Handbook of National Accounting

Integrated Environmental and Economic Accounting

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Preface

The discussion of environmentally sound and sustainable socio-economic development has received increased attention from the international community, stimulated in particular by the report of the World Commission on Environment and Development.[1] Environmentally sound and sustainable development was also the basic theme of the United Nations Conference on Environment and Development, held at Rio de Janeiro in June 1992.

The need for clarifying this new development concept and for developing methodologies for its assessment and implementation has been recurrently stressed in international conferences. Joint workshops, organized by the United Nations Environment Programme (UNEP) and the World Bank, set out to examine the feasibility of physical and monetary accounting in the areas of natural resources and the environment and to develop alternative macro-indicators of ecologically adjusted and sustainable income and product.[2] A consensus emerged in the workshops to the effect that enough progress had been achieved to develop the links between environmental accounting and the System of National Accounts (SNA),[3] and to elaborate certain aspects of environmental accounting in the ongoing revision of the SNA.

The revision of the SNA[4] presented a unique opportunity to examine how the various concepts, definitions, classifications and tabulations of environmental and natural resource accounting can be linked to the SNA. Such linkage was originally proposed in a framework for an SNA satellite system of integrated environmental and economic accounting.[5] Considering the current state of knowledge on environmental accounting and the divergent views on a number of conceptual and practical issues, it has not been possible to reach an international consensus at this time for a fundamental change in the SNA. Nevertheless, there was agreement that the SNA would address the issue of its links to environmental concerns. Therefore, the 1993 SNA devotes a separate section[6] to integrated environmental-economic satellite accounts and introduces refinements into the cost, capital and valuation concepts of the central framework that deal with natural assets. This will also facilitate using the SNA as a point of departure in the development of environmental accounts.

The satellite approach to environmental accounting expands the analytical capacity of national accounts without overburdening the central framework of the SNA. The Statistical Commission, as indicated in its report on its twenty-sixth session,[7] endorsed the satellite approach and requested that the concepts and methods of integrated economic and environmental accounting be developed by means of satellite accounts. This approach was confirmed by the United Nations Conference on Environment and Development, which recommended, in Agenda 21, that systems of integrated environmental and economic accounting, to be established in all member States at the earliest date, should be seen as a complement to, rather than a substitute for, traditional national accounting practices for the foreseeable future.[8]

Agenda 21, adopted by the United Nations Conference on Environment and Development, included a programme area on "Establishing systems for integrated environmental and economic

accounting" (paras. 8.41 - 8.54). Under the activities for that programme area, it was stated that the Statistical Division of the United Nations Secretariat should, *inter alia*:

(a) Make available to all member States the methodologies contained in *Integrated Environmental and Economic Accounting*;

(b) In collaboration with other relevant United Nations organizations, further develop, test, refine and then standardize the provisional concepts and methods such as those proposed by the present handbook;

(c) In close collaboration with relevant United Nations organizations, strengthen existing mechanisms for technical cooperation among countries, including exchange of experience in the establishment of integrated environmental and economic accounting;

(d) Provide the necessary technical support to member States to ensure the application of integrated environmental and economic accounts.

In addition, it was stated (para. 8.44 (a)) that the former Department of Economic and Social Development of the United Nations Secretariat should support, in all member States, the utilization of sustainable development indicators in national economic and social planning and decision-making practices, with a view to ensuring that integrated environmental and economic accounts were usefully integrated in economic development planning at the national level. The publication of the present version of the handbook is the first response to these recommendations, hopefully setting in motion the worldwide implementation of integrated accounting.

The immediate objective of the present handbook is thus to provide a conceptual basis for implementing a SNA (satellite) system for integrated environmental and economic accounting (SEEA) that describes the interrelationships between the natural environment and the economy. This is achieved by the linking of conventional economic accounts with environmental and natural resource accounts. Ultimately, integrated environmental and economic accounting is intended to support integrated social, economic and environmental policy by means of an integrated information system.

This handbook is based on the most recent version of SNA standards. The Statistical Commission, at its twenty-seventh session, held from 22 February to 3 March 1993, unanimously recommended the adoption of the revised System of National Accounts, subject to the amendments recommended by the Intersecretariat Working Group on National Accounts.[9] Chapters of the 1993 SNA relevant for developing the SEEA are especially chapter II (Overview), chapter IX (The use of income accounts), chapter XIII (Balance sheet), chapter XV (Supply and use tables and input-output), chapter XVIII (Functional classifications) and chapter XXI (Satellite analysis and accounts).

The first (introductory) chapter of this handbook discusses different approaches of environmental and natural resource accounting and provides an overview of how those approaches have been incorporated in the SEEA. It also illustrates the flexible and synthetic fashion in which alternative methodologies can be reflected in different versions or modules of the SEEA. The second chapter describes different possibilities of disaggregating the SNA flows and assets from the point of view of environment-related questions, without modifying the conventional SNA concepts. In this context, a detailed description of environmental protection activities and of natural asset accounts is proposed. The third chapter presents an accounting system of environmental and economic interrelationships in physical terms that is derived from the concepts of materials/energy balances and natural resource accounts. This physical accounting system is closely linked to the monetary accounts of the SNA. The fourth chapter describes the concepts of imputed environmental costs. Such costs are introduced for the depletion and degradation of the natural environment by economic activities. As those costs reduce the value of natural assets, they are also recorded in the asset accounts. The fifth chapter presents further, tentative extensions of the SEEA in order to achieve a more comprehensive description of environmental and economic interrelations. An extended concept of household production activities is presented and the treatment of environmental functions as services of nature to the economy is discussed. Furthermore, the application of input-output tabulations and analysis to the SEEA is briefly reviewed. The sixth chapter addresses several questions connected with implementing the SEEA at the national level; in particular it describes a building-block approach that would permit adaptation of the SEEA to particular concerns and statistical capabilities in different countries. A plea is made for gaining more practical experience through country projects of integrated accounting.

The present handbook is a work in progress. The complexity and diversity of the topics call for strict consistency with respect to both monetary and physical flows and assets within an integrated approach to environmental and economic accounting. This is not an easy task, and the expertise of other international organizations and the input of experts in the field have been essential in the development of the work. Preliminary versions of handbook chapters were distributed by the United Nations to obtain comments at an early stage of the work. Furthermore, they were discussed at the Special Conference of the International Association for Research in Income and Wealth (IARIW) on Environmental Accounting, which was held at Baden (Austria) in May 1991.

This conceptual discussion needs to be continued during the coming years to develop widely acceptable concepts and methods. The present interim publication is thus intended to make existing methodologies generally available in order to eventually facilitate a broad consensus on an integrated accounting framework. At the same time, the feasibility of the proposed concepts and methods needs to be tested by implementing the SEEA in countries at different stages of development. The results of the theoretical discussion and of the empirical work are to be used to prepare a more accomplished version of the handbook that will also take fully into account the internationally approved concepts and methods of the 1993 SNA. To the extent possible, those results have been anticipated in the current handbook.

The present version of the handbook was prepared by the Statistical Division of the United Nations Secretariat with the assistance of Carsten Stahmer, as consultant to the United Nations. Valuable advice and suggestions were received from many national accountants and environmental statisticians, notably Hans Adler, Alfred Franz, Allison Gilbert, Guenter Hamer, Anne Harrison, Roefie Hueting, Henry Peskin, Robert Repetto, André Vanoli and Klaus Wolff. Technical contributions were provided by Hans and Bela Adler, Guenter Bartel, Ulrike Goerner, Inge Herrchen, Ursula Trautner and Norbert Wirth. The generous financial support for the preparation of this handbook, furnished by the Government of Germany, the Ford Foundation and the Jessie Smith Noyes Foundation is gratefully acknowledged.

Notes

1. World Commission on Environment and Development, *Our Common Future* (Oxford and New York, Oxford University Press, 1987).

2. See Y. J. Ahmad, S. El Serafy and E. Lutz, eds., *Environmental Accounting for Sustainable Development* (Washington, D.C., World Bank, 1989).

3. *A System of National Accounts*, Studies in Methods, Series F, No. 2, Rev.3, 1968 (United Nations publication, Sales No.E.69.XVII.3).

4. *Revised System of National Accounts*, provisional, 1992 (ST/ESA/STAT/SER.F/2/Rev.4).

5. P. Bartelmus, C. Stahmer and J. van Tongeren, "Integrated environmental and economic accounting: framework for an SNA satellite system", *Review of Income and Wealth*, ser. 37, No. 2, pp. 111-148.

6. *Revised System of National Accounts*, provisional, op. cit., chap. XXI, sect. D.

7. *Official Records of the Economic and Social Council, 1991, Supplement No. 5* (E/1991/25), para. 154 (3) (iv).

8. *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), resolution 1, annex II, para. 8.42.

9. See *Official Records of the Economic and Social Council, 1993, Supplement No. 6* (E/1993/26), para. 62 (a).

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Explanatory notes

Reference to "tons" indicates metric tons, unless otherwise stated. A full stop (.) is used to indicate decimals.

The following abbreviations have been used:

CC	classification of columns
CEPA	(draft) classification of environmental protection activities
CES	Conference of European Statisticians
CNFA	classification of non-financial assets
COFOG	Classification of the Functions of Government
COICOP	Classification of Individual Consumption by Purpose
COIP	(Draft) Classification of Outlays of Industries by Purpose
COMPP	Classification by Purpose of Selected Outlays of Market Producers
COVC	classification of other volume changes
CPC	(provisional) Central Product Classification
CR	classification of rows
ECE	Economic Commission for Europe
EDP	environmentally adjusted net domestic product (eco domestic product)
EUROSTAT	Statistical Office of the European Communities
EVA	enyironmentally adjusted value added (eco value added)
FDES	Framework for the Development of Environment Statistics
GDP	gross domestic product
GNP	gross national product
IARIW	International Association for Research in Income and Wealth
IIASA	International Institute for Applied Systems Analysis
INSEE	Institut national de la statistique et des études économiques
ISIC	International Standard Industrial Classification of All Economic Activities
NDP	net domestic product
n.e.c.	not elsewhere classified
NNW	net national welfare
NPA	national patrimony accounting
NVA	net value added
OECD	Organisation for Economic Co-operation and Development
SEEA	System for Integrated Environmental and Economic Accounting
SERIEE	European System for the Collection of Economic Information on the Environment
SNA	System of National Accounts
UNEP	United Nations Environment Programme
UNU	United Nations University
WIDER	World Institute for Development Economics Research

I. Introductory overview

A. General observations

1. Increasing national and global impacts and repercussions of economic activities on and from the natural environment call for the analysis of environmental and economic problems within a common framework. The results of workshops, jointly sponsored by the World Bank and the United Nations Environment Programme (UNEP), have shown a great variety of opinions on how such a framework could be achieved (Ahmad, El Serafy and Lutz, 1989). The existing situation has induced the United Nations to develop concepts and methods for integrated environmental and economic accounting as a basis for internationally comparable work in this field.

