [July-December 1999];
Activity 2.4 Compilation of data on emission of pollutants and wastes, and other degradation of environmental assets [July-December 1999];
Activity 2.5 Compilation of monetary environmental accounts:

(i) Compilation of cost and price data for market valuation and maintenance cost valuation [July-December 1999];
(ii) Improvement/reformatting of physical data and valuation of physical data (United Nations Statistics Division mission) [January-February 2000].

PE 3 Evaluation of project results

Activity 3.1	Analysis of the implications of project results for planning and policy-making [March 2000];
Activity 3.2	Comprehensive project report (draft) [April 2000];
Activity 3.3	Popular (summary) version of project report (draft) [May 2000];
Activity 3.4	National seminar of data users and producers (United Nations Statistics Division participation/mission) [May 2000].

PE 4 Training of national staff

Activity 4.1	On-the-job training of national staff throughout the project.

PE 5 Finalization of project reports [June 2000]

D. Budget

COST-SHARING CONTRIBUTION	TOTAL	CONTRIBUTORS
National consultants	$70,000 [$100,000]*	....
Mission costs (foreign consultants) (2 man-months)	$20,000	....
Technical support (foreign consultants) (3 man-months)	$28,500	....

* Range of costs in pilot projects.

The (name of the executing agency) will receive in the course of the project a total sum of $70,000 [$100,000] to execute the project. The (donor agency) will be provided with statements of disbursement of these funds. The (donor agency) will provide technical backstopping missions to elaborate the SEEA framework and assist in the compilation and evaluation/analysis of physical and monetary accounts.

E. Follow-up activities

The final project report will include a detailed description of problems encountered and solved, or left open for further study. Problems might include data gaps and methodological questions. The report will make recommendations for improving the database and for research on concepts and methods applicable to the country s situation.

Since the pilot project will be carried out on an experimental basis, using readily available information only, the report will also make recommendations for a more permanent programme of integrated environmental-economic accounting and related data collection in the country. Such a programme might also include the application of integrated regional accounting to selected regions or provinces of the country.

On behalf of the Government:	**On behalf of the United Nations:**
(signature)	(signature)
(date, place)	(date, place)

ANNEX VII

SEEA software

Introduction

The SEEA software is a user-friendly software developed to support and facilitate the compilation of the more practical modules of the SEEA. It consists of a sequence of worksheets (WS), that is to say, tabulations of the raw data, that allow accounting for both physical and monetary flows and stocks in line with national accounts definitions and classifications.

The user can customize the WS by selecting the level of details for the classifications (ISIC and CEPA). He/she can also change the configuration/level of aggregation of the classifications of the WS after having included the data. The WS can be exported into a spreadsheet software, such as EXCEL or LOTUS, for further analysis. A detailed explanation of the software follows.

There are 16 worksheets in the SEEA software. The WS can be grouped as follows:

1. Supply and use (WS 1A and WS 2A);
2. Assets accounts (WS 3A, WS 4A, WS 5A, WS 5B, WS 5C and WS 6A);
3. Degradation (emission) accounts (WS 7A, WS 8A and WS 8B);
4. Summary tables (WS 9, WS 10A, WS 10B, WS 10C and WS 11).

1. **Supply and use** includes supply and use table (WS 1A) and environmental protection expenditures (WS 2A). WS 1A accounts for the supply of domestic output and imported products, their use for intermediate, final consumption and gross capital formation and value added both gross and net. WS 2A segregates environmental-related flows from the economic aggregates presented in WS 1A. Ancillary and external environmental protection expenditures as well as charges and subsidies are separately identified according to the classification of environmental protection activities (CEPA) (annex II).

2. **Assets accounts** include stocks and flows of:

   (a) Produced assets in monetary terms (WS 3A);
   (b) Non-produced economic assets in physical (WS 4A) and monetary terms (WS 5A, WS 5B and WS 5C);
   (c) Non-produced environmental assets in physical term (WS 6A).

3. **Degradation (emission) accounts** focus on the measure and value of changes in environmental quality, they include emissions by economic sector (WS 7A) and the related maintenance cost (WS 8A and WS 8B).

The compilation of monetary accounts of both asset accounts and degradation (emission) accounts requires the specification of at least one scenario, that is to say, it requires the choice of a specific method for the valuation of non-produced assets or emissions.

4. **Summary tables** are derived from the data contained in WS 1A through 8B and are designed for analysis of the results of the SEEA compilation. Integrated environmental and economic accounts (WS 9) provides a summary of the SEEA compilation. The conventional and environmentally adjusted indicators tables (WS 10A, 10B and 10C) include indicators that can be derived from the SEEA compilation. A selection of them is automatically derived. Other indicators can be calculated through formulae as discussed below. A table on indicators of environmental quality (WS11) is also included in this group.

The worksheets are linked through built-in formulae thus allowing for the automatic construction of grey cells and summary tables.

The present annex provides guidelines on using the software. It is divided into two parts: part one explains how to install and run the programme and introduces preliminary instructions for its use; and part two serves as a guide in a step-by-step approach to the compilation of each worksheet. The steps are the same as the ones presented in chapter III with the addition of step 0.

Step 0 → creation of a new year archive
Step 1 → compilation of supply and use table (**WS 1A**)
Step 2 → compilation of environmental protection expenditures (**WS 2A**)
Step 3 → compilation of produced asset accounts (**WS 3A**)
Step 4 → compilation of physical natural resource accounts (**WS 4A**)
Step 5 → compilation of market valuation of non-produced economic assets (**WS 5A**), monetary non-produced asset accounts (**WS 5B**) and depletion of non-produced economic assets by economic activities (**WS 5C**)
Step 6 → compilation of physical accounts of non-produced environmental assets (**WS 6A**)
Step 7 → compilation of emissions by economic sectors (**WS 7A**)
Step 8 → compilation of unit maintenance cost of emissions by economic sectors (**WS 8A**) and total maintenance cost of emissions by economic sectors (**WS 8B**)
Step 9 → compilation of integrated environmental and economic accounts (**WS 9**)
Step 10 → compilation and comparison of conventional and environmentally adjusted aggregates (**WS 10A**), percentage distribution of conventional and environmentally adjusted aggregates (**WS 10B**) and contribution of industries to conventional and environmentally adjusted aggregates (**WS 10C**)
Step 11 → compilation of indicators of environmental quality (**WS 11**)

Part one

Instructions to download and install the software

The SEEA software can be downloaded from the Internet. It is posted on United Nations Statistics Division web site (http://un.org/Depts/unsd/enviro) and the FEEM web site (http://www.feem.it/gnee/seeahot.html/info.html). The password is 654884449.

- *Downloading the software*

The software consists of three files:
Disk1.zip (1,3 Mb)
Disk2.zip (1,4 Mb)
Disk3.zip (1,2 Mb).

Create a temporary folder, for example, SEEA temp, into which to download the files.
To download, click on **File** and follow the onscreen instructions for installation to the hard drive.

Preliminary instruction to the use of the program

After the SEEA software icon is clicked on, the first window that appears on the screen is the year list window. It contains the list of year archives[a] created.

The menu bar at the top of the window contains:

- **File** menu which includes only the command ***Exit*** which allows you to exit the SEEA program;
- **Window** menu which includes:
    - Commands to rearrange the icons and windows (***Cascade***, ***Tile horizontally***, ***Tile vertically***, ***Arrange Icons***);
    - The ***Years list*** command which shows the year list window;
    - The ***Legend*** command which explains the worksheet status and the list of the windows currently open;
- **?** menu which accesses the *Help* of the software.

The button bar at the top of the screen shows the functions relative to the year archives. Included are:
New which creates a new year archive;
Delete which deletes an existing year archive;
Configure which changes the characteristics of a selected year archive;
Open which activates the window that contains the worksheets representation of a selected year archive;
Copy which duplicates a selected year archive.

A selected list of commands in the SEEA software is presented in table A.5. Other commands can be found in the *Help*.

Table A.5. Selected commands

Command	Function
F1	Actives the Help
[Shift + arrows]	Selects a group of cells
[CTRL-C] (copy)	Stores the selection to the clipboard without removing the contents of the selected areas. It is available also between two different SEEA worksheets and between SEEA and commercial spreadsheets software such as EXCEL and LOTUS.
[CTRL-X] (cut)	Removes the contents of the selected cells and places it on the clipboard.
[CTRL-V] (paste)	Inserts the contents of the clipboard at the insertion point, and replaces the current content of the selection. It is available also between two different SEEA worksheets and between SEEA and commercial spreadsheets software such as EXCEL and LOTUS.
[Shift + Del]	Deletes the contents of the selection.

Part two

Step 0 (Creation of a new year archive in the year list window)

Click on the icon ***New*** to configure a new year archive. The Year properties dialog box will appear. The box is devoted to the specification of the setting for all the WS for the new year selected. It provides a group of three tabs each acting as a container of the configuration of the year.
The tabs are: *General*, *Worksheet configuration* and *Worksheet specifics*.

General presents the following tab options:

Year - The configured year will be shown in the title bar of each worksheet window.
Description - A brief description of the new year will be shown in the title bar of each worksheet window linked to the year name. Setting of this option affects all the worksheets title bar.
Monetary unit - The configured monetary unit will be shown in row 4 of each worksheet window containing monetary values.
Country - The name of the country will be displayed at the top of each worksheet in the cell row 3, column B.

Worksheet configuration presents the following tab options:

<u>ISIC</u>
Defines the detail of ISIC in the worksheets. The economic activities (ISIC) chosen will be displayed in WS 1A, 2A, 5C, 7A, 8A, 8B, 9, 10A and 10C.

It is possible to choose among:
- **1 digit**: ISIC at 1 digit will be shown;
- **2 digits**: ISIC at 2 digit will be shown;
- **Custom**: the user selects (by clicking on it) the activities that should be included in the worksheets. The item *Other* allows the aggregation of values of those activities not shown in detail.

<u>CEPA</u>
Defines the detail of CEPA shown in the worksheets where applicable. This option affects only WS 2A.

It is possible to choose among:
- **1 digit**: CEPA at 1 digit will be shown;
- **2 digits**: CEPA at 2 digit will be shown;
- **Custom**: the user selects (by clicking on it) the categories to be included in the worksheets.

Worksheet specifics presents the following tab options:

<u>Worksheet 3A: Produced assets</u>

It is possible to choose among:
- **1 digit**: produced assets are classified into *Tangible fixed assets*, *Inventories*, *Intangible fixed assets* and *Not allocated*;
- **2 digits**: allows for both *Tangible fixed assets* and *Inventories* to specify produced assets owned by agriculture, forestry and fishery activities and to freely introduce headings for other assets. *Not allocated* is the aggregated value of those assets that are not specified;
- **Custom** allows the user to choose freely the level of aggregation. For example, it is possible to specify only the items Cultivated and Other without distinguishing between Fixed assets and Inventories. (For further explanations see *Year properties* in Help index.)

<u>Worksheet 5A: Market valuation of non-produced economic assets</u>
Defines the number of rows of WS 5A to be used for the estimation of natural assets values.

<u>Worksheet 6A: Physical asset accounts</u>
Defines the number of columns shown in WS 6A.

<u>Worksheet 7A: Emissions by economic sector</u>
Defines the number of rows shown for each group in WS 7A.

<u>Worksheet 11: Indicators of environmental quality</u>
Defines the number of rows shown for each group in WS 11.

To save all the options chosen, close the dialog box clicking ***OK***.

To activate the worksheets window, select a year archive from the year list and click ***Open***.
This window provides a representation of the worksheets of the selected year.