2. It is not the aim of this handbook to present just one more approach to environmental accounting; rather, it reflects as far as possible the different concepts and methodologies that have been discussed and applied in the past few years. The main task of the handbook is to effect a synthesis of the approaches of the different schools of thought in the fields of natural resource and environmental accounting. A thorough analysis of those approaches indicates that they are often complementary rather than mutually exclusive. The absence of a general approach seems to be due more to missing linkages among the different approaches than to the existence of contradictory concepts. The handbook therefore does not intend to replace existing data systems like the natural resource account or the System of National Accounts (SNA), but rather to incorporate their elements as far as possible in order to establish a comprehensive data system.

3. The synthesizing of different approaches should not lead to a combination of incompatible data sets. The System for Integrated Environmental and Economic Accounting (SEEA) presented in the handbook has been developed with the aim of providing a picture of the interrelationships between the natural environment and the economy that is both comprehensive and consistent. An efficient analysis of environmental-economic relations necessitates having a data system in which the different parts are built on comparable concepts and can thus be closely linked to each other.

4. In the sections of this chapter that appear below, the choice of specific concepts is explained. Furthermore, an overview of the SEEA and its different versions is given. The presentation starts with some general considerations on the interrelationship between environment and economy (subsection B (1)). Thereafter, the scope and limits of monetary valuation and physical description are discussed (subsections B (2) and B (3)). In subsections B (4) through B (6), some aspects of defining natural assets and describing their economic use are presented. An outline of the data sources for the SEEA is given in subsection C (1). The relation of the planned system to the national accounts is discussed in subsection C (2). Further information on

the different versions of the SEEA and on its accounting scheme (SEEA matrix) is given in subsections C (3) and C (4).

B. Environmental-economic interrelationships

1. Ecological versus economic point of view

5. It is difficult to make an unambiguous distinction between the natural environment and the economy. It could be argued that the economy is part of nature. Human beings are living organisms like animals and plants, and their economic and other activities are often comparable to the similar activities of animals. From an ecological point of view, there is no absolute difference between human and other living beings, but rather a gradual one: Human beings should accept the fact that they are part of nature and should act so as not to upset the natural balances. Their intellectual power should be used to create living conditions that minimize their impacts on the environment of other living organisms. Human beings should accept the fact that their lives constitute a part of ecosystems that are moulded by their own activities as well as by those of other biota in interaction with the abiotic physical environment.

6. From the ecological point of view, integrated environmental and economic accounting should not consist in an economic accounting of the environment; rather, the economy should be treated as part of an environmental accounting system. Integrated economic and environmental accounting should help to define possible ecologically sound balances between nature and man and reveal actual imbalances. The objective is thus not optimal use of the environment for economic purposes but rather optimal balance between human and non-human claims. The influence of human economic activities on the natural environment, for example, on its state and its changes, needs to be carefully monitored.

7. From an anthropocentric point of view, the natural environment exists to be exploited by man, especially in the context of man's economic activities. The natural environment needs to be taken into account only in so far as it benefits human beings. The environment has to support human activity by providing natural resources for economic use and by disposing of the unwanted residuals of economic processes. Natural ecosystems have value only if they can be used for recreational purposes or in the extraction of natural products. From a simplistic economic point of view, it is of no interest whether natural balances are disturbed or other living beings are in danger of extinction. The natural environment has certain functions for human beings, and an accounting system has the task of monitoring the exploitation of those functions. If the quality of environmental functions deteriorates, the introduction of measures to keep them intact should be considered.

8. In the past few years, an increasing number of scientists have called for a synthesis of the ecological and anthropocentric points of view. The exploitation of nature for economic purposes has reached its limit: The excessive exploitation of certain environmental functions has become counter-productive because the benefits of some types of environmental use have

resulted in disbenefits with respect to other competing uses. For instance, the need for the environment's discharge of its waste disposal function may compete with the physiological need for its provision of clean air and water. The exploitation of nature has reached a point where human beings are impairing their own living conditions. It seems necessary, therefore (even from an anthropocentric point of view) that they question their own behaviour, considering that human life is an integral part of the environment and that its survival may be at stake if the rules of natural balances are not respected.

9. In this context, the concept of sustainability has achieved increasing importance (Bartelmus, 1992b, forthcoming; Daly, 1989, 1990, 1991a, 1991b; Daly and Cobb, 1991; Hueting, 1988; MacNeill, 1990; Norgaard and Howarth, 1991; Pearce, 1989; Pearce, Barbier and Markandya, 1990; Pearce, Markandya and Barbier, 1989; Pezzey, 1989; Simonis, 1990; Uno, 1991b; World Commission on Environment and Development, 1987). The short-term exploitation of environmental resources should be replaced by a long-term concept of preserving the environment for both human and natural needs. From a relatively radical point of view, the concept of sustainability should not be restricted to covering sustainable use of the natural environment for human purposes but should also include a broader perspective on natural balances: Not only the functions of the environment for human use, but the environment itself, should be kept intact, even if there might not be an apparent human use for it. An intact environment is considered to be part of the natural patrimony and might very well prove to be a precondition of human survival.

10. These considerations affect the design of an integrated system for environmental and economic accounting (see, for example, Bartelmus, 1992b; Peskin, 1991, forthcoming). An integrated framework should reflect a synthesis of, or at least a compromise between, the ecological and anthropocentric (economic) points of view. The economy should not be considered only in terms of its being a part of the environment nor should the natural environment be viewed only in terms of its economic usefulness. The natural environment and the economy could be interpreted as constituting two sides of the same coin. An accounting framework should therefore assist in identifying strategies of sustainable development that balance the satisfaction of human needs with the long-term maintenance of environmental functions.

2. Valuation and monetary accounting

11. National accounts view the relationship between the environment and the economy from an economic perspective only (System of National Accounts (United Nations, 1968)). In national accounts, valuation is normally restricted to market values. Production in the SNA covers all goods whether sold in the market or not, and selected non-market services (own-account production of housing services, and production of non-market government services). Non-market goods and services are valued either on the basis of prices of similar products that are marketed (agricultural products that are output of subsistence farming) or at cost (government services).

12. The use of the natural environment for economic purposes is not taken into account in the calculation of cost in the SNA and is therefore not reflected in important aggregates of national accounts, for example, the gross domestic product (GDP). Some uses may be recorded not as cost but as "other changes in assets", which reflect changes in the market value of the natural asset in question. The cost of depletion of natural resources includes only extraction costs: Losses of income-generation capacity for future production periods and generations caused by decreasing natural wealth are not taken into account in the production accounts of the SNA, but only recorded as "other changes in assets" which have no effect on cost or on GDP. If land is used as a sink for wastes, only the transportation costs of the wastes to the sink are recorded as cost in the SNA. The decreasing quality of land may be reflected under other changes in the value of land if the market price of land reflects such changes; however, those environmental uses are treated as part of cost in the SEEA. Also, environmental effects on human health may be recorded in the SNA, if actual expenditures are made for health restoration, but these also are not treated as cost.

13. Most approaches to the valuation of the non-economic benefits and disbenefits of the use of the natural environment have been developed independently of national accounts, typically as part of cost-benefit analyses for project or programme evaluations or for the overall modification of macro-aggregates such as national income or product (OECD, 1989; Johansson, 1990; Pearce, Markandya and Barbier, 1989). To a large extent, these valuations have not been reflected in the concepts of national accounts, in so far as they are not taken into account in market valuations.

14. The revised SNA contains a more detailed description of assets (United Nations, 1992). Tangible assets include parts of the natural environment such as land and subsoil assets in so far as they provide economic benefits to an owner, the characteristic of providing such benefits manifesting itself through those assets being controlled by an institutional unit. This often means explicit ownership, subject to government legislation in the case of natural forests, and/or availability of a market price. Those assets are referred to as economic assets. From an ecological standpoint, such coverage may be incomplete: Tropical forests, for instance, might have a market value because of their yield of tropical wood commanding high market prices, while other functions of such forests that could have non-market value from an ecological point of view are not registered. Among the other functions may be mentioned the role of those forests in the global climate balance, as well as their cultural and spiritual use for indigenous people. From an ecological point of view, tropical forests are one of the most important habitats for a great variety of animals and plants. Furthermore, market valuation for assets is not the only type of valuation possible. Natural assets might have a market value that differs substantially from a combined economic-ecological value, which not only reflects the economic uses of those assets but covers a broad range of additional ecological functions as well (OECD, 1989, chap. 3; Pearce, Markandya and Barbier, 1989, chap. 3). An integrated environmental and economic accounting system should therefore not only comprise the market aspects of national accounts but also apply a broader concept of economic-ecological valuation.

15. The main advantage stemming from the economic approach of conventional national accounts is the availability of comparable data on market values. The restriction to market transactions and market valuation means that statistical work can be based on observable data in terms of monetary values. Non-market valuation is usually connected with more or less controversial assumptions. The valuation problems connected with non-market uses of the environment present typical examples of such assumptions. A direct valuation of the benefits (or losses) connected with economic functions of the environment is normally possible only by asking people about the monetary value of those functions. This method (contingent valuation) assumes that respondents have sufficient information about the benefits of the functions in question and are willing and able to express those benefits in monetary terms. There are also cases (involving, for example, value of health or of human life) where monetization of environmental benefits (or damages) would seem to be a highly debatable undertaking.

16. If no attempt is made to value the functions of the environment directly, but cost data are used as a means of indirect measurement, the availability of data on values improves whereas the theoretical foundation of the valuation concept weakens (see, for example, Schulz, 1989; Schulz and Schulz, 1989). In the case of the disposal services of the environment with respect to wastes and other residuals, an opportunity-cost approach could be applied. The costs involved could be the expenditures that would have to be made to prevent the emission of residuals. Prevention costs could thus be a measure for the value of disposal services (Hueting, 1980; Hueting and Leipert, 1987). In a similar vein, the actual costs of health damages caused by environmental deterioration represent the least amount people are willing to pay to avoid the negative health effects of a deteriorated natural environment. Of course, other value losses of an aesthetic or even ethical nature are not accounted for in such costing. Actual costs reflect, therefore, only a partial value of the total negative impacts of decreasing environmental quality.

17. Actual damage costs caused by environmental deterioration could also be assessed on the basis of so-called defensive expenditures or costs (Leipert, 1986, 1987, 1989; Olson, 1977). Defensive environmental costs comprise the actual environmental protection costs involved in preventing or neutralizing a decrease in environmental quality, as well as the actual expenditures that are necessary to compensate for or repair the negative impacts of an actually deteriorated environment. The advantage of this approach is that estimates can be based on observable costs in monetary terms. It may well be that in many countries an increasing proportion of economic output has indeed to be used for avoiding or repairing unwanted consequences of production. An approach limited to observable costs in monetary terms does not, however, provide a complete picture of the advantages and disadvantages of the economic use of the natural environment. Moreover, their deduction as production cost is controversial (Bartelmus, 1992b).

3. Physical accounting

18. Valuation in monetary terms presents a dilemma: On the one hand, valuation methods involving not only market but also other values would lead to a more comprehensive description of the interrelationship between the environment and the economy but would at the same time

require extensive assumptions. On the other hand, exclusive use of observable monetary data based on market values would eliminate the need for assumptions on valuation and the resulting inconsistencies between the different values used; at the same time it would lead to an insufficient description of the interrelationship between the environment and the economy (Norgaard, 1989; Bartelmus, 1992a; Blades, 1989). The question is whether the use of data in physical units can overcome this dilemma? Also, would more data be available if data in physical units were used?

19. Indeed, a comprehensive description of the interrelationship between the environment and the economy is not possible without using physical data. In many cases, they are more suitable than monetary data. This is especially true for the description of the flow of materials and nutrients within the natural environment, and from the natural environment to the economy and back to the environment as residuals. The concepts of material/energy balances (especially in connection with input-output tables) can be used as a suitable instrument for analysing the material flows between the environment and the economy (Alfsen, 1991; Ayres, 1978; Isard, 1969; Isard and others, 1972; Kneese, Ayres and d'Arge, 1970; Leontief, 1970; United Nations, 1976).

20. It is easier to describe the process of transformation of materials and energy sources in the economic sphere than to give a complete picture of the consequences of economic activities for the environment. There is no widely accepted model of the transformation processes taking place within the natural environment and of the dynamics of the economic influences acting on it. There have been some attempts to develop global climate (change) models, and local or regional models of statistical ecology or eco-development (Bartelmus, 1986). In particular, modelling of the spatial distribution of residuals and their (partial) assimilation, physical and chemical transformation and final location, including the contamination of biota, has been successful only in specific circumstances and for selected pollutants.

21. Normally, it is possible to measure the emission of certain residuals of economic activities and their impact on the quality of the environmental media (air, water, soil) only in particular regions (Friend and Rapport, 1979; United Nations, 1988, 1991a). The dynamics that link environmental stress, response and contamination are in most cases unknown. This is the reason why the Framework for the Development of Environment Statistics (FDES) limits itself to listing statistical topics in a sequence of activities, impacts and (social) responses rather than formulate causal relationships among those topics (United Nations, 1984). No attempt is made, therefore, to base integrated accounting on a complete model of the environment.

22. Currently available possibilities of environmental accounting in physical terms are illustrated by work on natural resource accounts (Cornière, 1986; Friend, 1986; Garnasjordet and Viggo Saebφ, 1986; Gilbert and James, 1988; Gilbert, 1990; Longva, 1981; Norwegian Central Bureau of Statistics, 1987, 1990; Young, 1992, forthcoming). Those accounts show the stocks and flows of materials that are used as primary input of economic activities. Natural resource accounts are a suitable complement to material/energy balances that describe the transformation of natural resources within economic processes. Natural resource accounts have

already been developed for several countries. Linking those data to the monetary data of the national accounts is essential for the development of environmental-economic accounting systems.

23. Natural resource accounts can also be linked to systems of environment statistics and, together, could be employed as an overall framework for monitoring the natural environment (United Nations, 1991a, annex I; Friend, forthcoming). Such a framework could not only attempt to measure the short-term economic exploitation of the environment but also deal with aspects of sustaining the natural environment for future generations. The French *patrimoine naturel* (natural heritage or natural patrimony) accounts reflect ambitions in this regard (Institut national de la statistique et des études économiques (INSEE), 1986b; Weber, 1983, 1989). All this work could be used and further developed to better describe the interrelationship between the environment and the economy.

24. Quality indicators of water, air and soil could play an important role in the physical accounting of the environment. They could usefully supplement data on quantitative stocks and flows. Two main problems connected with environmental quality indicators have to be considered: It is difficult to choose the most relevant constituents of environmental quality and it is even more difficult to aggregate measures of those constituents into overall indices of the quality of water, land or ecosystems. Environmental indicators and indices had already been discussed in North America in the 1970s with mixed reviews and results (Inhaber, 1974; Ott, 1978). New attempts have now been initiated in Europe (Kuik and Verbruggen, forthcoming; Federal Statistical Office, Germany, 1990). United Nations methodologies also discuss the compilation of environmental indicators and indices (United Nations, 1991a). A broader approach requesting the development of indicators of sustainable development is advocated in Agenda 21, adopted by the United Nations Conference on Environment and Development (United Nations, 1993, resolution 1, annex II, paras. 40.6 and 40.7).

25. Physical data are necessary for describing environmental-economic linkages but they are not sufficient. The difficulty of using figures in physical terms lies in the development of huge data sets without reaching general conclusions on their (economic and non-economic) significance. It is often difficult to obtain a more condensed physical description—an important precondition for economic environmental accounting—in so far as use the underlying data are difficult or impossible to aggregate owing to the use of different statistical units (for example, tons and cubic metres) and the lack of knowledge of their relative importance. The spatial orientation of environmental data is a further obstacle to obtaining an aggregation level that allows the provision of unambiguous advice to policy makers on national environmental concerns. It remains to be seen to what extent weighting procedures can be devised that could overcome these difficulties. In many cases, the only way to obtain comparable results is to use a valuation in monetary units.

4. Asset boundary and scope of natural assets

26. The central focus of this handbook is the environment of human beings, which in principle includes all natural assets. In practice, when the SEEA is being implemented, the coverage may be more limited. For instance, when a description of the environment in physical terms is needed, an asset boundary may be defined that is more extensive than that devised when all assets need to be valued in monetary terms. Also, if the description of the environment emphasizes the impact of economic activities, its scope may be more limited than that of a description that aims to depict the environment in terms of stocks of available natural assets.

27. When an environmental-economic accounting system directs its attention to the stress on natural balances and ecosystems as a result of economic activities, the part of the natural environment that has been or could be affected by human activities should be the central focus. The assets of the natural environment that are—directly or indirectly, actually or potentially—affected by human activities are called natural assets or natural capital. Natural assets consist of biological assets (produced or wild), land and water areas with their ecosystems, subsoil assets and air. Special attention should be paid to living entities (animals, plants) and their natural environment (ecosystems). Thus all animals and plants should be associated with the natural environment and their living conditions should be monitored. Livestock and other animals that are controlled by man should be included, as well as wild animals. Cultivated crops and trees connected with agriculture and forestry have to be taken into account as well as wild plants and trees. Subsoil assets are included because their extraction provides a significant resource input into economic production and may affect both the surrounding landscape and ecosystems. Furthermore, the degree of depletion of subsoil assets may be a limiting factor with respect to the level of economic activities and may thus indirectly determine the amount of residuals discharged by those activities.

28. The definition of natural assets corresponds to the concept of the natural heritage (*patrimoine naturel*) developed by French statisticians (Cornière, 1986; INSEE, 1986b; Weber, 1983). From an ecological point of view, the term natural resources, which has often been used in this context, seems to be too narrow, because the phrase implies actual or potential exploitation or use by man. This constitutes, as French conceptual considerations have shown, only one aspect of the natural environment. Only if the focus is on the actual use of natural assets is the term natural resources strictly applicable.

29. The asset boundary in the SNA (United Nations, 1992) is between these two extremes. It includes only economic assets within its scope. Such economic assets, however, cover only those natural assets that result in future benefits to their owners. A distinction is made in the SNA between produced and non-produced assets, and within the category of produced assets a further distinction is made between fixed assets and inventories. In the category of produced assets, the natural assets consist of all those whose growth is controlled by man through processes of cultivation, including vineyards, orchards, timber tracts and other plantations yielding repeat products, and livestock for breeding, dairy and draught, all of which are treated as fixed produced assets and included in the category entitled "cultivated assets". Also included

under produced assets are the growing stock of agricultural crops, and fruits on trees and bushes, as well as livestock destined for slaughter, and fish in aquaculture, which are treated as inventories in the SNA and included in a category entitled "Work in progress on cultivated assets". The non-produced natural assets that are treated in the SNA as economic assets are included in a single category entitled "Tangible non-produced assets" which covers four broad categories, namely land, subsoil assets, non-cultivated biological resources and water resources.

30. While the formal SNA definition of economic assets as quoted above refers to assets that result in future benefits to their owners, in practice the SNA asset boundary would be restricted to assets that have a market value and/or over which the owners have control, either through ownership or otherwise. The market value is either the actual market price of an asset or the present value of future returns (in the case, for example, of subsoil assets or timber tracts). The criteria of market value and control should be used simultaneously. This is necessary because natural assets of nearly every type (biological assets, land, subsoil assets, water) could have a market value in so far as some products may be extracted and sold in the market. Market values could be attached to wood gathered from virgin forests, and to fruits gathered in the wild, as well as to ocean fish, as a limited amount of fish may be caught and sold in the market. Those assets, however, are not economic assets in the SNA sense, as there is no economic control over them. Normally, all assets over which there is economic control have market value. Although some non-controlled natural assets may or may not be valued in the market, they are not economic assets in the SNA sense.

31. The classification of natural and man-made assets in table 1.1 reflects the content of the above discussion of asset scope and asset categories. The asset categories presented in the table are the ones that will be used throughout this handbook. For the description of the natural environment and its relation to the economy in physical terms, the handbook uses a cross-classification by type of natural asset and by degree of economic control/use. In monetary terms, a distinction between natural assets having market and non-market value is made. As table 1.1 shows, market valuation could be applied to produced as well as to non-produced assets.

32. Classification systems of assets might take both ecological and economic considerations into account. The economic element may be reflected in the degree of control over the natural environment exercised by man. This criterion has a different relevance for different types of natural assets. Air, of course, is used but not controlled. Water can be controlled if it is stored in artificial watercourses or impoundments. Subsoil assets become economically controlled assets through the establishment of mines or exploration facilities. If land is cultivated or used for other economic purposes (for example, in underlying buildings and works, and in recreation, it belongs to the category of controlled assets. Virgin forests and wild animals belong to the category of uncontrolled assets, whereas timber tracts and livestock belong to that of controlled assets.