Worksheets are grouped within the four coloured frames:

- The **yellow** frame contains buttons of the **Supply and use tables** (WS 1A and WS 2A);
- The **blue** frame contains buttons of **Asset accounts** (WS 3A, WS 4A, WS 5A, WS 5B, WS 5C and WS 6A);
- The **red** frame contains buttons of worksheets that account for **Degradation (emissions)** (WS 7A, WS 8A and WS 8B);
- The **green** frame contains buttons of **summary tables** (WS 9, WS 10A, WS 10B, WS 10C and WS 11).

Each frame comprises:

- The button with the related worksheet name, which can be opened and viewed, compiled or modified by clicking on the button;
- The traffic lights showing the status of the worksheet (green: completed, yellow: compilation in progress, red: not started);
- The list of scenarios (valuation methods) for the selected year. After creating a new scenario, type its name in the list box, click the ***Add*** button, or choose an existing one (from the list box). The buttons of the worksheets linked to the scenario will be activated. Click ***Delete*** button to delete a selected scenario. The maximum number of scenarios is 100.

The arrows connecting the worksheets or frames represent their functional dependence.
Once an archive for one year has been configured, it is possible to change its original configuration (that is to say, it is possible to move from ISIC, 2 digits, to ISIC, 1 digit, or custom and vice versa). In order to change the configuration, select the desired year in the year list window and click the ***Configure*** button. The year properties dialog box, which sets the new configuration, will appear. Any data aggregation deriving from the new configuration will be automatically executed.

Note: Once the new configuration is updated, it will not be possible revert to the original one. It is advisable to make a ***Copy*** before changing an original configuration.

Each worksheet contains a toolbar. The buttons that appear on this toolbar are:
Grid lines used to show or hide the grid of the worksheet;
Sign as completed used to indicate if the current worksheet is completed;
Consistency check used to check possible errors of consistency on the current worksheet;
Save which saves current worksheet;
Print which prints current worksheet;
Close which closes current worksheet;
Text which indicates type of a cell or a group of cells. Select your cell or group then press the button to change it in text-type;
Method which indicates a relation between a cell and a window.

By clicking the ***Print*** button, the Worksheet is printed one page at a time. A group of cells can be printed by selecting them.

Step 1 (WS 1A)

Compilation of supply and use table

WS 1A contains the supply and use table.
The data, exclusively monetary, are used as a starting point for the compilation of the other worksheets. In fact, most of the data in WS 1A, are automatically transferred to the other worksheets for further disaggregations, extensions or modifications.
As stated in the Introduction, use of the tab ***Worksheets configuration*** of the *Year properties* dialog box allows the user to choose the desired level of disaggregation of the ISIC activities particularly relevant for environmental analysis.

Rows 8-12
In each ISIC column the <u>output</u> (row 8) can be further disaggregated in market output (row 9), output for own use (row 10), other non market output (row 11).
<u>Not allocated</u> (row 12) represents a residual item and it is automatically calculated so that, in each column of the ISIC, the following holds:

Output = Market output + Output for own use + Other non market output + Not allocated

Row 13
<u>Intermediate consumption/final use</u> (row 13) contains Intermediate consumption of economic activities (columns G-CN), Imports (column CP); with negative sign: Exports (column CP), Final use of government (column CT), Households and NPISHs (column CV), Capital formation (column CY).

Rows 14 and 16
<u>Gross value added</u> (row 14) and <u>Net value added</u> (row 16) are automatically calculated as follows:

Gross value added = Output   Intermediate consumption

Net value added = Output   Intermediate consumption   Consumption of fixed capital

Rows 17-20
In each ISIC column, the <u>Net value added</u> can be further disaggregated into Compensation of employees (row 17), Operating surplus (row 18), Taxes (row 19) and Subsidies (row 20).
The following identity must be satisfied:

Net value added = Compensation of employees + Operating surplus + Taxes   Subsidies (see box 3 in chap. III)

Consistency check

Worksheet 1A contains two consistency checks:

Warning 1
Warning 2

Warning 1 will appear if the supply and use identity is not satisfied:

Total output (row 8, column CN) = Intermediate consumption (row 13, column CN) + Exports (row 13, column CR) + Final consumption (government (row 13, column CT) + Households and NPISHs (row 13, column CV)) + Gross capital formation (row 13, column CY) Imports (row 13, column CP)

Note: Imports have a negative sign.

Warning 2 identifies columns (ISIC) for which the following identity is not satisfied:

Net value added (row 16) = Compensation of employees (row 17) + Operating surplus (row 18) + Taxes (row 19) - Subsidies (row 20)

For examples, the window/dialog box ***Warning (col. G): (2)*** shows that the following identity is not satisfied:

(column G, row 16) = (column G, row 17) + (column G, row 18) + (column G, row 19) - (column G, row 20)

Note: Subsidies have a negative sign.

Step 2 (WS 2A)

Compilation of environmental protection expenditures

WS 2A separately accounts for environmental protection[b] (EP) expenditures as a subset (Of which) of Output (EP services, row 9), Intermediate and final consumption (Environmental products, row 15), Imports and exports (Environmental products, row 15), Capital formation (Environmental products, row 15) and Value-added components (Environmental charges, row 101, and Environmental subsidies, row 111).

The ***column headings*** are the same as in WS 1A.
The ***row headings*** contain both WS 1A headings (excluding rows 9, 10 and 11) and EP expenditures (by CEPA).

WS 1A and WS 2A are linked so that cells common to both worksheets are automatically transferred from WS 1A to WS 2A (grey rows in WS 2A).

Rows 9-11

Row 9 displays the EP output. Ancillary[c] EP services (row 11) are distinguished from External[d] ones (row 10).

Rows 13, 15-90

Intermediate consumption/final use (row 13) includes the Environmental products and Extraction products used by the different industries.

Environmental products (rows 16-74) are identified according to the classification of environmental protection activities (CEPA) (annex II).[e]
As stated in the Introduction, using the ***Worksheets configuration*** tab of the *Year properties* dialog box, it is possible to set the level of disaggregation of CEPA (1 digit, 2 digits or custom) in order to show the only relevant categories.

The following identity would have to be satisfied:

> Total EP supply = Total EP use (see *Warning 1* below for further details)

Rows 77-90 contain data related to the intermediate consumption of forest products, fish and minerals. These rows are left open for the user to list the products used as intermediate consumption by industry. Forest products are to be listed in rows 78-81, Fish in rows 83-85, Minerals in rows 88-90. Please note that only the total value of these products is reported in WS 9.

Rows 96-119

As in worksheet 1A, for each ISIC, the Net value added (row 96) can be further disaggregated into Compensation of employees (row 98), Operating surplus (row 99), Taxes (row 100) and Subsidies (row 110).
Environmental charges (row 101) and Subsidies (row 111) are displayed.

These items can be further disaggregated to specify the destination and magnitude of different environmental charges and subsidies.

Consistency check

Worksheet 2A contains two kinds of consistency check:

> ***Warning 1***
> ***Warning 2***

Warning 1 appears if the supply and use identity for EP is not satisfied:

> Total environmental protection products (column CL, row 9) = Intermediate consumption of environmental products (column CL, row 74) + Final use of environmental products (column CR, row 74 + column CT, row 74) + Exports (column CP, row 74) + Gross capital formation (column CV, row 74) Imports (column CN, row 74)

In practice, the supply and use identity for EP is generally not satisfied.

Warning 2 identifies the columns (ISIC) for which the following is not satisfied:

EP services (row 9) = EP for sale (row 10) + EP for internal use (row 11)

For example, the dialog box ***Warning (col. Q): (1)*** shows that the following identity is not satisfied:

(column Q, row 9) = (column Q, row 10) + (column Q, row 11)

Step 3 (WS 3A)

Compilation of produced asset accounts

WS 3A Produced assets are those assets that come into existence as outputs of production processes. The classification of non-financial assets (CNFA) distinguishes produced and non-produced assets. Produced assets are further classified into Man-made assets and Cultivated natural growth assets. WS 3A renames the CNFA terms of *Cultivated natural growth assets* and *Man-made assets* as *Cultivated* and *Other* to emphasize the focus on natural assets in environmental accounting. For each category of asset change, the SNA code is given in parentheses in the worksheet.

Using ***Worksheet specifics*** of the *Year properties* dialog box, it is possible to choose the ***column headings***:
- **1 digit;**
- **2 digits**;
- **Custom** (for explanations see *Year properties* in the *Help* index).

Column L is fixed and contains the total values of the produced assets.

Rows 7 and 23
Opening stocks (row 7) and Closing stocks (row 23) of produced assets should be valued at purchaser prices at the beginning and at the end of the accounting period.

Rows 8-13
Gross capital formation (row 8) of natural produced assets is the total value of acquisition less disposal of all mature and immature animals, trees and so forth, including work in progress, that is to say, growth of fixed assets such as orchards, trees, livestock and fish in aquaculture. Gross capital formation includes Acquisitions less disposals of tangible fixed assets (row 10), Change in inventories (row 11) and Acquisitions less disposals of valuables (row 12). The last-mentioned is related to those assets that are not used primarily for production.
Not allocated (row 13) is a residual item and it is automatically calculated so that, in each column, the following holds:

Gross capital formation = Acquisitions less disposals of fixed assets + Changes in inventories + Acquisitions less disposals of valuables + Not allocated

Row 14

Consumption of fixed capital represents the reduction in value of fixed assets used in production (namely, trees, animals, and so forth) resulting from physical deterioration or normal accidental damage.

Note: Consumption of fixed capital always has a negative sign.

Rows 15-21

Other volume changes (row 15) are caused by natural disasters or other non-economic factors (wars and so forth), reducing natural capital. It includes Economic appearance of non produced assets (row 16), Catastrophic losses (row 17), Uncompensated seizures (row 18), Other volume changes in non-financial assets (row 19), Changes in classification and structure (row 20).
Not allocated (row 21) is a residual item and it is automatically calculated so that, in each column, the following holds:

Other volume changes = Economic appearance of produced assets + Catastrophic losses + Uncompensated seizures + Other volume changes in non-financial assets n.e.c. + Changes in classification and structure + Not allocated

Row 22

Revaluation is automatically calculated as a residual item as follows:

Revaluation = Closing stocks - Opening stocks - Gross capital formation + Consumption of fixed capital - Other volume changes

Step 4 (WS 4A)

Compilation of physical natural resource accounts

WS 4A records, in physical terms (for example square kilometres (km^2), cubic metres (m^3), metric tons), the stocks and all changes therein of non-produced natural asset during the accounting period.
The column headings, already given, are divided into five groups: Land, Soil, Subsoil assets, Non-cultivated biological resources and Water resources. Each group is further disaggregated into different sub-groups (row 2) and each sub-group into different items (row 3). Row 3 contains some free cells for the inclusion of selected assets. This is the case for Metallic mineral reserves (columns N-R), Non metallic mineral reserves (columns S-W), Forest resources (columns X-AB), Fish resources (marine) (columns AC-AG), Fish resources (fresh water) (columns AH-AL), Other biota (columns AM-AQ). The items introduced are automatically transferred to WS 5A and WS 5B so that the three worksheets (WS 4A, WS 5A and WS 5B) always have the same column headings.

Row 8 and 22
Opening stocks (row 8) and Closing stocks (row 22) of non-produced economic assets represent the economically exploitable quantity of reserves or stocks available at the beginning and the end of the accounting period.

Rows 9 and 10
Sustainable use (row 9) and Depletion (row 10) are separately identified.
They represent changes in quantity brought about by the direct economic use/exploitation of the asset, including the extraction of minerals, logging, fish catch and water abstraction, and are shown in advance of environmental costing carried out by step 5.
Sustainable use (row 9) refers to the volume used without impairing long-term capacity to yield economic products. Depletion (row 10) represents exploitation of the resource beyond natural regeneration or replenishment.

Sustainable use and Depletion do not appear for Land (columns E-I) as there are no quantitative losses of land due to economic uses. Changes in the area of a country can be caused only by wars or political decisions and, in some cases, natural disasters, and are therefore recorded in Other volume changes. There could, however, be addition to the land through reclamation.