33. From an economic point of view, the use of the terms produced and non-produced is self-evident. From an ecological point of view, the distinction is less clear, as the activities of biological organisms in an environment not controlled by economic activities may also result in

Table 1.1 Man-made and natural assets

<table>
<tr><th></th><th>Man-made assets</th><th colspan="5">Natural assets</th></tr>
<tr><th></th><th></th><th>Biological assets</th><th>Land (with ecosystems)</th><th>Subsoil</th><th>Water</th><th>Air</th></tr>
<tr><td rowspan="2">Description in physical terms</td><td rowspan="2">Economically produced</td><td>(Economically) produced</td><td>Economically used</td><td>Developed</td><td>Economically stored</td><td rowspan="2">Non-economic</td></tr>
<tr><td>Wild</td><td>Uncultivated etc.</td><td>Undeveloped</td><td>Other bodies of water</td></tr>
<tr><td rowspan="2">Monetary valuation</td><td rowspan="2">Market value</td><td>Market value</td><td>Market value</td><td rowspan="2">Market value (proved reserves)</td><td>Market value</td><td rowspan="2">Non-market value</td></tr>
<tr><td>Non-market value</td><td>Non-market value</td><td>Non-market value</td></tr>
</table>

produced natural assets and thus "production" from an ecological point of view. It may therefore be more precise in the context of environmental accounting to use the terms economically produced and economically non-produced. The shorter terms produced and non-produced will continue to be used in the text, however.

34. In the table, subsoil assets consist only of the proved reserves. According to the Twelfth World Petroleum Congress, proved reserves of petroleum are "the estimated quantities, as at a specific date, which analysis of geological and 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. Proven developed reserves are those proved reserves that can be expected to be recovered through existing wells and facilities and by existing operating methods" (Martinez and others, 1987, p. 7; see also Masters and others, 1987, p. 3; Ferran, 1981). The definition of proved reserves refers to the criterion of market value (positive net returns on exploitation); the definition of developed reserves refers to the degree of control/use of subsoil assets.

35. Biological assets are in principle reflected twice in table 1.1: as individual plants or animals (species) and as part of ecosystems (Gilbert, 1990, p. 5; Gilbert, Kuik and Arntzen, 1990). Terrestrial ecosystems comprise the environmental media (land, water, air), as well as associated animals and plants; aquatic ecosystems comprise the sea bottom, water and air as well as associated animals and plants. From an ecological point of view, one cannot regard living organisms as individual species only (Myers, 1988). Nature can only be protected if complete ecosystems are maintained intact. Thus from an economic and ecological point of view, the value of assets depends heavily on intact ecosystems and not on individual species. Biological assets will therefore be described twice in this handbook, that is to say, once as elementary assets and once as part of ecosystems.

5. Use of natural assets

36. The use of natural assets can effect their temporary or permanent depletion (quantitative use) or leave nature unchanged quantitatively while possibly affecting the quality of the environment (qualitative use). In the first case, the flow of quantities from the natural environment to the economy is viewed as a flow of environmental goods. In the second case, the use of natural assets is interpreted as involving a flow of environmental services from the natural environment to the economy. The use of environmental goods may thus lead to depletion of natural assets, and the use of environmental services may cause degradation (qualitative deterioration) of natural assets.

37. The terms environmental goods and environmental services are introduced in analogical relation to economic products. However, the analogy may be misleading. From an ecological point of view, nature does not aim at producing goods and services for economic purposes. In the case of biota, natural production has the objective of reproducing the species and not of meeting particular human needs. Contrary to economic services, natural services are involuntary

(imposed) and may cause severe damage to the environment. The use of the more neutral term economic functions of the environment, which avoids the connotation of natural production to serve the purposes of human beings, has therefore been proposed (Hueting, 1980, chap. 4).

38. Natural assets can exhibit the characteristics of inventories or of fixed assets. Quantitative use will lead to a reduction in the inventories of natural assets if there are no other factors to counterbalance that reduction, for example, natural growth or replenishment by cyclic processes. In the case of qualitative use, nature serves as a fixed asset without the occurrence of immediate quantitative change. Such a distinction is useful for some natural assets but of only limited value for others. Subsoil assets could be considered inventory assets; land is more in the nature of a fixed asset. However, such simple classification becomes ambiguous if natural assets exhibit both quantitative and qualitative functions. Forests have characteristics of inventories with regard to the quantities of growing wood therein, but they also have characteristics of fixed assets with regard to their function of serving as a habitat for animals. From a more restricted economic point of view (market valuation), natural assets normally have a value with regard only to depletion (exception: land). From an economic and ecological point of view, values are also attached to environmental services and the natural environment then acquires the characteristics of a fixed asset.

39. Different functions of the natural assets are listed in table 1.2. The scheme also contains a description of the functions of man-made assets. It is not the aim of this scheme to offer a complete review of all possible functions, but rather to give some indication of the variety of possible functions. The scheme shows that the same natural asset can have different functions. The forest is a producer of timber as a result of logging activities, an important component of ecosystems (a habitat for animals and plants), a producer of consumption goods (fruits, medicine, construction material), a regulator of climate and water regimes, an absorbing medium for carbon dioxide and a retainer of soils. The forest also fulfils recreational (including aesthetic) purposes. These different functions are partly in competition with each other. This is especially true for the natural environment's function as a dumping ground for wastes (sink) on the one hand and that related to household consumption (involving, for example, drinking-water, respiration, recreation) on the other. The use of one function of the natural environment can impair its capacity to serve others. These trade-offs among the functions of natural assets are the main focus of the ecological-economic interrelationships that are studied in environmental accounting.

40. As a first step in assessing the different functions of natural assets, those functions have to be described in terms of physical units, because normally they do not have a market value. Physical flows connected with the quantitative uses of natural assets, in other words, those involving the depletion of biota, subsoil assets and water, can be measured. The disposal service provided by the natural media (air, water, land) could be assessed by the flow of residuals that are loaded into those media. The suitable framework for describing the interaction of the physical environmental and economic flows are material/energy balances that show the flow of quantities of natural resources into the economy, the transformation processes within the economy and the flow of residuals back to the natural environment. Further linkage to socio-

Table 1.2 Environmental and economic functions of tangible assets

Type of use	Man-made assets (including historical monuments)	Natural assets				
		Biological	Land (including ecosystems)	Subsoil	Water	Air
Quantitative (flow of goods, depletion of stocks)	Economically produced goods: input of further production, household consumption	Food for man and animals, Raw materials for clothing, wood products etc.	Nutrient flows	Raw material for economic production and energy sources	Drinking Cooling Process water Irrigation	Physiological purposes (life of humans, animals, plants)
Qualitative (flow of services, degradation of fixed assets)	Buildings, machinery, equipment etc: means of production Historical monuments: aesthetic use	Fruit-bearing (for example, vineyards and orchards) Stockbreeding Production Aesthetic use	Area for buildings, roads etc. Agriculture, forests Recreation Aesthetic use Habitat for plants and animals		Recreation Navigation Habitat for plants and animals Hydropower	Sensory perception (hearing, smell, sight) Wind, heat: energy source
Qualitative (disposal service, flow of residuals, degradation of environmental media)		Decomposers of residuals	Land/soil for storing/ absorbing residuals	Mines for storing nuclear wastes	Storing/absorbing residuals	Storing/absorbing residuals Radiation Transmission of noise

economic data would have to be achieved by broader accounting frameworks or systems of environment statistics (United Nations, 1984).

41. The disposal function of the natural environment can be considered part of a recycling activity in which there is movement of quantities between the economy and the natural environment, without any long-term change in the quality of the latter. There are other qualitative uses of the environment that lead to long-term physical changes within the environment. Economic use of land is often connected with slower or more rapid processes of deterioration. Agricultural use could cause soil erosion. The opening of uncultivated land (such as virgin forests and wetlands) for recreational or agricultural purposes may upset ecological balances. The exposure of areas to traffic or human settlement has radically changed the characteristics of land and ecosystems. It is often difficult to find suitable indicators in physical terms to describe these degradation processes. Indicators could be soil loss, decrease in different species (animals, plants) and patterns and trends of land use (United Nations, 1988, 1991a).

42. A description of the uses of the natural environment in physical terms should start with the immediate consequences of human intervention in natural balances, even though in many cases such intervention has a variety of indirect effects. However, those indirect effects can be recorded only partially. The disposal services of the environment are an important example in this regard. On the one hand, it is relatively easy to record the quantities of residuals that are emitted into the natural environment; on the other, it is much more difficult to describe the flows from ambient concentrations that result in the contamination of biota and the final effects on the health of biota, ecosystems and human beings.

6. Valuation of natural assets

43. The valuation of the use of natural assets is one of the most difficult tasks in environmental accounting and statistics (see, for example, Beckenbach, Hampicke and Schulz, 1989; Pearce, Markandya and Barbier, 1989, chap. 3). Market values are normally missing and even cost data often have only a hypothetical character. The general problems of valuation of natural assets were discussed above in subsection B (2). Based on the discussion, three methods of valuation emerge:

(a) Market valuation;

(b) Direct non-market valuation (involving, for example, the willingness-to-pay concept);

(c) Indirect non-market valuation (involving cost data on, for example, damage costs or those incurred in meeting certain standards).

The same methods of valuing tangible assets could also be applied to valuing flows of goods and services connected with the use of tangible assets. Table 1.3 illustrates, without aiming at completeness, different approaches to valuing those flows.

Table 1.3 Valuation and use of tangible assets

Type of valuation	Use of man-made assets	Use of natural assets				
		Biological	Land (including ecosystems)	Subsoil	Water	Air
Market	Market prices (decrease of stocks) Replacement costs (use of fixed assets)	Market prices (produced biota) Market valuation of net returns (wild biota)	Market prices	Market valuation (net returns of exploitation	Market prices (direct water use) Market valuation of net returns (water abstraction)	
Direct non-market	User and non-user values for historical monuments	Existence values of animals and plants	Aesthetic, recreational value of landscape Existence value of ecosystems		Value of decrease in water quality (willingness to pay) Existence values of aquatic ecosystems	Value of decrease in air quality (willingness to pay)
Indirect non-market		Costs of balancing depletion and natural growth	Costs of preventing land degradation by pollution, agricultural or recreational use	Costs of providing alternative income sources	Costs of balancing average water reserves Costs of preventing a decrease in quality of water by pollution	Actual damage costs caused by decreased air quality Costs of preventing a decrease in air quality by pollution

44. *Market valuation* seems at first sight to be an easy way of valuing the use of assets, because the valuation procedure can use observable data. However, the complexity of market valuation becomes apparent in the following four cases in which market valuation is applied to assets and to the corresponding flows of goods and services (United Nations, 1977b, chap. VI):

(a) *Produced natural assets, inventories.* In the case of inventories of biological or non-biological goods such as agricultural crops, and livestock raised for slaughter, which were produced and are immediately marketable, the current market price of those goods can be used for valuing both the stocks and the flows that decrease or increase the stocks. However, even in this case, alternative methods could be applied to the valuation of inventories;

(b) *Produced fixed natural assets.* For produced fixed natural assets such as orchards and plantations, and livestock raised for breeding, draught or dairy, which were produced and/or bought in the market (man-made assets), the market value is in principle determined in the SNA by the same two factors used in valuing man-made assets that are not natural assets: the present market price of similar new fixed assets (the current replacement costs) and the residual lifetime in relation to the total lifetime of the assets. The cost of using these assets in production can be estimated by assuming that they are equal to their depreciation in the reporting period. The depreciation (consumption of fixed assets) reflects the decrease in asset value caused by economic use and is estimated in the national accounts by multiplying the average market price of new similar produced assets (current replacement costs) in the reporting period by the depreciation rate (length of the reporting period in relation to the total lifetime of the assets);

(c) *Non-produced fixed assets.* Non-produced fixed assets (such as land) that are marketed could be valued by applying the market prices used in the transaction, and if they are not marketed the market prices of similar assets could be used. The market prices reflect the value of the flow of future net returns connected with the use of the assets. The flow of services of the marketed but not produced fixed assets could be estimated by using data on rents or leases that were actually paid for the purpose of securing permission to use these or similar assets;

(d) *Non-produced natural assets, inventories.* Depletable natural assets like wild biota and subsoil assets have a market price if they can be exploited. In this case, the market value of the assets consists in the future sales value, reduced by the exploitation costs (net return). If the exploitation is spread over a lengthy period, the flow of future net returns has to be discounted. In some cases, the reserves of depletable natural assets and the exploitation rights are marketed. The market prices will then reflect to a high degree the expected net returns from the exploitation of the resource.