Quantitative loss of soil due to economic use is to be recorded in rows 9 and 10.

Rows 11-15
Other accumulation (row 11) refers to changes due to economic decisions or interests. In the SEEA, it continues to be accounted for outside the production and income accounts and therefore it does not affect value added and income-generation (as cost). It includes Economic appearance of non-produced assets (for example, Discoveries of subsoil assets) (row 12), Natural growth of non-cultivated biological assets (row 13) and Changes in classification and structure (row 14).
Not allocated (row 15) represents a residual item and it is automatically calculated for each column so that the following holds:

> Other accumulation = Economic appearance of non-produced assets + Natural growth of non-cultivated biological assets + Changes in classification and structure + Not allocated

The figures in all sub-items of other accumulation appear with a plus or minus sign according to whether they represent an increase or a decrease in the volume of the assets.

Rows 16-21
Other volume changes (row 16) refers to changes due to non-economic causes (political or natural events/disasters). It includes Economic disappearance of non-produced assets (row 17), Catastrophic losses (row 18), Changes in seizures (row 19) and Other changes in non-financial assets (row 20). Not allocated (row 21) represents a residual item and it is automatically calculated for each column so that the following holds:

> Other volume changes = Economic disappearance of non-produced assets + Catastrophic losses + Changes in seizures + Other changes in non-financial assets + Not allocated

Rows 24-31
Since Quality changes are relevant (physical) aspects of environmental costs, but are difficult to incorporate into physical quantitative asset accounts, they are presented at the bottom of the table. Rows 26-31 are left blank for the purpose of specifying the appropriate indicators, and inserting their name and unit in the shaded/yellow area and their value in the appropriate cells of columns E-AT.

Consistency check

Worksheet 4A contains one consistency check:

Warning 1

Columns E-I

Warning 1 identifies the columns (ISIC) in E-I for which the following is not satisfied :

Closing stocks (row 22) = Opening stocks (row 8) + Other accumulation (row 11) + Other volume changes (row 16)

For example, the window/dialog box ***Warning (col. I): (1)*** shows that the following identity is not satisfied:

(column I, row 22) = (column I, row 8) + (column I, row 11) + (column I, row 16)

Columns K-AT

Warning 1 identifies the ISIC columns in K-AT for which the following identity is not satisfied:

Closing stocks (row 22) = Opening stocks (row 8) + Sustainable use (row 9) + Depletion (row 11) + Other accumulation (row 11) + Other volume changes (row 16)

Step 5 (WS 5A, WS 5B)

To open WS 5A and WS 5B, it is necessary to specify at least one scenario by typing its name in the box and then clicking the Add button. Each scenario implies the choice of a specific valuation method for non-produced economic assets (see ***Worksheets window*** in the *Help* index for further explanations).

Compilation of market valuation of non-produced economic assets

WS 5A shows the unit value of non-produced economic assets according to the scenario chosen.

The column headings are the same as those for WS 4A as previously explained.
The row headings are split into two areas, both yellow. The top area can be used as a workspace for the calculation of the asset values. The rows (20 maximum, rows 8-27) in the top area can be selected by using the ***Worksheets configuration*** option. The bottom area reports the values, obtained from the top area, to be used in the derivation of monetary accounts.

Rows 8-27
These rows can be used to estimate the asset values according to the selected method. The row headings can be specified according to the selected method (for example, for the calculation of net price the row headings could be Market price, Factor cost per unit of resource and Net price). For further explanations, see WS 5A in chapter III of the manual.
In columns E-AT, it is possible to use the cells to insert both numerical values and formulae. (For further explanations, see ***Formula*** or ***Operator*** in *Help* index.)

Rows 29-31
Show the values at the beginning (row 29) and end (row 30) of the accounting period and average values during the period (row 31).

These values will be used to automatically calculate in WS 5B the value of the stocks at the beginning and the end of the accounting period and the changes therein.

Compilation of monetary non-produced asset accounts

WS 5B records monetary value of the stocks and changes therein. The worksheet is derived by applying unit values, that is to say, market prices or estimated (imputed) market values introduced in WS 5A to the physical stocks and changes in stock in WS 4A.

WS 5B shows the same ***column headings*** as WS 4A and 5A for the different categories of natural resources.

Row headings are modified to introduce those items (rows 7-11 and 26) relevant to the monetary accounts. The values of the rows that have the same heading both in WS 5A and in WS 5B are automatically calculated as the product of the physical quantity of WS 4A and the monetary value of WS 5A. In particular, the values of opening and closing stocks is calculated using the values at the beginning and the end of the accounting period, respectively. The value of the changes in stock is calculated using the average value.

Note: In some cells n.a. (not applicable) appears.

Rows 6 and 27

The value of Opening stocks (row 6) and Closing stocks (row 27) is automatically calculated by multiplying the cells of row 8 and 22 of WS 4A and rows 29 and 30 of WS 5A.

Rows 7-11

Gross fixed capital formation and Consumption of fixed capital for non-produced assets are recorded for land improvement, as discussed in the 1993 SNA. For other non-produced environmental assets, production of new capital and consequently its consumption is not possible by definition and is thus marked as "n.a.".

Gross fixed capital formation (row 7) is defined as the total expenditures related to land improvement, including land reclamation, clearance of forest land, drainage of wetlands, and prevention of flooding and erosion. It includes: Additions to the value of non-produced non-financial assets (P.513) (row 8), further disaggregated into Major improvement to non-produced non-financial assets (P.5131) (row 9) and Costs of ownership transfer on non-produced non-financial assets (P.5132) (row 10). The total value appears in row 8.
Capital consumption (row 11) is the decline in the value of land improvement during the accounting period due to the depreciation of produced capital acquired for land improvement.
Both Gross fixed capital formation and Consumption of fixed capital are introduced in the monetary account but do not appear in WS 4A.

Rows 12, 13

Sustainable use (row 12) and Depletion (row 13) are calculated by multiplying physical quantities, already accounted for in worksheet 4A rows 9 and 10, by the average value during accounting period (row 31 of WS 5A).

Rows 14-19

The value of Other accumulation (row 14) includes not only the items already present in WS 4A, but also Acquisitions less disposal of non-produced assets (row 15). This item is related to capital transactions that do not affect capital formation, value added and income generation and concerns only land and subsoil assets. For the other assets, Acquisitions less disposals is hardly measurable, unlikely to occur or of minor significance.
Row 15 includes Acquisitions less disposals of non-produced assets which, as for Gross fixed capital formation, appears only in monetary values.
The other items of Other accumulation (rows 16-19) are automatically calculated multiplying physical quantities of WS 4A (rows 12-15) by the average value during accounting period (row 31, WS 5A). The total Other accumulation (row 14) is automatically calculated adding the amounts of rows 15-19.

Rows 20-25

Other volume changes (rows 20-24) include the same rows as WS 4A. Therefore all rows are automatically calculated by multiplying the physical quantity of WS 4A (rows 16-21) by the average value during the accounting period (row 31, WS 5A).

Row 26
Revaluation is automatically calculated as a residual item so that the following identity is satisfied:

> Revaluation = Closing stocks - Opening stocks - Gross capital formation + Consumption of fixed capital + Sustainable use + Depletion - Other accumulation - Other volume changes

Note: Consumption of fixed capital, Sustainable use and Depletion always have a negative sign.

Consistency check

Worksheet 5B contains one kind of consistency check:

> ***Warning 1***
>
> **Columns E-I**

Warning 1 identifies the ISIC columns in E-I for which the following identity is not satisfied:

> Additions to the values of non-produced non-financial assets (row 8) = Major improvements to non-produced non-financial assets (row 9) + Costs of ownership transfer on non-produced non-financial assets (row 10)

For example, the window/dialog box ***Warning (col. I): (1)*** shows that the following identity isn t satisfied:

> (column I, row 8) = (column I, row 9) + (column I, row 10)

Compilation of depletion of non-produced economic assets by economic activities

WS 5C shows depletion by economic activities.

Column headings are non-produced economic assets: soil, subsoil, forest, fish, other biota, water.

Row headings are the same as in WS 1A and show the ISIC activities selected using Worksheet configuration option.

Step 6 (WS 6A)

Compilation of physical accounts of non-produced environmental assets

WS 6A shows physical accounts for environmental assets. Non-produced environmental assets are those assets for which ownership rights are not enforced and from whose use no direct economic benefits (income) are derived.

The number of columns can be specified using the option Worksheet specifics . The headings can be written in the columns.

As in WS 4A, row headings are split into two areas: one records stocks and changes in stocks (rows 8-25) and the other records quality changes (rows 27-34).

Rows 8-25
Show the stock and changes therein for environmental assets. Headings of rows 12-17, related to Other volume changes, can be named by the user.

Step 7 (WS 7A)

Compilation of emissions by economic sector

WS 7A contains data on emissions in physical terms, including discharges of wastes, from polluting sectors.
Column headings are split into three groups to distinguish between the national source of emissions and the flows from and to the rest of the world. Column headings of national polluting sector (col. D-CK) show the same ISIC activities as those chosen for WS 1A. These columns are also shown in the monetary accounts.

Sectors responsible for the emissions from the rest of the world (columns CL-FT) and to the rest of the world (columns FW-JC) are given and include all 1-digit activities. Since valuation of their flows is controversial, only data in physical terms are presented.

Row 6-28
Row headings are split into three groups: *Water* (row 6), *Air* (row 17) and *Land/soil* (row 27). The rows under each assets identify the pollutants. Their number can be determined using the ***Worksheets configuration*** option.
The headings inserted will be automatically transferred to WS 8A and WS 8B.
The icons ***ab*** and ***12*** at the top of the page show the possibility of inserting in each cell respectively both numbers and letters or numbers only. For example, in the cell **Do** it is possible to click on the icons ***ab*** to insert both the level of the emissions and its unit of measure (for further explanations, see ***Number*** or ***Text*** in *Help* index).

Step 8 (WS 8A, WS 8B)

In order to start WS 8A and WS 8B, one specific scenario has to be defined by typing its name in the list box and then clicking the ***Add*** button. Each scenario represents the choice of a specific valuation method for the emissions (in other words, maintenance cost - best available technology - least cost).

Compilation of unit maintenance cost of emissions by economic sectors

WS 8A shows the environmental unit cost of net emissions specified in WS 7A, except for transboundary flows.

Both the ***columns*** and the ***rows*** are the same as in WS 7A.
The ***M*** button shows the possibility for each cell of opening a window called ***Method*** showing the calculation of the unit maintenance cost (for further explanations, see ***Method*** in *Help* index).

Window *Method*

Cell B1
Contains the name of the method chosen to calculate the maintenance cost.

Cell F3
This cell contains the calculated unit maintenance cost.

Rows 4-21
These rows are used for the calculation of the unit emission cost. As in WS 7A, icons ***ab*** and ***12*** can be clicked to configure each cell as text or numeric, respectively. Formulae and numbers can be inserted in the cells. (For further explanations, see ***Formula*** or ***Operator*** in *Help* index.)

Compilation of total maintenance cost of emissions by economic sectors

WS 8B shows the total environmental cost of net emissions specified in WS 7A.
Total maintenance cost of emissions is automatically calculated by multiplying the physical quantity in WS 7A by the unit maintenance cost in WS 8A.

Step 9 (WS 9)

In order to start WS 9, WS 10A, WS 10B and WS 10C, one specific scenario for both Non-produced assets account and degradation has to be chosen. As stated before (steps 5 and 8), setting scenarios implies the choice of a specific valuation method. (For further explanations see ***Worksheets window*** in *Help* index.)

Compilation of integrated environmental and economic accounts

WS 9 is a summary table presenting the main results of the above-described compilations and showing the extended supply and use table and asset accounts. The production account is modified to include environmental costs of depletion and degradation, thus allowing for the calculations of environmentally adjusted aggregates such as EVA and EDP.