45. If the use of natural assets is not connected with market transactions, direct or indirect non-market valuation has to be applied. Direct valuation techniques rely on some eliciting of

preferences (OECD, 1989, p. 15); indirect valuation techniques normally use the concept of replacement costs or of opportunity costs.

46. *Direct non-market valuation* techniques (contingent valuation) could be applied especially for the case of the qualitative (and quantitative) use of the natural environment as a public consumption good (Pearce, Markandya and Barbier, 1989; OECD, 1989; Johansson, 1990; Schulz and Wicke, 1987). Examples are the value of air and water use or the value of the recreational services provided by of natural assets. Often, it is not possible to value natural assets as a whole but only to determine a monetary amount corresponding to a decrease or an increase in those services. One example is the valuation of the decrease in air quality. People could be asked what annual amount they would be willing to pay to avoid the observed quality change. This amount could be interpreted as the decrease in the quality of the air as perceived by the population. The best-known direct valuation methods are the willingness-to-pay and willingness-to-sell approaches. Other methods use hedonic property prices, wage-risk studies and travel-cost approaches. It should be mentioned that these methods can be applied to valuing not only the different functions of natural assets but also man-made assets (for example, historical monuments) that have no market value.

47. The direct valuation method is not undisputed. Many economists doubt whether it is really possible to determine monetary values for preferences in the absence of markets (see, for example, Hueting, 1980, chap. 4.5). Difficult conceptual problems and a rather poor database are the usual arguments. On the other hand, these valuation methods frequently present the only possibility of approximating the value of a wide range of functions of the natural environment.

48. *Indirect non-market valuation* of environmental functions uses actual or hypothetical cost data. Actual costs comprise expenditures incurred for maintaining the services of the natural environment. Examples are environmental protection costs or expenditures for the mitigation of damage (for example, to human health and materials (corrosion)) caused by decreased environmental quality. An increase in environmental protection activities that prevent degradation of natural assets or restore their degraded nature could be an indication of a reduction in the quality of environmental assets and their functions as a consequence of economic activities that was avoided or restored.

49. The valuation based on avoidance or restoration cost may not be an adequate one: environmental protection activities might not be sufficient to balance the negative impacts of economic activities on the environment. The actual damage costs incurred are thus in general only a lower limit for valuing the decrease in environmental quality. People may be assumed to be willing to pay at least the amount of their actual expenditures to ward off the effects of deteriorating air and water quality. In this sense, those expenditures could be interpreted as the (minimum) value of the decrease in environmental quality.

50. In the SEEA, another indirect non-market valuation technique, which is based on hypothetical (imputed) cost data, plays a prominent role. The cost of using the natural environment is extended to include costs that *would* have been incurred if the environment had

been used in such a way as not to have affected its future use. Those costs are of course hypothetical because in reality an actual use occurred that did affect the environment. The inclusion of hypothetical costs is an attempt to value comprehensively actual environmental depletion or degradation. The rationale behind this approach is based on the following two criteria:

(a) Application of the sustainability concept, which has gained a central role in the discussion of integrated (environmentally sound and sustainable) development;

(b) Extension of the national accounts concept of consumption of a fixed capital of man-made assets to the valuing of the use of non-produced natural assets in production.

51. From an ecological point of view, an important task for any environmental policy is to balance the needs of humans with those of other living organisms (animals or plants). Economic activities should not—at least in the long run—impair the natural environment. For instance, the disposal services of nature should be used only to the extent that waste flows can be transformed by natural processes into materials that are not dangerous for man, animals and plants. Land use for recreational and other economic purposes should not be connected with a further destruction of ecosystems.

52. Balancing human and natural needs not only protects fauna and flora from human influences, but also maintains the natural environment in an intact state for future human generations. This leads to the concept of sustainability (Bartelmus, 1992b; Daly, 1991a, 1991b; Maler, 1989; Opschoor, 1989b; Pearce, 1989; Pearce, Barbier and Markandya, 1990, chap. 1; Pearce, Markandya and Barbier, 1989, chap. 2; Hueting, Bosch and de Boer, 1991). The concept of sustainable development can be interpreted as implying that economic activities should be extended only as far as the maintenance of man-made and natural capital will permit. A narrower definition of sustainability excludes the substitution of man-made for natural assets and requires maintenance of the level of natural as well as of man-made assets. If this sustainability concept is applied to the valuation of natural assets, the use of those assets will be valued on the basis of the costs necessary to fully maintain them.

53. This sustainability concept could also be supported by conservationist preferences for or attitudes oriented towards changing the level of natural assets. The uncertainty about possible far-reaching disadvantages arising from disturbing the natural environment and the irreversibility of many negative impacts of economic activities on the environment would call for a high degree of risk aversion and the maintenance of at least the present level of environmental quality.

54. Valuing the use of environmental functions through the use of the maintenance cost approach is similar to valuing the services of man-made capital in the national accounts through the consumption of fixed capital. The value of the consumption of fixed capital represents the current costs of these fixed assets when used in production. Those costs could be interpreted as constituting a payment for the services of man-made capital. The consumption of fixed capital is estimated as the amount necessary to maintain the level of man-made assets and keep them

intact. This maintenance cost approach uses (as has already been mentioned) actual market prices for estimating the necessary replacement investments. Nevertheless, the compilation has a hypothetical character because it is by no means certain whether actual investment expenditures coincide with maintenance cost levels.

55. In the case of maintaining natural assets, the market prices of assets slated to replace used natural assets normally cannot be applied because many types of natural assets are not replaceable. The (hypothetical) maintenance costs are therefore mainly prevention costs that would have been necessary to prevent negative impacts of economic activities on the environment and/or to meet given sustainability standards (Hueting, Bosch and de Boer, 1991). Despite this distinction, the two concepts, namely, the concept of marked-priced capital consumption and that of hypothetical maintenance costs, have many similarities. The use of both natural and man-made assets is valued with regard to its influence on the availability of capital. If use does not affect capital, user cost will be zero independent of the value of such use for society. Neither concept has a direct welfare orientation; and according to both, the users of natural assets would obtain a quantitative impression of the additional costs that would have had to be incurred (by them or by society) if their economic activities had been neutral with regard to the natural environment.

56. The sustainability concept need not necessarily be applied to each and every use of the natural environment but could focus on the maintaining of vital natural resources only. Those would include the resources that are difficult or impossible to replace and whose degradation or depletion would lead to unacceptable effects on human safety, health and/or welfare. Sustainable development requires in particular sufficient water-supply, sufficiently high land quality (prevention of soil erosion), protection of key ecosystems (for example, tropical forests) and the maintenance of air and water quality above minimum levels. In these cases, the sustainability concept should imply constancy not only of natural assets as a whole (assuming possibilities of substitution) but also of each type of natural asset.

57. In the case of subsoil assets, it seems unrealistic to estimate the costs for maintaining these stocks. The depletion of subsoil resources does not necessarily affect the natural environment and the living conditions of man and other living beings. The environmental problems of depleting assets are usually local and limited in scope (exceptions include problems derived from surface mining and oil spills connected with the exploitation and transport of crude oil). Major problems (for example, air pollution caused by energy consumption, or the presence of heavy metals as residuals of production and consumption activities) normally arise during the use of depleted raw materials. It seems therefore acceptable to apply a broader concept of sustainability in the case of subsoil depletion. That concept would include the possibility of substituting for subsoil assets other natural or man-made assets in environmentally benign production processes.

58. The maintenance cost concept implies that uses of the environment that have no impacts on nature have a zero (monetary) value. For instance, if water is used, and it is available in sufficient quantities, water abstraction has no maintenance costs. The same is true of fishing and

logging if natural growth compensates for exploitation. The disposal of residuals in natural media has no maintenance costs if nature can safely absorb those residuals and is not affected in the long run.

59. The value of deteriorating natural assets could also be partly or completely balanced by activities that aim at restoring the natural environment. The restoration costs could be regarded as gross investment which would offset the depreciation values. However, irreversibility of impacts on the natural environment may limit the possibilities of restoration.