All values in WS 9 are automatically transferred from the worksheets in monetary terms.

Column headings are split into four groups: Supply and use table (columns G-CV), Produced assets (column CX), Natural economic assets (columns CZ-DF) and Environmental assets (columns DH-DJ). ***Row headings*** show items of both supply and use and asset accounts.

Supply and use table (columns G-CV)

It presents the same ISIC activities as WS 1A.

Rows 10, 16, 27, 44, 46, 47, 48, 49 and 51
The values contained in these rows have been transferred from WS 1A. The link between the two worksheets is the following:

	WS 1A	WS 9
ROW	8	10
	13	16
	15	27
	14	44
	16	46
	17	47
	18	48
	19	49
	20	51

Rows 11, 12, 13, 18, 19, 20, 21, 23, 24, 25, 50 and 52
The values contained in these rows have been transferred from WS 2A. The link between the two worksheets is the following:

	WS 2A	WS 9
ROW	9	11
	10	12
	11	13
	16+41	18
	21	19
	28+35+47	20
	55+59+68	21
	77+78+79+80	23
	82+83+84+85+86	24
	87+88+89+90	25
	101	50
	111	52

Rows 31, 32 and 33

The values contained in these rows have been transferred from WS 8B. The link between the two worksheets is the following:

	WS 8B	WS 9
R	9+10+....+16	31
O	18+19+ +26	32
W	28+29+ +36	33

Rows 35, 36, 37, 38, 39 and 40

The values contained in these rows have been transferred from WS 5C. The link between the two worksheets is the following:

WS 5C	WS 9
Column E	35
Column F	36
Column G	37
Column H	38
Column I	39
Column J	40

Rows 34 and 41

In each column, the subtotal represents the sum of degradation (emissions) (row 34) and depletion (row 41) costs.

Row 42

Depletion and degradation (emission) costs caused by consumption activities of Households and NPISHs are shifted to the production accounts and allocated to Other (column CM). In this manner, pollution caused by final consumption is treated as negative production activity of households.

Row 54

In each ISIC, column environmental adjusted value added (EVA) is calculated by subtracting the total amount of Degradation (emission) (row 34) and Depletion (row 41) costs from Net value added (row 46). EVA in Other (column CM) and Total (column CN) is calculated by subtracting the degradation (emissions) caused by consumption activities of households (shift).

EVA is calculated in the following way:

<u>Columns G-CK:</u>

EVA = NVA (row 46) - subtotal degradation (emissions) (row 34) - subtotal depletion (row 41)

Columns CM and CN:

EVA = NVA (row 46) - subtotal degradation (emissions) (row 34) - subtotal depletion (row 41) shift (row 42)

Produced assets (column CX)

This column contains the asset accounts for produced assets.
All values are imported from both WS 2A and WS 3A.

Rows 7, 16, 27, 58, 60 and 62
The values contained in these rows have been transferred from column L of WS 3A. The link between the rows of the two worksheets is the following:

	WS 3A	WS 9
	7	7
	8	16
	14	27
	15	58
	22	60
	23	62

Rows 18, 19 and 21
The values contained in these rows have been transferred from column CV of WS 2A. The link between the two worksheets is the following:

	WS 2A column CV	WS 9
R	16+41	18
O	21	19
W	55+59+68	21

Natural economic assets (columns CZ-DF) and Environmental assets (columns DH-DJ)
An explanation of the cell content will appear on Clicking the icon ***?***

Step 10 (WS 10A, WS 10B, WS 10C)

Compilation and comparison of conventional and environmentally adjusted aggregates

WS 10A shows a summary comparison of conventional and environmentally adjusted indicators obtained from the re-elaboration of values included in WS9.

Column headings present the same ISIC activities (columns F-CK) as WS 9. Column D shows total values, while columns F-CK include values by industry.
Row headings presents both conventional and environmentally adjusted aggregates and their elaboration. All the other rows present values only in column D. All the values in rows 9-19 are percentages.

Row 6
NDP (net domestic product) is reported from row 46 of WS 9.

Row 7
EDP I (environmental adjusted net domestic product) at market price is calculated by subtracting the depletion costs from NDP. The values of this row are calculated subtracting values of row 41 from values of row 46 in WS 9.

Row 8
EDP II (environmentally adjusted net domestic product at maintenance cost) is calculated by subtracting both depletion and degradation (emission) costs from NDP. It is equal to the EDP calculated in row 54 of WS 9.

Row 9
(NDP-EDP II)/NDP is calculated using values of rows 6 and 8 of WS 10A.

Row 10
(NDP-EDP I)/NDP is calculated using values of rows 6 and 7 of WS 10A.

Row 11
C (final consumption) represents the final consumption of households and NPISHs and Government. It is equal to the sum of cells CT16 + CV16 of WS 9.
NDP is in cell D6 of WS 10A.

Row 12
C represents the final consumption of households and NPISHs and Government. It is equal to the sum of cells CT16 +CV16 of WS 9.
EDP II is in cell Do of WS 10A.

Row 13
NCF (net capital formation) is calculated subtracting Consumption of fixed capital (cells CX 27 + CZ27 of WS 9) from Gross capital formation (cells CX16 + CZ16 of WS 9).
NDP is in cell D6 of WS 10A.

Row 14
ECF (environmentally adjusted capital formation) is calculated subtracting total depletion and degradation (emission) costs of the industries (cells CN34 + CN41) and households and NPISHs (cell CV34) from net capital formation.

Row 15
NDP is in cell D6 of WS 10A.
CAP (capital stock produced) is equal to the Opening stock of produced assets (cell CX7 of WS 9).

Row 16
EDP I is in cell D7 of WS 10A.
CAP I (capital stock including economic natural capital at the beginning of *t*) is the sum of Opening stocks of produced assets (cell CX7 of WS 9) and Opening stock of natural economic assets (cells CZ7, DB7, DC7, DD7, DE7, DF7).

Row 17
CAP (capital stock produced) is equal to the Opening stocks of produced assets (cell CX7 of WS 9).
CAP I (capital stock including economic natural capital at the beginning of *t*) is the sum of Opening stocks of produced assets (cell CX7 of WS 9) and Opening stock of natural economic assets (cells CZ7, DB7, DC7, DD7, DE7, DF7).

Row 18
ICEP (intermediate consumption for environmental protection) is obtained by summing cells CN18, CN19, CN20, CN21 of WS 9 by industry and total.
GDP (gross domestic product) is reported from row 44 of WS 9.

Row 19
GCFEP (gross capital formation for environmental protection) is obtained by summing Capital expenditures of produced assets (cells CX18+CX19+CX21) and Natural economic assets (cell CZ 20).
GDP (gross domestic product) is reported from cell CN 44 of WS 9.

Rows 20-23
These are left open to allow the users to report the indicators of their choice. Note that no formula can be calculated in those cells.

Compilation of percentage distribution of conventional and environmentally adjusted aggregates

WS 10B presents a percentage breakdown of the conventional and environmentally adjusted indicators. The percentages presented on the left-hand side of WS 10B refer to components of NDP (columns A-C), while those on the right-hand side show the breakdown of EDP II (columns O-Q). The difference between NDP and EDP analyses are explained by detailing the economic transactions related to natural assets (columns E-M).

The figures in WS 10B are obtained from the re-elaboration of the figures in WS 9. Each value is automatically calculated as a percentage of NDP (columns C-Q) and EDP (column O).

Rows 13-15

Environmental charges less subsidies (row 13), Intermediate consumption/use of environmental protection products (row 14) and Use of natural assets by industries (row 15) are identified as of which elements of NDP (columns C-Q) and EDP (column O).

In row 13, figures are obtained as the ratio of total amount of Environmental charges (cell 50CN of WS 9) less subsidies (cell 52CN of WS 9) to NDP (cell 46CN of WS 9) in column C and to EDP (cell 54CN of WS 9) in column O.

In row 14, figures are obtained as the ratio of the total amount of Intermediate consumption/use of environmental protection products (rows 18-21 of column CN of WS 9) to NDP (cell 46CN of WS 9) in coumn C and to EDP (cell 54CN of WS 9) in column O respectively. Values in columns K-M represent the ratio of intermediate consumption/use of environmental protection products to NDP according to the media (Land/soil (column K), Air (column L) and Water (column M)) that they affect. The figures are imported from WS 9 as follows: for Land/soil, cell 20CN; for Air, cell 18CN; for Water, cell 19CN.

In row 15, figures have been calculated by dividing the total amount of use of natural assets by industries (cells CN34+CN41 of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O. Figures in columns E-M represent the share of use of natural assets by industries in NDP (Forests (column E), Fish (column F), Minerals (column G), Water (column H), Other biota (column I)) and in the media (Land/soil (column K), Air (column L) and Water (column M)) that they affect. The values are imported from WS 9 in the following way: for Depletion of forest, cell CN 37; of fish, cell CN38; of Minerals, cell CN 36; of Water, cell CN 40; and of other biota, cell CN39; for Degradation (emissions) of Land/soil, cell 20CN; of Air, cell 18CN; and of Water, cell 19CN.

Rows 17-20

In row 17, indicators have been calculated by dividing the Final consumption of households and government (cells CT16 + CV16 of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O.

In the rows of final consumption of households and government, two of which elements are shown: Final consumption by households and government of environmental protection products (row 19) and Use of natural resources (row 20).

Values contained in row 19 have been calculated by dividing the total amount of Final consumption of environmental protection products of households and government (rows 18-21 of columns CT and CV of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O. Values in columns K-M represent the share of environmental protection product by media (the values are transferred from WS 9 as follows: for Land/soil, cells CT20 + CV 20; for Air, cells CT18 + CV18; and for Water, cells CT19 + CV19).

In row 20, figures have been calculated by dividing the total amount of degradation (emissions) by households (cell 34CV of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O. Values in columns K-M represent the share of degradation by media. The figures are imported from WS 9 as follows: for Land/soil, cell CV33; for Air, cell CV31; and for Water cell CV32).

Rows 22-24
Figures contained in row 22 have been calculated by dividing the total amount of Net capital formation (cells CX16 + CZ16 + CX27 + CZ27 of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O. Of which (row 23) refers to Gross fixed capital formation on environmental protection equipment (row 24). Values contained in this row have been calculated by dividing Gross fixed capital formation for EP (cells CX18 + CX19 + CZ20 + CX21 of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O. Values in columns K-M represent the share of Gross capital formation for EP by media. The figures are imported from WS 9 as follows: for Land/soil, cell CZ20; for Air, cell CX18; and for Water, cell CX19.

Row 26
Figures in row 26 are obtained by dividing Exports (cell CR16 in WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O.

Rows 27-29
Figures in row 27 are obtained by dividing Imports (cell CP16 in WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O.

Figures in row 28 have been calculated as the ratio of the sum of Imported products for environmental protection (cells CP18 + CP19 + CP20 + CP21of WS 9) to NDP (cell 46CN of WS 9) in column C and to EDP (cell 54CN of WS 9) in column O. Figures in row 29 have been calculated by dividing the total amount of Imports of natural resources (cells CP23 + CP24 + CP25 of WS 9) by NDP (cell 46CN of WS 9) in column C and by EDP (cell 54CN of WS 9) in column O.

Figures in columns K-M are obtained by identifying separately the share of imports of natural resources by natural assets (the values are imported from WS 9 as follows: for Forest, cell CP23; Fish, cell CP24; Minerals, cell CP25).

Compilation of contribution of industries to conventional and environmentally adjusted aggregates

WS 10C extends the content of WS 10B to allow a detailed analysis for the different industries.
The grey cells represent the data automatically calculated.
Column A shows the same ISIC activities as WS 9.

Column E shows the percentage distribution of NDP by industries. It is obtained by dividing the NVA of each industry (row 46 of WS 9) by NDP (WS 9, cell CN46).

Columns G-J show the impacts of economic activities on natural assets and the economic responses to these impacts in term of EP expenditures. The data are expressed as percentages of the net value added

(NVA) of each industry. Figures in column G are obtained from the re-elaboration of the figures contained in rows 18-20 of WS 9. Figures in column H are obtained from the re-elaboration of the figures contained in rows 50 and 52 of WS 9. Figures in column I contain Total industries. They have been obtained from the re-elaboration of figures contained in rows 18-21 of columns CX and CZ of WS 9. Figures in column J have been obtained from the re-elaboration of values contained in row 21 for depletion and rows 31-34 for degradation.

Column K shows EVA/NVA by industries. It is obtained by dividing EVA (row 54 of WS 9) by NVA (row 46 of WS 9) for each industry.

Column M shows the percentage distribution of EDP by industries. It is obtained by dividing the EVA of each industry (row 54 of WS 9) by EDP (WS 9, cell CN54).

Step 11 (WS11)

Compilation of indicators of environmental quality

WS 11 covers environmental quality indicators.

Row headings are related to the categories in CEPA. The number of rows for each item can be chosen using ***Worksheet specifics*** of the Year properties dialog box. In columns C and D the user inserts the quality indicator related to the row heading and the appropriate unit of measurement. Column E contains the value of the indicator.

Notes

a. A year archive is the set of worksheets relative to a common year.

b. Environmental protection expenditures are actual expenses incurred by industries, households, the government and non-governmental organizations to avert environmental degradation or to eliminate part or all of the effects after degradation has taken place.

c. Ancillary activities consist of goods and services produced by establishments for own use to support the production of principal or secondary products of the industry; they include activities such as environmental clean-up or maintenance of protection facilities.

d. External EP output consists of principal and secondary production activities of establishments, in other words, the provision of EP products (goods and services) to other establishments.

e. CEPA includes only those activities and corresponding expenditures that are an immediate response to environmental degradation *caused* by production units, the government and households. It does not cover reactions and expenses related to further repercussions or effects of environmental impacts such as additional health and travel costs, *borne* usually by other than those who caused them.

GLOSSARY

Access rights: authorization, given to a user by a competent management authority or by legislation, to exploit a resource. Access rights can be granted against payment or free of charge.

Air pollution: presence of substances in the atmosphere resulting either from human activities or from natural processes, in sufficient concentration and for a sufficient time, the circumstances being favourable, to interfere with the comfort, health or welfare of persons or the environment.

Allowable catch: catch allowed to be taken from a stock by a fishery during a specified time period. It is often allocated explicitly among those having *access rights* to the stock. See also *quota*.

Ancillary activity: a supporting activity undertaken within an enterprise in order to create the conditions within which the principal and secondary activities are carried out. See also *externalization of environmental protection cost*.

Aquaculture: farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators and so forth. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms that are harvested by an individual or corporate body that has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms that are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries. See also *produced natural assets and economic assets.*

Avoidance costs: actual or imputed costs for preventing environmental deterioration by using alternative production and consumption processes, or by reducing or abstaining from those economic activities causing environmental degradation. See also *maintenance costing.*

Biodiversity: range of genetic differences, species differences and ecosystem differences in a given area.

Biomass: total weight (generally measured in dry weight) of all living organisms in a particular area or habitat.

Biome: ecological regions determined by complex interactions of climate, geology, soil type, water resources and latitude.

Built-up and related land: land under houses, roads, mines, quarries or any other facilities, including their auxiliary spaces, deliberately installed so that human activities may be pursued. Included are also certain types of open land (non-built-up) that is closely connected with activities such as waste tips, derelict land in built-up areas, junkyards and city parks and gardens. Land occupied by scattered farm buildings, yards and their annexes is excluded.

By-catch: species taken in a fishery targeting other species or a different size range of the same species. The part of the by-catch that has no commercial value is discarded and returned, usually dead or dying, to the sea.

Capital accumulation (environmental accounting): environmentally adjusted concept of capital formation that accounts for additions to and subtractions from natural capital. The concept may also include discoveries or transfers (from the environment into the economic system) of natural resources, and the effects of disasters and natural growth.

Capital consumption: the 1993 SNA (para. 6.179) classifies consumption of fixed capital as a cost of production and defines it as the decline, during the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. It excludes damage from war or natural disasters accounted for as *other volume changes* in asset accounts. The SEEA extends the concept of capital consumption to encompass natural capital in terms of *depletion* and *degradation* costs, that is to say, imputed *environmental cost.*

Carrying capacity: maximum number of animals of one or more species that can be supported by a particular habitat or area through the most unfavourable period of the year. The carrying capacity is different for each species in a habitat because of particular food, shelter and social requirements and because of competition from other species that may have similar requirements. See also *ecological footprint.*

Cohort: group of fish in a stock that were generated during the same spawning season and are born at the same time. In cold and temperate areas, where fish are long-lived, a cohort corresponds usually to a year class. In the tropics, where fish tend to be short-lived, cohorts may correspond to shorter time intervals (for example, spring cohort, autumn cohort, monthly cohorts).

Catch per unit of effort (CPUE): measure of the volume of fish caught with given numbers and types of vessels and fishing gear, and with a given number of fishermen. CPUE may vary with the amount of fish in the water (size of fish stocks), the congestion of vessels and other factors. It is an important indicator for estimating the size of fish stocks and the unit cost of fish catch.

Contingent valuation: valuation method used in cost-benefit analysis and damage valuation in environmental accounting. Contingent valuation is conditional (contingent) on the simulation of hypothetical markets, reflected in the willingness to pay for potential environmental benefits or for the avoidance of their loss.

Cost-benefit analysis: assessment of the direct economic and social costs and benefits of a proposed programme for the purpose of programme selection. The cost-benefit ratio is determined by dividing the projected benefits of the programme by the projected costs.

Cost internalization: incorporation of negative external effects, notably environmental depletion and degradation, into the budgets of households and enterprises by means of economic instruments, including fiscal measures and other (dis)incentives.

Cultivated natural assets: include livestock for breeding, dairy, draught, and so forth, and vineyards, orchards and other plantation trees yielding repeated products and whose growth is under the direct control, responsibility and management of *institutional units* (within the production boundary of the SNA). See also *non-produced natural assets.*

Defensive expenditures: expenditures incurred to mitigate or avoid the external costs of the general growth process of production and consumption. Defensive environmental costs are expenditures for preventing or neutralizing a decrease in environmental quality, as well as for compensating for or repairing negative effects (injury to human health and welfare, and other damage to material systems) of environmental deterioration. Their deduction from net domestic product (NDP) is sometimes suggested to obtain a measure of environmentally adjusted economic welfare, but it is not recommended in the SEEA.

Deforestation: clearing of tree formations and their replacement by non-forest land uses.

Degradation of environmental assets: deterioration in environmental quality, beyond safe absorption or regeneration by environmental media, from ambient concentrations of pollutants and from other activities and processes such as improper land use and natural disasters. See also *air pollution.*

Depletion of natural resources: for renewable resources, the part of the harvest, logging, catch and so forth that exceeds the sustainable level of resource use; for non-renewable resources (mineral deposits), the quantity of the resource extracted. In the SNA, it is defined as the reduction in value of deposits of subsoil assets, natural forests, fish stocks in the open seas and other non-cultivated biological resources as a result of the physical removal and using up of the assets.

Discount rate: the rate at which to discount future income in the net present value method of valuing natural resource assets. The discount rate expresses the degree to which an economic agent prefers income today rather than in the future. This time preference will vary depending on the agent in question. In general, individuals and businesses have higher rates of time preference than Governments. In addition to time preference, discount rates can also reflect the risks associated with the future returns expected from an investment.

Ecological footprint: land (and water) area of the planet or particular area required for the support either of humankind s current lifestyle or the consumption pattern of a particular population. It is the inverse of the *carrying capacity* of a territory.

Economic assets: assets recorded in the balance sheets of conventional national accounts, defined as entities over which ownership rights are enforced by *institutional units*, individually or collectively, and from which economic benefits may be derived by their owners by holding or using them over a period of time. Economic *natural assets* can be produced assets such as agricultural products or non-produced assets such as land, mineral deposits or forests in the wilderness. In the SEEA, economic non-produced natural assets are defined more broadly, including also those natural resources that are currently exploitable, or are likely to be so, for economic purposes, even if no explicit ownership or control is currently exerted over these resources (for example, fish in the oceans, or commercially exploitable timber in tropical forests). See also *cultivated natural assets, non-produced natural assets* and *environmental assets.*

Economic instruments: fiscal and other economic incentives and disincentives to incorporate environmental costs and benefits into the budgets of households and enterprises. The objective is to encourage environmentally sound and efficient production and consumption through full-cost pricing. Economic instruments include effluent taxes and charges on pollutants and waste, deposit-refund systems, and tradable pollution permits. See also *cost internalization* and *tradable pollution permits.*

Ecosystem: system in which the interaction between different organisms and their environment generates a cyclic interchange of materials and energy.

Emission: 1. direct discharge of pollutants into the atmosphere from stationary and mobile sources; 2. in environmental accounting, direct discharges of residuals (pollutants, waste) by *an institutional unit* into any environmental medium (land, air, water).

Emission factor (coefficient): ratio of the amount of a pollutant generated to the amount of a given raw material processed. May also refer to the ratio of the emission generated to the output of a production process.

Emission standard: maximum amount of a polluting discharge legally allowed from a single source, mobile or stationary.

End-of-pipe technology: equipment added to a production process (but not an integral part of the process) with the sole intent of reducing and/or neutralizing the waste/residual associated with the process. It is used in reference to *environmental protection* expenditures.

Environmental assets: all *natural assets* that are not *economic assets.* Environmental assets are non-produced natural assets that function not as providers of natural resource inputs into production but as providers of environmental services of waste absorption, ecological functions such as habitat or flood and climate control, and other non-economic amenities such as health and aesthetic values.

Environmental charges: see *environmental taxes.*

Environmental cost: 1. actual expenditures for *environmental protection;* 2. imputed cost for *depletion* and *degradation* of natural assets. Various valuation techniques, including *market valuation, maintenance costing* and *contingent valuation*, are applied to *environmental impacts* and effects in environmental accounting**.**

Environmental damage cost: cost generated by repercussions (effects) of direct environmental impacts (for example, emission of pollutants) such as the degradation of ecosystems, damage to produced structures and health effects borne by individuals. Valuation techniques for damage costs include *contingen*t and related demand-side *valuations.*

Environmental debt: accumulation of past environmental impacts of natural resource depletion and environmental degradation, whose restoration is owed to future generations.

Environmental expenditures: capital and current expenditures for *environmental protection.*

Environmental externalities: uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost of other economic agents without being borne (accounted for) by the causing agent. As a consequence of negative externalities, private costs of production tend to be lower than its social cost. Environmental accounting attempts to value externalities, through different valuations of emissions and changes in environmental quality. See also *internalization of environmental cost.*

Environmental functions: environmental services, including spatial functions, waste disposal, natural resource supply and life support.

Environmental impact assessment (EIA): analytical process that examines systematically the possible environmental consequences of the implementation of projects, programmes and policies.

Environmental impacts: direct effects of socio-economic activities and natural events on the components (media) of the environment. See also *environmental damage cost.*

Environmental indicator: parameter, or value derived from parameters, that points to, provides information about, and/or describes the state of the environment, and has a significance beyond that directly associated with any given parametric value. The term may encompass indicators of environmental pressures, conditions and responses.

Environmentally adjusted national income (ENI): *environmentally adjusted net domestic product (EDP),* plus factor income and current transfers paid to less received from abroad, plus national use of external (of other countries or global commons) natural assets less external use of national natural assets.