C. System of integrated environmental and economic accounting (SEEA): an overview

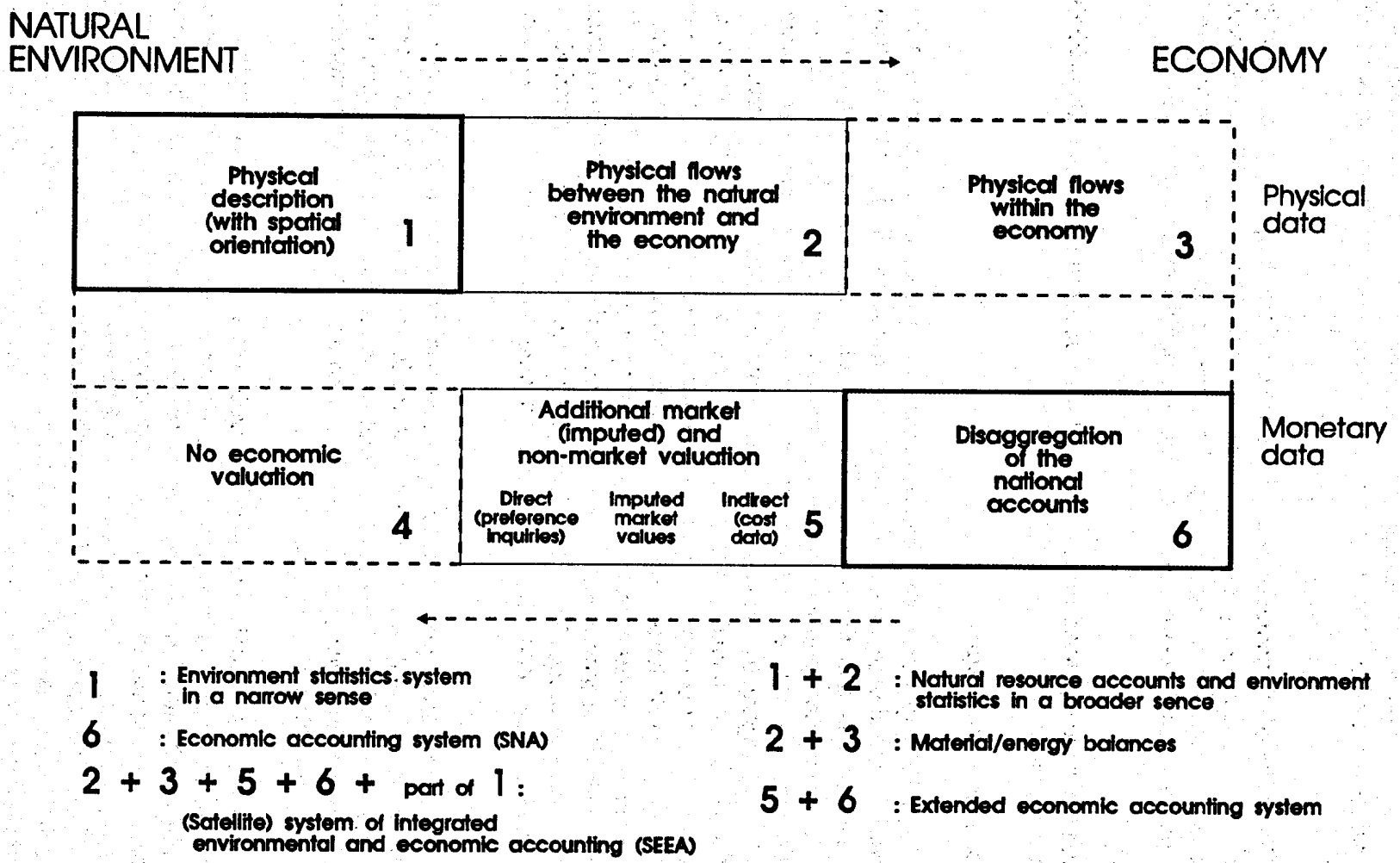
1. Scope and coverage

60. As actual experience and the above discussion have shown, there is a large variety of approaches in the design of statistical systems describing the interrelationships between the natural environment and the economy (United Nations, Economic Commission for Europe, 1991a). Two extreme positions can be identified. On the one hand, there is the statistical description that focuses on the natural environment. Environmental-economic linkages are described with regard to impacts on the environment. Much of the statistical framework is concentrated on the spatial description of the natural environment, involving the use, for instance, of maps of particular regions (ecosystems or eco-zones). The information is normally presented in physical units. On the other hand, some statistical frameworks focus on the economy and take environmental-economic linkages into account only in so far as they are connected with actual economic transactions (for example, environmental protection expenditures and actual damage costs). The latter data systems are typically more detailed presentations of conventional national accounts, as they present monetary data on actual transactions in market values.

61. In figure I these two concepts—physical data collection and monetary accounting—are indicated in boxes 1 and 6. Approaches that are located between these two extremes could be classified with regard to that use of the unit of measurement, for example, money values or physical units: Some data systems take into account either physical or monetary data; some present a combination of both types of data.

62. Systems that mainly use physical units could extend the description of the natural environment to include information on the physical flows between the environment and the economy (use of natural resources, flow of residual products). The existing systems of natural resource accounting and environment statistics comprise such data (figure I, boxes 1 and 2) (see, for example, Cornière, 1986; Garnasjordet and Viggo Saebϕ, 1986; United Nations, 1984, 1988, 1991a). This description in physical terms could be further extended to include information on transformation processes within the economy. Material/energy balances comprise a physical description of the use of natural resources, their transformation by production and consumption

Figure I. Data sources for integrated environmental and economic accounting



activities and the flow of residuals back to the natural environment (figure I, boxes 2 and 3) (United Nations, 1976). Natural resource accounting and material/energy balances overlap, especially with regard to flows between the economy and the environment (figure I, box 2).

63. The description of economic activities in monetary terms has been extended in the case of the SEEA to the valuation of the use of the natural environment. Different methods have already been discussed above. The comprehensive measurement of costs and benefits of economic activities and their environmental impacts is the purpose of such calculations (figure I, boxes 5 and 6) (see, for example, Peskin, 1989c; Bartelmus, Stahmer and van Tongeren, 1991). Such valuation not only facilitates the incorporation of environmental concerns into economic analysis but also creates a common scale of measurement that allows the compilation of economic-environmental aggregates on a highly condensed level.

64. The SEEA thus covers in principle both national accounts describing economic activities and environmental accounts including all monetary and physical flows that describe the interrelationship between the environment and the economy (figure I, boxes 1, 2, 3, 5 and 6). This ideal concept cannot be fully realized at present, since comprehensive data systems for describing the natural environment and its interaction with the economy are still missing (for example, Richter, forthcoming; Tappeiner, 1992; Friend and Rapport, 1989; Ward, 1990). Some ambitious approaches have been advanced in several countries, but no overall description of the natural environment has been realized so far.

65. This is not only due to inadequate financial support. It is true that additional financial resources would have probably brought about more success in developing comprehensive statistical systems in the field of environment. However, the main reasons for the absence of comprehensive environmental accounting are the difficulties in describing the natural environment with its climatic, biological, physical and chemical changes within a generic model of complex interrelationships. To date, most environmental assessments describe the state of the natural environment at a certain point in time. However, in general, except for selected regional case-studies, it has been impossible to fully portray the dynamics of natural processes. A complete integration of existing environmental and economic data systems seems, therefore, to be still an elusive objective.

66. It is therefore necessary to concentrate first of all on improving basic environment statistics and to develop as a second step consistent systems for describing the natural environment. The Framework for the Development of Environment Statistics (FDES) of the United Nations and the work of the Economic Commission for Europe in the field of environmental statistics are pertinent initiatives in this regard (United Nations, 1984, 1988, 1991a; United Nations, Economic Commission for Europe, 1988). The work of France in the field of natural patrimony accounting (INSEE, 1986b; Weber, forthcoming) could also play an important role in the furthering of conceptual improvements in this field. Natural resource accounts and material/energy balances, as described above, have focused on the natural environment from the point of view of economic use. The experience gained in these fields in several developing and developed countries could be used to establish consistent data systems.

67. The SEEA includes the following four elements:

(a) Transaction and other economic flow and stock elements of the established economic accounting system of the SNA, which are of special relevance to the measurement of the environmental impact of economic activities and will have to be further disaggregated to identify monetary flows and assets related to the use of the natural environment and/or treated differently in environmental analysis carried out in the context of the SEEA (figure I, parts of box 6);

(b) Environmental stocks and flows to which alternative monetary (non-market) valuations for the use of the environment are applied (figure I, box 5);

(c) Physical data on the flows of natural resources from the natural environment to the economy and their transformation within the economy, and on the flows of residuals of economic activities to the natural environment (figure I, boxes 2 and 3);

(d) A description of the natural environment in physical terms in so far as it is necessary for the purpose of analysing the impacts of human use. This part would thus not represent a comprehensive description of the state of the environment (figure I: parts of box 1).

The SEEA focuses on the interrelationships between the environment and the economy. Economic activities, as well as events within the natural environment, are dealt with in detail only in so far as they are necessary for understanding the relations between the economy and the environment. Furthermore, the relationships with sociodemographic data systems (for example, Bartelmus, 1992a) are not elaborated.

68. Using the SNA as a starting-point for the SEEA does not necessarily lead to a purely economic view of environmental concerns. Rather, it permits the introduction of ecological elements into economic thinking and decision-making through the employment of a common framework. If ecological issues can be translated into monetary terms, the possibility of economic decisions, taking environmental problems into account is much improved. The aim of the SEEA is thus to establish a suitable database for policies of sustainable development that incorporate the issue of the environment into mainstream policies. The next section will discuss the connections between the SEEA and the SNA. Special attention will be paid to questions of how the SEEA can introduce ecological elements and how the SEEA is linked to the core of the SNA.

2. The SEEA as satellite system to the national accounts

69. During the last 20 years, proposals have been made to modify the national accounting system with regard to environmental factors (Baltensperger, 1972; Bartelmus, 1974, 1987, 1989; de Boo and others, 1991; Eisner, 1988; Fickl, forthcoming; Hamer, 1974; Harrison, 1989a, 1989b, 1992; Hueting, 1980; Levin, 1990; Marin, 1978; NNW Measurement Committee, 1973;

Nordhaus and Tobin, 1973; OECD, 1971; Olson, 1977; Peskin, 1989c; Richter, 1989; Uno, 1989, 1990; Reich, forthcoming; Reich and Stahmer, 1983; Thage, 1990, forthcoming). It has been argued that environmental concerns cannot be well dealt with within the bounds of transactions, flows and stocks of the SNA. Nevertheless, the majority of national accounts experts reject the possibility of substantial changes to the conventional national accounts which are used for many other types of analyses. As a consequence, the following course was preferred: to establish a special satellite system outside the traditional framework of national accounts for the purpose of describing environmental-economic relations (United Nations, 1977a; Adler, 1982; Carson, 1989; Drechsler, 1976; Bartelmus, 1989; Bartelmus, Stahmer and van Tongeren, 1991).

70. The traditional national accounts are used to analyse the economic structure and developments of a market economy. There are many applications for which the restriction to market transactions is rather an advantage than a disadvantage (Reich, forthcoming). Short-term and long-term economic policies traditionally require monetary data on production and employment, capital formation, consumption, income distribution and saving, and financial transactions; all of these are valued in the market and therefore included in the traditional national accounts in monetary terms. As the data included in the national accounts are obtained directly in value terms from economic surveys and administrative records, a problem of valuation is generally not encountered.

71. However, to describe the interrelationships between the environment and the economy would require additional data that are generally not available in value terms. In a satellite system of environmental accounts those data would be included in a special data set that though remaining separate, could still be closely linked with the traditional national accounts. This approach necessitates having two systems, the traditional national accounts used as a core system and a special data framework with the character of a satellite system (or of satellite accounts) (Lemaire, 1987; Reich and others, 1988; Schäfer and Stahmer, 1990; Teillet, 1988; Vanoli, 1989; Weber, 1983, 1989). The Statistical Commission, at its twenty-sixth session, in 1991 (United Nations, 1991c, para. 154(e) (iv), and, more recently, the United Nations Conference on Environment and Development (United Nations, 1993, resolution 1, annex II, para. 8.42) therefore requested that the SEEA be developed as a satellite system of the SNA.