Environmentally adjusted net capital formation (ECF): 1. net capital formation of fixed capital and changes in inventories minus imputed *environmental cost* of depletion and degradation; 2. an alternative definition, sometimes termed *net capital accumulation (NCA)*, includes also discoveries or transfers (from the environment to the economy) of natural resources and their natural growth. Negative ECF is considered an indicator of non-sustainable economic performance and growth.

Environmentally adjusted net domestic product (EDP): figure obtained by deducting the *environmental cost* of natural resource *depletion* and *environmental degradation* from net domestic product (NDP). Contributions to NDP and EDP by production sectors are termed value added (VA) and environmentally adjusted value added (EVA), respectively. EDP I, accounting for natural resource depletion only, can be distinguished from EDP II, accounting for both depletion and environmental degradation.

Environmentally sound technologies: techniques and technologies capable of reducing environmental damage through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior to discharge, or utilize and recycle production residues. The assessment of these technologies should account for their interaction with the socio-economic and cultural conditions under which they are implemented.

Environmental protection: any activity to maintain or restore the quality of environmental media (air, water, land) through preventing the emission of pollutants or reducing the presence of polluting substances in environmental media.

Environmental services: Qualitative functions of natural non-produced assets of land, water and air (including related ecosystems) and their biota. There are three basic types of environmental services: (a) disposal services, which reflect the functions of the natural environment as an absorptive sink for residuals; (b) productive services, which reflect the economic functions of providing natural resource inputs and space for production and consumption; and (c) consumer or consumption services, which provide for physiological as well as recreational and related needs of human beings.

Environmental tax: a tax whose tax base is in a physical unit (or a proxy thereof) that has a proven negative impact on the environment.

Environment statistics: statistics that describe the state and trend of the environment, covering the media of the natural environment (air/climate, water, land/soil), the biota within the media, and human settlements. A broad definition includes *environmental indicators*, indices and accounting. Typically, it involves a stress-response framework such as the United Nations Framework for the Development of Environment Statistics, which distinguishes data of activities generating environmental impacts, the impacts themselves, the social response to the impacts and inventories of natural resources and ecosystems.

Erosion: wearing away of the land by running water, rainfall, wind, ice or other geologic agents, including such processes as detachment, entrainment, suspension, transportation and mass movement. Geologically, erosion is defined as the process that slowly shapes hillsides, allowing the formation of soil cover from the weathering of rocks and from alluvial and colluvial deposits. Erosion is often intensified by land-clearing human activities related to farming, and resident and industrial development and it has as effect increasing run-offs, decline of arable layers, and siltation in lakes, lagoons and oceans.

Exclusive economic zone (EEZ): zone declared under national jurisdiction (up to 200 nautical miles wide) in line with the provisions of the 1982 United Nations Convention of the Law of the Sea, within which the coastal State has the right to explore and exploit, and the responsibility to conserve and manage, living and non-living resources.

Existence value: value of knowing that a particular species, habitat or ecosystem does and will continue to exist. Such value is independent of any use the valuer may or may not make of the resource.

Externalities: see *environmental externalities.*

Externalization of environmental protection cost: presentation of internal (*ancillary*) environmental protection activities (environmental clean-up and reuse of materials) and their cost as a separate production activity delivering the services at cost to the establishment carrying out these activities. Output of the establishment is increased in this manner, while value added remains unchanged.

Fish catch/landing: catch and landing are frequently used as synonyms for the volume of fish brought ashore. In some cases, fish catch is defined as the volume of fish taken out of the sea, differing from fish landing by the volume of fish discarded at sea.

Fish farming: see *aquaculture.*

Fishing effort: overall amount of fishing (usually per unit of time) expressed in units such as boat days on the fishing ground, number of traps or trawl haul and so forth. It usually relates to a specific fishery and gear. If more than one gear is considered, the fishing effort has to be standardized to ensure proportionality with fishing mortality (biologists perspective) or cost of fishing (economists perspective).

Fish stock: living resources in the community or population from which catches are taken in a fishery. Use of the term fish stock usually implies that the particular population is more or less isolated from other stocks of the same species and hence self-sustained. In a particular fishery, the fish stock may consist of one or several species of fish.

Fixed assets: tangible or intangible assets produced as outputs from processes of production that are themselves used repeatedly or continuously in other processes of production for more than one year.

Genuine saving: term coined by the World Bank. Saving (disposable income minus final consumption) minus imputed *environmental* (depletion and degradation) *cost*. Negative genuine savings is considered an indicator of non-sustainable economic performance. See also *environmentally adjusted net capital formation (ECF).*

Gross capital formation: measured by the total value of the gross fixed capital formation, changes in inventories and acquisition less disposal of valuables for a unit or sector. It is inclusive of the value of capital consumption.

Gross capital stock: value of all fixed assets still in use at the beginning of the accounting period, at the actual or estimated price of new assets of the same type, irrespective of the age of the asset. In the SEEA, capital stock is defined as the sum of the value of fixed assets and non-produced economic assets at the beginning of the accounting period.

Holding gains: gains that may accrue during the accounting period to the owner of an asset as a result of a change in the asset price.

Hotelling rent: net return realized from the sale of a natural resource under particular conditions of long-term market equilibrium. It is defined as the revenue received minus all costs of resource exploitation, exploration and development including a normal return to fixed capital employed. Used as a measure of natural resource *depletion.* See *market valuation.*

Individual transferable quota (ITQ): management tool used to allocate the *total allowable catch (TAC)* to individual fishermen or companies. ITQs are usually granted as a form of long-term fishing right and are tradable (transferable).

Individual transferable share quota (ITSQ): management tool used to allocate a fixed share of the *quota* to individual fishermen or companies. ITSQs are usually granted as a form of long-term fishing right and are tradable (transferable).

Institutional unit: SNA term. An economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities.

Internalization of *environmental cost*: incorporation of *environmental externalities* (imputed environmental costs) into the budgets of *institutional units*, typically prompted by economic instruments (fiscal incentives and disincentives of environmental subsidies, effluent charges, tradable pollution permits or user fees). *Environmental cost* accounting permits setting the initial level of these internalization instruments.

Land degradation: reduction or loss of the biological or economic productivity and complexity of rain-fed crop land, irrigated crop land, range, pasture, forest or woodlands resulting from natural processes, land uses or other human activities and habitation patterns such as land contamination, *soil erosion* and destruction of the vegetation cover.

Land improvement: the only change in non-produced natural (economic) assets accounted as gross fixed capital formation in the SNA. It consists of acquisitions (expenditures) related to land reclamation, forest clearance, drainage of wetlands and flood and erosion prevention.

Maintenance costing: method of measuring imputed environmental *degradation* (in some cases also *depletion/*destruction) cost caused by economic agents. The value of the maintenance costs depends on the most efficient *avoidance, restoration,* replacement or prevention activities chosen. It is defined as the cost of using the natural environment, that would have been incurred if the environment had been used during the accounting period in such a way as not to have affected its future use.

Market valuation: 1. market price valuation applied in national accounts; 2. imputed value of natural resources and of their *depletion* and *degradation,* based on expected market returns. Methods applied, in the absence of market prices of natural assets, include (a) finding the *net present value* of future net returns from natural asset use, (b) the *net price* method which determines the unit asset value as the difference between market price of a raw material minus its unit exploitation cost (including a normal return to the produced capital invested) and (c) the *user cost* allowance, that is to say, the difference between the finite net returns from the sales of an exhaustible asset during the accounting period and true income remaining after investing the allowance during the lifetime of the asset so as to penetrate a permanent income stream.

Material flow accounts: accounts that measure the material throughput through the economy by providing information on the material input from the environment into the economy, the transformation and use of that input in economic processes (extraction, conversion, manufacturing, consumption) and its return to the natural environment as residuals (wastes).

McKelvey box: two-dimensional scheme that combines criteria of increasing geologic assurance (undiscovered/possible/probable/proved reserves) with those of increasing economic feasibility (subeconomic resources as compared with economic *reserves*, depending on price and cost levels).

Mineral reserves: see *subsoil assets.*

Natural assets: assets comprising *economic assets (produced and non-produced)* and *environmental assets,* including biological assets, land and water areas with their ecosystems, subsoil assets and air.

Natural capital: natural assets in their role of providing natural resource inputs and environmental services for economic production and human well-being.

Natural resources: see *natural assets.*

Net capital accumulation (NCA): see *environmentally adjusted net capital formation (ECF)* and *other accumulation*.

Net present value: present value of an investment, found by discounting all current and future streams of income by an appropriate rate of interest. See *market valuation.*

Net price: see *market valuation.*

Non-produced natural assets: naturally occurring assets, such as land and certain uncultivated forests and deposits of minerals that are needed for production but have not themselves been produced. They can be economic or environmental. See *economic assets* and *environmental assets*.

Normal return to capital: portion of the earned revenue from the use of produced capital by the owner of the capital asset.

Operating surplus: the surplus or deficit accruing from production before taking account of any interest, rent or similar charges payable on non-financial and tangible non-produced assets borrowed or rented by the enterprise, or any interest, rent or similar receipts receivable on financial non-produced assets owned by the enterprise.

Opportunity cost: value of the next best use (or opportunity) for an economic good, or value of the sacrificed alternative.

Other accumulation: volume changes in natural assets, based on economic decisions or interest, thus distinct from non-economic causes of asset change, for example, political or natural events or disasters. It includes, for example, discoveries of natural resources, natural growth of economic assets and changes in land use. Added to *environmentally adjusted net capital formation (ECF),* a broader indicator of net capital accumulation (NCA) is obtained.

Other volume changes: 1. in the SNA, changes in assets that are not economic transactions and are thus recorded outside the production (supply and use) accounts. Include changes in non-produced natural assets such as discoveries, natural growth, *depletion* and *degradation* of *natural assets*, and natural disasters or war that may affect produced and non-produced assets; 2. in the SEEA, depletion and degradation of natural assets are shifted from other volume changes into the production accounts as cost and into the accumulation/asset accounts as capital consumption. All other changes in asset volume remain as other volume changes in the asset accounts.

Pollutant: substance present in concentrations that may harm organisms (humans, plants and animals) or exceed an environmental quality standard. The term is frequently used synonymously with contaminant .

Pollution: 1. presence of substances and heat in environmental media (air, water, land) whose nature, location or quantity produces undesirable environmental effects; 2. activity that generates pollutants.

Pollution abatement: technology applied or measure taken to reduce pollution and/or its impacts on the environment. The most commonly used technologies are scrubbers, noise mufflers, filters, incinerators, waste-water treatment facilities, and composting of wastes.

Pollution abatement costs or expenditures: costs incurred to reduce or mitigate specific pollution. See also *maintenance costing.*

Produced natural assets: see *cultivated natural assets.*

Proven reserves: see *subsoil assets.*

Quota: share of the *total allowable catch (TAC)* allocated to an operating unit such as a country, a vessel, a company or an individual fisherman (individual quota). Quotas may or may not be transferable, inheritable or tradable. While generally used to allocate TAC, quotas could be used also to allocate fishing effort or biomass.

Recruitment: 1. process by which fish enter the exploitable stock and become susceptible to fishing; 2. the number of fish added to the exploitable stock, in the fishing area, each year, through a process of growth or migration; 3. the number of fish from a year class reaching the age-at-first-capture; 4. the number of fish entering any age or size interval.

Renewable natural resources: natural resources that, after exploitation, can return to their previous stock levels by natural processes of growth or replenishment. Conditionally renewable resources are those whose exploitation eventually reaches a level beyond which regeneration becomes impossible. Such is the case with the clear-cutting of tropical forests.

Rent: property income paid to the owners of land and subsoil assets by tenants or users of the assets. Rents for the use of subsoil assets are often termed royalties. See also *hotelling rent.*

Reserves: see *proven reserves.*

Resource management: integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of regulations by which the management authorities control the present and future behaviour of interested parties, in order to ensure the continued productivity of the resources.