72. Such a satellite system can provide a greater degree of freedom to concepts and valuation than conventional national accounts. Valuation methods could be used that are not necessarily consistent with the market valuation used in traditional national accounts. In view of the complexity involved in the use of the environment for economic activities, different concepts and valuation methods could be tested and different options described. As already mentioned, the most comprehensive measures of economic-environmental relations represent at the same time the most controversial concepts and valuation methods. The experimental character of possible environmental accounting systems should therefore be reflected in the corresponding methodological proposals. The satellite system should certainly present a consistent framework, but this framework should also take into account as far as possible different schools of thought.

73. The objective of the environmental accounting system should be to monitor the environmental changes caused by economic activities and thus to become the basis (in terms of data) for integrated environmental and economic policies. Such an aim can only be realized if both the direct and the indirect impact of the economic use of the environment on economic activities can be analysed. This implies the existence of close connections between the traditional economic accounting system and the new satellite system. The links between the two data systems could be used to establish comprehensive economic models comprising not only economic but also environmental variables.

74. At first sight, the flexibility, experimental character and close linkage between the satellite system and national accounts, appear to be conflicting objectives. Close linkage to the national accounts would seem to preclude the establishment of an experimental design, in particular for the purpose of achieving a more ecologically oriented satellite system. A possible conflict in this regard could be avoided by a system with a high degree of built-in flexibility (van Bochove and van Tuinen, 1986). The system should comprise modules or building blocks whose links to the traditional accounting system reflect differing degrees of integration (see, for example, Friend, forthcoming). As far as possible, the same concepts should be used for both the core and the satellite system. In cases where different concepts are required, bridge tables are necessary that explicitly show conceptual differences and could be used as links between the new data and those of the traditional national accounts.

75. The SEEA could be called a system of *national* integrated environmental and economic accounts because it focuses on the description of environmental-economic relations at the national level. The data normally do not comprise regionalized information but only figures for the country as a whole. The breakdown of data by region could of course be presented in supplementary tables. This might be preferable, especially in the case of indicators of air and water quality and land use.

76. The focus on national data has both disadvantages and advantages. The main disadvantage is the exclusion of regional or local dimensions that are particularly relevant for describing and understanding environmental problems. On the other hand, it seems necessary to start with an accounting framework that is readily applicable. In general, national economic accounts are easier to compile than regional ones owing to data constraints regarding cross-boundary economic flows for subnational regions. In most instances, therefore, physical environment statistics constitute for the time being the best way to describe local environmental impacts and the sources/origins of those impacts (United Nations, 1984, 1988, 1991a). However, experimental applications of the SEEA to large regions could be carried out with a view to developing a possible regionalization of the system.

77. The international and global elements of the economic use of the natural environment have gained national and international attention (Boulding, 1985, 1991; Leontief and others, 1977; MacNeill, 1990; Opschoor, 1989a; Opschoor and Reijnders, 1991; World Commission on Environment and Development, 1987; United Nations, 1993). The SEEA, similar to conventional accounts, takes international issues into account by incorporating imputed "exports"

and "imports" of environmental services into accounts of the "rest of the world". Part of those exported or imported environmental services are already reflected in the foreign trade figures of the national accounts, which include, for instance, imports and exports of tropical wood. Separate identification of the imputed and actual imports and exports of environmental services is important in order to determine the extent to which national environmental problems have their roots in foreign countries and vice versa. If, for instance, tropical wood is imported by industrialized countries, this might cause severe environmental problems related to logging in developing countries. Estimation of the direct and indirect content of (imputed and actual) environmental costs in the value of these imported goods through input-output analysis would provide a quantitative indication of the environmental problems caused by the imports in the exporting country (chap. V, sect. D).

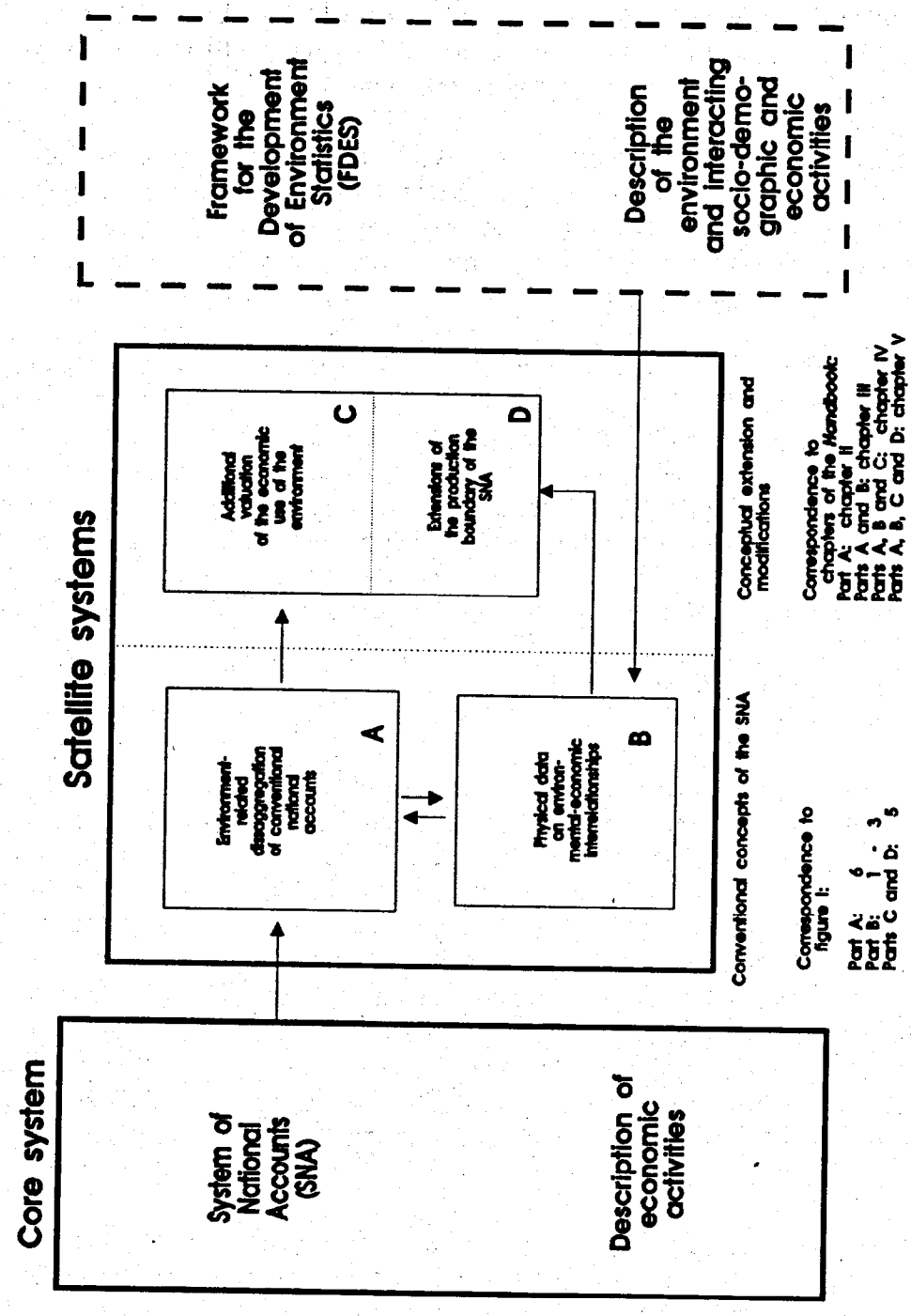
78. An increasingly important problem is the export and import of residuals, including solid wastes exported from industrialized to developing countries. Attempts should be made to identify these flows in physical and in monetary terms. It will be difficult, however, to give a complete picture of the cross-boundary flows of residuals, as residuals are recorded in the SEEA at the moment of leaving the polluter, independently of whether the pollution will finally affect the domestic or the foreign natural environment. Future applications of the SEEA could attempt to link spatial models of the natural environment with the data of the SEEA to obtain a complete picture of the impacts of economic activities on the domestic and the foreign environment.

3. Versions of the SEEA

79. The SEEA contains four parts, each of which follows the concepts of the SNA to a different extent (figure II). Part A, setting out from the production account of the SNA, provides the basic framework for the SEEA. It contains a description of production and consumption activities (supply and disposition tables), and of the accounts of non-financial assets. The production segment of the SNA constitutes the data basis for input-output tables with uniform row and column classifications (Franz, 1991). The input-output framework is the most suitable economic one for analysing environmental-economic relations because it can be easily extended to include flows of natural resources from the natural environment as input of economic activities and flows of residuals of production and consumption activities as unwanted output delivered back to the natural environment. The starting point for the natural asset accounts of the SEEA are the non-financial asset accounts of the SNA comprising also non-produced natural assets.

80. The SEEA contains the above-mentioned accounts of the SNA partly in an aggregated version and partly in a more disaggregated form. Disaggregation facilitates the identification of the environmental protection activities that prevent and mitigate environmental deterioration or restore the damage (reflected in health expenditures, material corrosion) caused by the deteriorated environment. In the case of non-financial assets, further disaggregation of stocks and volume changes of natural assets is proposed.

Figure II. SNA (satellite) system of integrated environmental and economic accounting (SEEA)



81. A second part of the SEEA (part B) consists of a description of the interrelationships between the natural environment and the economy in physical terms. This part incorporates the relevant concepts and methods of natural resource accounting, material/energy balances, and input-output tabulations; and it is closely linked to the monetary flows and assets of the SEEA, derived from the production segment of the SNA. The inclusion of natural resource accounts and balances can be made without modifying the concepts of the SNA.