Resource rent: difference between total revenue generated from the extraction of natural resources and all costs incurred during the extraction process including the cost of produced capital, but excluding taxes, royalties and other costs that are not directly due to the extraction process. See *market valuation* and *hotelling rent.*

Restoration costs: actual and imputed expenditures for activities aimed at the restoration of depleted or degraded natural systems, partly or completely counteracting the (accumulated) environmental impacts of economic activities.

Royalties: rents paid for the use of subsoil assets. See *rent.*

Run-off: portion of rainfall, melted snow or irrigation water that flows across the ground s surface and is eventually returned to streams. Run-off can pick up pollutants from air or land and carry them to receiving waters.

Salinization: change in the salinity status of the soil. It can be caused by improper management of irrigation schemes, mainly in the arid and semi-arid regions covering small areas, or it may also occur if sea water or fossil saline groundwater intrudes in coastal regions or in closed basins with aquifers of different salt content when there is an excessive use of groundwater. It usually takes place where human activities lead to an increased evapotranspiration in soils on salt-containing parent material or with saline groundwater.

Satellite accounts: additional or parallel accounting system that expands the analytical capacity of national accounts. The purpose is to avoid overburdening or disrupting the central system. The System of integrated Environmental and Economic Accounts (SEEA) is a satellite account of the System of National Accounts (SNA).

Soil erosion: see *erosion.*

Straddling fish stock: fish stocks that migrate between *EEZs* and the high seas.

Stumpage value: maximum amount that potential concessionaires are willing to pay for logging rights. Under perfect market conditions, this value reflects the net present value of the discounted net returns from using forests for timber production.

Subsoil assets: 1. proved reserves are such quantities of mineral deposits, at a specific date, as analysis of geologic engineering data demonstrates with reasonable certainty to be recoverable in the future under the same economic and operational conditions; 2. probable (indicated) reserves are the estimated quantity and grade of a mineralized body for which sufficient information on continuity, extent, grade, operating and capital costs, and so forth is available on the basis of a study indicating an economically viable operation at long-term forecast average mining prices; 3. established (demonstrated) resources are the sum of (1) and (2); 4. possible (inferred) resources are resources for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples of measurements.

Sustainability: (1) use of the biosphere by present generations while maintaining its potential yield (benefit) for future generations; (2) non-declining trends of economic growth and development that might be impaired by natural resource depletion and environmental degradation.

Sustainable catch: number (weight) of fish in a stock that can be taken by fishing without reducing the stock biomass from year to year, assuming that environmental conditions remain the same. Different levels of sustainable catch exist for different stock sizes. Maximum sustainable catch is defined in reference to the size and composition of a stock that make the natural growth of the stock equal to this maximum.

Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Assumes the conservation of natural assets for future growth and development.

Sustainable income: sustainable national income is defined as the maximum amount a nation can consume while ensuring that future generations will have living standards at least as high as those of the current generation.

Sustainable yield: yield of a renewable (living) resource exploited without compromising the ability of the population/ecosystem to regenerate itself. It is usually taken to be equal to the growth of the resource.

Tangible assets: assets including human-made (produced) non-financial assets and non-produced natural assets and excluding intangible (non-produced) assets such as patents or good will. See also *natural assets.*

Technological change: improvement of technology that allows for more output created by the same amount of inputs.

Total allowable catch (TAC): see *allowable catch.*

Tradable pollution permits: rights to sell and buy actual or potential pollution in artificially created markets. See also *economic instruments.*

Transboundary pollution: pollution that originates in one country but, by crossing the border through pathways of water or air, is able to cause damage to the environment in another country.

User cost: see *market valuation.*

Valuation: see *market valuation, maintenance costing and contingent valuation.*

Value added: difference between the value of goods produced and the cost of materials and supplies used in producing them.

Waste: materials that are not prime products (that is to say, products produced for the market) for which the generator has no further use in terms of his/her own purposed of production, transformation or consumption, and of which he/she wishes to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded.

Water resources: a distinction is made between renewable and non-renewable water resources. Non-renewable water resources are not replenished by nature at all or not for a very long time. These include the so-called fossil waters. Renewable water resources, comprising groundwater aquifers and surface water like rivers and lakes, are rechargeable owing to the hydrologic cycle unless they are overexploited. Internal renewable water resources encompass the average annual flow of rivers and groundwater generated from endogenous precipitation.

Willingness to pay: See *contingent valuation.*

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1. Other more controversial versions or modules of the SEEA do expand the production boundary for the incorporation of environmental services as outputs of nature and for the production of household (domestic) services. They are not further discussed in the present manual (see chap. II, sect. B).

2. Principle 7 of the Rio Declaration on Environment and Development (United Nations, 1993b, resolution 1, annex I) adopted at the Earth Summit, states that ... In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

3. Accumulated (restoration) costs may assess how far a nation has drifted away from a sustainable development (Hueting, 1989, p. 37). The concept of environmental debt has been discussed by the National Institute of Economic Research and Statistics Sweden (1994), p. 40.

4. The difference between environmentally adjusted (net) capital formation (ECF) and genuine saving is that the latter excludes possibilities of financing capital formation through capital transfers from abroad. However, both indicators are, in principle, modified by the same amount of environmental cost. It is another question whether estimates of human capital formation, for example, in the form of expenses for education, should be added to genuine saving and thus de facto deducted from public and private consumption, as suggested by the World Bank (1997). The complex topic of human capital includes much more than just education and is not discussed here further; it is a topic of further research by national accountants in UNSD.

5. Note that different valuations may imply different sustainability concepts. Maintenance costing of the preservation of natural assets assumes a strong sustainability concept that does not allow for substitution. On the other hand, valuations that aim at income maintenance, such as the user cost allowance, are used to indicate overall sustainability of the total value of different kinds of assets (even of financial assets), reflecting a weak sustainability concept (Bartelmus, 1998). For economic assets, the different categories of sustainability are significant for ex ante analysis of future economic growth. In national accounting of past economic performance, and in the absence of replacement values of natural assets depleted or degraded, the future (discounted) loss in income-generation capacity is the allowance to be costed as capital consumption - irrespective of whether this allowance is reinvested or not, and where.

6. The present description of the SEEA also includes cross-boundary pollution as "transfers" from and to the "rest of the world" (see figure VII, below). Those transfers would affect the current external balance (but not the external balance of goods and services) and thus national (disposable) income (but not gross domestic product/environmentally adjusted net domestic product (GDP/EDP)).

1. An exception is the shift of the environmental costs caused by consumption activities of households to the production accounts where they are allocated to the other industries section. In this manner, pollution caused by final consumption is treated as negative production activity of households and government.

2. Obtained by deducting additionally the consumption (depletion/degradation) of natural capital from the conventional indicator of net capital formation (see chap. III). The more correct, but somewhat unwieldy term is therefore environmentally adjusted net capital formation (ECF). Both terms are used interchangeably herein after.

3. See, for example, the Framework for the Development of Environment Statistics (FDES) (United Nations, 1984), the matrix of indicators of sustainable development (World Bank, 1995), the Framework for Indicators of Sustainable Development (FISD) (Bartelmus, 1994a) and the Driving Force-State-Response Framework (DSRF) (United Nations, 1996).

4. To this end, material/energy processes are aggregated into activities of "industries" rather than processes, asset accounts of the environment are introduced without a description of environmental transformations (for example, pollutant flows through environmental pathways and their effects on ecosystems) and natural resource uses and the emission of pollutants are related to the responsible economic activities (United Nations, 1993a, chap. III).

5. The more controversial aggregation of physical indicators into contributions to environmental themes (greenhouse effects, ozone layer depletion, acidification, eutrophication, waste) is not further discussed here.

6. A brief formalized description of these valuations is given in box 3 of chapter III. For a more detailed comparative discussion of different valuation methodologies and the underlying assumptions, see Bartelmus (1998).

7. See, for example, Pearce, Markandya and Barbier (1989), chap. 6, for a general discussion of discount rates used in natural resource valuation.

8. For more recent applications, see Uno and Bartelmus (1998).

9. Contingent valuation, for instance, faces free-rider attitudes, shortsightedness or ignorance of consumers about long-term environmental impacts, and effects of income levels and distribution when questioning individuals (in opinion surveys) about their preferences for environmental quality and related social values. Also, contingent valuation is inconsistent with the predominant national accounts application of market prices, since it includes consumer surplus which is appropriate for

welfare measurement but incorrect in recording national accounts transactions. Other methods such as costing increased travel or estimating change in property values due to environmental deterioration may be more consistent with market values but face problems of distinguishing environmental from other socio-economic effects.

1. Note that transactions with the rest of the world are incorporated in the supply (imports) and use (exports) table, and the national income accounts (factor incomes, capital transfers and use of natural assets by other countries). Also, non-produced economic assets are distinguished from produced ones, owing to the different (from SNA) treatment of non-produced assets in the SEEA.

2. See, for example, Nestor and Pasurka (1998) for the use of input-output tables in compiling and analysing environmental protection expenditures and environmental employment.

3. Such deduction within an accounting system is questionable. The exclusion of defensive or any other undesirable activity from the economy would change the production boundary quite arbitrarily, since it is hardly possible to obtain consensus on what is desirable or regrettable in society. Moreover, simple deduction would not take into account the contribution of antecedent industries (for example, steel, cement, parts to waste treatment plants): deduction of indirect value added would require modelling that is outside the scope of environmental accounting.

4. Also, the net (value added) contribution of the EP goods and services industry to the economy cannot be measured with the data given in WS 2A, since the total intermediate consumption by this industry is not known in the present case, as indeed in most actual case studies. However, estimates could be made based on the number of employees, if available, or on ratios of average sales to value added by industry.

5. Such charges should be for environmental purposes, that is to say, to avoid depletion or degradation of natural assets, and are not to be mixed up with rents (in the SNA sense) or royalties from land/water use or the extraction of subsoil assets. These rents are property income paid to the owner of natural resources for the rights to exploit them (see 1993 SNA, paras. 7.128-7.133).

6. The existing classifications of individual consumption by purpose (COICOP), the Functions of the Government (COFOG), the purposes of the non-profit institutions serving households (COPNI) and outlays of producers by purpose (COPP) (1993 SNA, annex V, part I, sects. H-K) are currently further elaborated by the United Nations Intersecretariat Working Group on National Accounts. The revised versions show more detail on environmental protection expenditures (EPE) so that basic data will improve.

7. Actual experiments with input-output tables in the UNSD-supported projects did not provide useful results, as it was not possible to identify environmental protection outputs in the commodity classifications. However, in the United states of America an input-output framework was recently used to incorporate EP into the SEEA framework and to estimate indirect employment and value added attributable to the EP industry (Nestor and Pasurka, 1998). This is one of the methods recommended by Eurostat and the Organisation for Economic Cooperation and Development (Eurostat, 1998a; and Organisation for Economic Cooperation and Development, 1999).

8. The 1993 SNA and SEEA definitions of non-produced natural assets are further discussed below for step 4, for non-produced economic assets, and in section D, for non-produced environmental assets.

9. Arguably, natural resources should include all assets that are currently exploitable, or likely to be so, for economic purposes, even if no explicit ownership or control is currently exerted over these resources (as, for instance, in the case of fish in the oceans or commercially exploitable timber in tropical forests). In practice, however, it can be assumed that the government will lay claim to any such assets, thus exercising more or less stringent ownership over all assets that are not privately owned. All these natural assets that may potentially provide economic benefits can thus be considered economic assets.

10. In the SNA, quality losses are treated as other economic disappearance of non-produced assets (1993 SNA, para. 12.33). The physical description of degradation of economic and environmental assets is typically part of systems or frameworks of environment statistics (see, for example, United Nations, 1984 and 1991). In order to facilitate linkage of environment quality statistics with environmental accounting data, the software developed for this manual introduces an additional worksheet (11) (see anex VI).

11. Note that depletion and degradation are not necessarily synonymous with losses of economic and environmental assets, respectively. Soil erosion, for instance, can be interpreted as a change in soil *quantity*, but can also be seen, and is here accounted for, as a change in the *quality* of agricultural land, in other words, land degradation. For reasons of simplicity, depletion is generally used here to mean the permanent loss of economic natural, non-produced assets, and degradation , the loss of environmental assets and asset functions.

12. Land reclamation is recorded as capital formation , in other words, as the result of a production process, in the SNA. For reasons of simplicity, land reclamation is included in other accumulation in the physical accounts of WS 4, but is shown separately as capital formation in the monetary accounts of WS 5. It is an open question whether such a treatment applies also to other non-produced natural resources, for example, in cases where forests increase as a result of reforestation. For the time being, net increase in forest volume is recorded as other accumulation in both physical and monetary accounts.

13. As the decrease in land quality is due mostly to nutrient loss, it has been suggested that soil erosion equals depletion of soil nutrient stock in full-fledged asset accounts for nutrients (Royal Tropical Institute and Food and Agriculture Organization of the United Nations, forthcoming).

14. Legal logging might be permitted in protected areas. In this case, forests should be treated as economic assets with environmental functions, as discussed above.

15. In Indonesia, a case study (Repetto and others, 1989) applied two measures of stock: (a) "volume over bark" (VOB) which is the volume from stump to crown point of the first main branch of all living trees more than 10 centimetres in diameter at breast height and (b) "volume actually commercialized" (VAC) which is the volume under bark of commercially logs exploitable actually

extracted from the forest.

16. A Statistical Office of the European Communities (Eurostat) task force on satellite accounts for water is currently exploring the concept and measurement of potential water availability, taking into account hydrologic managerial constraints (Herrera and Bayo, cited in Møllgaard, 1997).

17. In-stream water use for purposes of transportation or recreation is dealt with as a form of land use (of "associated waters") (see step 4 (a) above).

18. In the SNA, capital formation and consumption are the consequence of shifting previously produced capital into production and consumption where it is gradually "consumed". Capital consumption is costed as the current prorated replacement value of physical wear and tear of the capital goods. For non-produced (natural) capital, such costing of the consumption of previously produced capital does not apply, and a more normative criterion of the long-term sustainability of production and income-generation has to be introduced (Bartelmus, 1998).

19. Note that there is an error in the heading X.D of the 1993 SNA (just above para. 10.120) which seems to classify acquisition less disposal of non-produced assets in capital formation by code No. P. 513, when indeed the correct code No. is K.2 (see 1993 SNA, annex V, part I.B.4).

20. Double counting could occur when maintenance costing was applied to an asset whose use might bring about erosion indirectly, for instance, through exposure of deforested land to wind and precipitation.

21. In some cases, a direct connection between an economic activity and a quantitative change of environmental assets can be made as indicated for forests (cleared) and species (captured or killed). The permanent loss of these assets could be valued in principle through maintenance costing (income forgone from forgoing the destructive activity). However, it is both conceptually and practically difficult to distinguish such activities and assets from economic depletion, as discussed in the preceding section, and this issue of quantitative change in environmental assets is not pursued further here.

22. See, for example, the theme indicators created in this manner by the Netherlands (NAMEA) (de Haan and Keuning, 1995). The problem with such indicators is that they are limited to particular policy themes and do not permit inter-theme comparison. Also, theme selection and definition will depend very much on a particular country s concerns and priorities.

23. In principle, a maintenance costing approach could be applied to the causing (pollution exporting) country.

24. It can be shown that under certain conditions, market values and maintenance costs are consistent and can be added and deducted from conventional indicators. Deduction of a hypothetical cost from observed market values is controversial, however (see, for a discussion of these issues and their relevance to environmental accounting, Bartelmus, (1998)).

25. Soil erosion is accounted as a degradation (of land quality) cost of agriculture, but is included as a depreciation cost of economic capital, affecting the productivity of agricultural land (cf. para. 181 above).

26. Cf. Chap. II, note 1, where the costing of pollution from consumption by households and government is explained.

27. No data on capital expenditures for EP were available or recorded during the accounting period.

1. The 1993 SNA distinguishes four categories of land: land underlying buildings and structures, land under cultivation, recreational land and associated surface water, and other land and associated surface water.

2. Native forests are those forests that do not result from a plantation or whose natural growth is not under the effective control of an institutional unit, although they may be protected and somehow managed .

3. In chapter III, forest ecosystems consist of environmental forest land only. This has been done to avoid double-counting. Economic forest land, including quality indicators, is reported, in physical terms, in worksheet 4 and could be further classified according to the associated ecosystems.

4. When the Government is the owner of the subsoil assets, resource rent could be estimated directly as the total fees, taxes and royalties collected by the Government from the companies involved in the resource extraction.

5. For a more comprehensive discussion of methods for the valuation of soil resources, refer to FAO and others (1994).

6. This method is widely used, as it is simple and applicable to all types of land degradation. In this method, crop yields or other output net of costs of intermediate inputs and consumption of fixed capital, are estimated for the non-degraded and degraded soil and then priced. The difference measures the value of lost production. If this value was considered a permanent loss, it would have to be extrapolated and discounted to obtain the total loss from soil erosion during the accounting period.

7. For a comprehensive description of the degree, the relative extent and causative factors of soil degradation, refer to L. R. Oldeman (1993).

8. Landings are defined as catches less discarded fish (fish thrown dead back to the sea), that is to say, the weight of the catch landed at the wharf.

9. For further information about stock assessment methods see Hilborn and Walters (1992), King (1995) and Sparre and Venema (1992).

10. For further information about fisheries economics and optimal exploitation, see Clark (1990), Cunningham, Dunn and Whitmarsh (1985) and Hannesson (1993).

11. Estimation of the monetary value of cod, shrimp and capelin in the Icelandic EEZ can be found in

Danielsson and others (1997).

12. The economic territory of a country may differ from the national boundaries. It includes: (a) airspace, territorial waters and continental shelf lying in international waters over which the country enjoys exclusive rights (for example, mineral deposits of oil and natural gas in international waters operated by a resident unit) ; (b) territorial enclaves in the rest of the world; and (c) any free zones (1993 SNA, para. 14.9).

13. The valuation of transboundary flows presents methodological as well as data problems and is not further discussed here (see chap. III, para. 203 and note 23).

14. A tourist or visitor, as defined in *Tourism Satellite Accounts* (World Tourism Organization, 1998), is any person travelling to a place other than that of his usual environment for less than 12 months and whose main purpose of trip is other than the exercise of an activity remunerated from within the place visited. This definition includes both tourists for leisure purposes as well as business travellers. Note, also, that tourists may be residents or non-residents of the country they visit.

15. See para. 365 above. Also, the 1993 SNA (para. 4.16) elaborates the concept of residence for individuals and corporations, thus distinguishing between tourists as individuals and tourists as business travellers, employed by non-resident producing units.

16. Tourism services may include the services of produced assets (namely, car rentals, hotel, taxi services and so forth). In the 1993 SNA, a consumer purchasing such services has the right to use the asset for the time specified by the contract. The value of the services includes the consumption of the fixed capital of the asset (namely, car, hotel, taxi and so forth), the interest costs as well as any other cost incurred by the owner to operate the asset. In line with this, the imputed cost of emissions caused by the use of the asset represents a cost to be incurred by the asset owner and should therefore be allocated to the tourism industry.

1. Note that gross domestic product (GDP) is often mistakenly used as an indicator of welfare or social progress.

2. However, the System of Integrated Environmental and Economic Accounting (SEEA) issued by the United Nations as an interim version and the ongoing process of its revision represent important steps towards further standardization of concepts and methods, which have already been developed in consistency with the procedures and definitions of the world-wide adopted 1993 SNA (chap. XXI, sect. D).

3. As described in chapter II and box 5 of chapter III, the method of such valuation is based on the net present value of total net income generated from the potential use of the asset; in practice, however, simplifications of this method, notably the net price and user cost valuations, are frequently applied.

4. For a more accurate assessment, these figures would have to be supplemented with gross capital

formation expenditures which are available only as a total (for government and industries) of 752 for waste disposal, surpassed by 1,340 for waste water management.

5. Another concept of environmental debt would have to assess the value of environmental costs, accumulated over the past in expanded financial accounts (Bartelmus, 1998, box 5). However, such accounts are not yet established in the SEEA.

6. Of course, consumption can be financed by income transfers from abroad, included in the concept and definition of national income. Also, the measurement of changes in consumption patterns would require a more detailed analysis of different consumption categories.

7. Input-output models have the double advantage of (a) being consistent - via make-use matrices of the supply and use accounts - with the national accounts framework and (b) facilitating the linkage between monetary economic variables and physical environmental indicators (see sect. 1, above).

8. Questions of income distribution and the allocation of environmental cost to social groups could be addressed by extending environmental accounts into social accounting matrices, incorporating environmental impacts, as, for example, in the Netherlands Social Accounting Matrix including Environmental Accounts (SAMEA) (Keuning and de Haan, 1998).

9. Assuming that the transfer of an environmental asset has resulted in the replacement of a non-produced asset (a forest in the wildness) by a produced asset that was generated within the production boundary of the national accounts (a plantation) (1993 SNA, para. 10.6).

10. Actual commercial shipments of wastes to and from the rest of the world are already accounted for as exports and imports in the conventional accounts, increasing GDP by an excess of exports over imports, or decreasing it by an excess of imports over exports.

1. The six phases or milestones were proposed by the Intersecretariat Working Group on National Accounts to provide countries with a framework for formulating their individual SNA implementation plans and with an instrument for characterizing the levels of national accounts development. The milestone approach was endorsed by the United Nations Statistical Commission at its 29th session in February 1997.

2. See, for a discussion of such linkage between SNA/SEEA, physical natural resource accounts and the Framework for the Development of Environment Statistics (FDES), Bartelmus (1997).

3. Information provided by E. Domingo, National Statistical Coordination Board, the Philippines, and leader of the pilot project on SEEA implementation.

a. The steps represent building blocks of the SEEA and could be implemented selectively according to country priorities and data availability.

a. Based on United Nations, Economic Commission for Europe (1994).

a. Figure in Nutrient in soil column multiplied by nutrient loss coeffcient (44,431).

a. By this definition, it follows that traffic from Copenhagen to the nearby Malmoe City in Sweden is neither Danish nor Swedish national traffic, while traffic from a Russian port in the Baltic Sea, through the North Sea, and the English Channel, around Portugal and Spain through the Mediterranean Sea and through Bosporus, to a Russian port in the Black Sea is national Russian traffic.

b. The IPCC reporting instructions also include emissions from international traffic, but these emissions are not included in the national totals.

c. It should be observed, however, that according to the IPCC guidelines, Greenland and the Faeroe Islands are part of Denmark while in the Danish national accounts, these part of the Danish kingdom are regarded as part of the rest of the world.

a. A year archive is the set of worksheets relative to a common year.

b. Environmental protection expenditures are actual expenses incurred by industries, households, the government and non-governmental organizations to avert environmental degradation or to eliminate part or all of the effects after degradation has taken place.

c. Ancillary activities consist of goods and services produced by establishments for own use to support the production of principal or secondary products of the industry; they include activities such as environmental clean-up or maintenance of protection facilities.

d. External EP output consists of principal and secondary production activities of establishments, in other words, the provision of EP products (goods and services) to other establishments.

e. CEPA includes only those activities and corresponding expenditures that are an immediate response to environmental degradation *caused* by production units, the government and households. It does not cover reactions and expenses related to further repercussions or effects of environmental impacts such as additional health and travel costs, *borne* usually by other than those who caused them.