82. In a third part of the SEEA (part C), different approaches for estimating the imputed costs of the use of natural assets are discussed. In this context, three different valuation methods, already described in subsection B (6) above, are used:

(a) Market valuation according to the concepts of the non-financial asset accounts in the SNA;

(b) Maintenance valuation, which estimates the costs necessary to sustain at least the present level of natural assets;

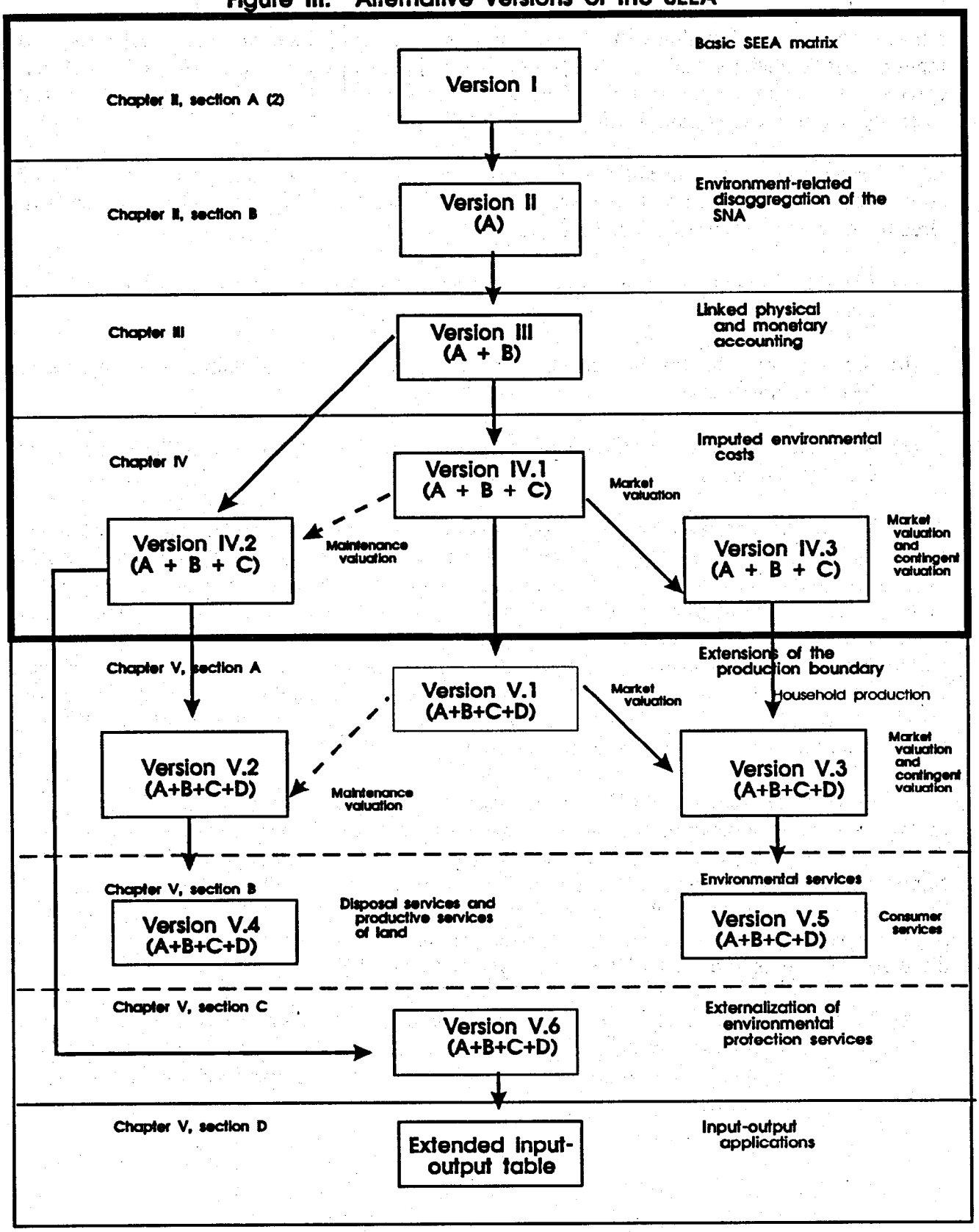
(c) Contingent valuation, which could be applied especially for estimating the value of the consumptive services of the natural environment.

83. The fourth part of the SEEA (part D) contains additional information that could be obtained by further extensions of the SEEA. Those extensions have been applied especially in the case of household activities whose detailed analysis can contribute to a better understanding of the social and demographic forces behind the impacts of human activities on the natural environment and of the effects on human welfare. Furthermore, the consequences of treating environmental functions in terms of the production of environmental services are discussed. Finally, treating both internal and external environmental protection activities as production activities can be viewed as introducing a broader concept of output (by means of externalizing internal intermediate costs of environmental production).

84. The different parts of the SEEA are described not as separate entities but as extensions or modifications of a common accounting framework. Each stage of the extension comprises the data of the preceding stages as long as the valuation methods are not mutually exclusive. In figure III, the relationships between the different versions of the SEEA are shown, including references to the chapters and sections of the handbook dealing with particular versions. The following six basic versions, each (except for version I) linked to the chapter in which it is discussed, thus make up the building-block system of the SEEA:

(a) Version I. This version is the basic accounting framework of the SEEA, obtained through appropriate reformatting of, or gleaning from, the conventional SNA. Section A (3) of chapter II introduces a numerical example to illustrate conventional accounts data to be modified in further versions (II-V);

Figure III. Alternative versions of the SEEA



(b) Version II. In chapter II, version II of the SEEA (covering part A), describing possible environment-related disaggregations of the SNA is discussed;

(c) Version III. In chapter III, the monetary data of part A of the SEEA are linked to environment-related information in physical terms to obtain version III of the SEEA (covering parts A and B);

(d) Versions IV, 1-3. In chapter IV, imputed environmental costs (part C) are added to obtain versions IV of the SEEA (covering parts A, B and C). Three different types of valuation of imputed costs are discussed: market valuation (version IV.1), maintenance valuation (version IV.2) and a joint use of contingent valuation and market valuation (version IV.3);

(e) Versions V, 1-6. In chapter V, various more tentative extensions of the SEEA are described in combination with different types of valuation of imputed environmental costs, to obtain versions V of the SEEA (covering parts A, B, C and D). An extended recording of household production activities is related to the three methods of valuation of imputed environmental costs already discussed in chapter IV, leading to versions V.1, V.2 and V.3. Environmental services are treated as production of nature in versions V.4 and V.5. The externalization of internal environmental protection activities is described in version V.6. The chapter also discusses a product-based symmetric input-output table with environment-related extensions as the conceptual basis for applications of the SEEA in input-output analysis (modelling).

85. Chapters II, III and IV and the corresponding versions of the SEEA constitute the core of the handbook and the SEEA. Versions V and the input-output tabulations presented in chapter V are for the purpose of opening a window on further analytical applications of the SEEA. They have not yet been thoroughly discussed and will require further research and experimentation. They are a response, however, to various international endeavours to extend the analysis of environment and development to include social and demographic concerns (United Nations Conference on Environment and Development, (United Nations, 1993, resolution 1, annex II, para. 8.45)) or to apply input-output methodologies for the global assessment of sustainable development.

4. SEEA matrix

86. The SEEA is presented mainly in matrix form, and constitutes a description of both flow and asset accounts. Table 1.4 shows the SEEA matrix in different stages of extension. In order to facilitate the description, only monetary data are described. Flow data are recorded in rows 2-12; the asset accounts, in columns 5-7. Flow and asset accounts are linked to each other by the volume changes of assets described in rows 2-10 and columns 5-7.

Table 1.4 SEEA matrix in different stages of extension: monetary data

Disaggregation of the SNA (version II)

Imputed environmental costs (version IV)

Extensions of the production boundary (version V)

		1 Domestic production			2 Final consumption	3 Non-financial assets (Uses & stocks of assets)			4 Exports	5 Total uses
		1.1 Industries	1.2 Other household activities	1.3 Environmental services		3.1 Produced assets		3.2 Non-produced natural assets		
						3.1.1 Industries	3.1.2 Consumer durables			
		1	2	3	4	5	6	7	8	9
1	1. Opening stocks									
2	2.1 Use of products of industries									
3	3.3.1 Use of produced fixed assets of industries									
4	2.2 Use of other household outputs									
5	3.3.2 Use of consumer durables									
6	2.3 Use of environmental services									
7	3.1 Use of non-produced natural assets									
8	3.2 Treatment of residuals									
9	4.1 Adjustments due to market valuation									
10	4.2.1 Eco-margin									
11	4.2.2 Net value added/Net domestic product									
12	5. Gross output									
13	6. Other volume changes									
14	7. Revaluations due to market price changes									
15	8. Closing stocks									

87. The structure of the columns shares some similarities with that of the columns in input-output tables. The first three columns cover different production activities and columns 4-8 present final uses. In addition to these traditional elements of presentation of an input-output table, the columns of gross capital formation (columns 5-7) are supplemented by complete asset accounts for non-financial assets, including opening and closing stocks and other volume changes of assets that are not capital formation.

88. The structure of the rows reflects a combination of items necessary for establishing asset accounts, and items used for recording flows. Rows 1 and 13-15 are relevant only in the context of asset accounts. The structure of rows 2-12 is again similar to that of input-output tables. The rows cover use of products and assets, net value added (net domestic product) and gross output.

89. The SEEA matrix is used for describing all versions of the SEEA in different stages of extension. Three stages are differently hatched in table 1.4:

(a) Version II (black). This version refers to data according to the conventional concepts of the SNA. Those data are further disaggregated to reveal environment-related activities, flows and stocks. Domestic production activities comprise only production activities of industries (column 1) and therefore produced assets comprise only assets of industries (column 5). The use of products is limited to that of products of industries (row 2), and use of assets to that of produced fixed assets of industries (row 3). The asset accounts comprise opening stocks (row 1), net capital formation (rows 2 and 3), other volume changes (row 13), revaluations due to market price changes (row 14) and closing stocks (row 15) which are the column totals of the asset accounts;

(b) Version IV (lightly shaded). The versions discussed in chapter IV describe different approaches to valuing imputed environmental costs. They record additional costs associated with different economic transactions (production, final consumption, use of produced assets) and (with the signs reversed) volume changes of natural assets used by economic activities (rows 7 and 8). Adjustment items are introduced (rows 9 and 10) that balance imputed environmental costs against the conventional figures of net domestic product (column 1) and the corresponding volume changes of natural assets against other volume changes and the closing stocks of natural assets still valued according to the SNA concepts of market valuation;

(c) Version V (darkly shaded). A third stage of development of the SEEA implies further extensions of the SEEA. An extended concept of household production activities is reflected in the SEEA matrix as "other household activities" (column 2) and "use of other household outputs" (row 4). The corresponding extension of the concept of produced assets entails the introduction of asset accounts of consumer durables and the record of corresponding user costs (row 5). If environmental services are treated as production activities, a further extension of the concept of domestic production is necessary (column 3 and row 6). The conceptual implications of externalizing internal environmental protection services are not explicitly shown in table 1.4 for the sake of

simplicity. Such externalization would imply modifications in the concepts of industries (column 1, row 2).

90. The black and shaded elements of the SEEA could, at least theoretically, contain figures in physical and/or monetary terms. Chapters II-V describe in detail the different versions of the SEEA matrix.

91. The order of the rows in table 1.4 does not follow the decadic system as applied in the detailed SEEA matrices in chapters II-V. The reason for this is to allow an easier understanding of the stages of extension. The matrices record the use of produced fixed assets of industries (row 3) and the use of consumer durables (row 5) after the use of non-produced natural assets (row 7) because the use of non-produced assets could imply both the intermediate consumption of depleted stocks and the use of fixed assets.

92. Comparison of the different versions of the SEEA presented in the handbook is facilitated by using common basic classifications of rows (CR) and columns (CC) for the different types of the SEEA matrix. The items of those classifications will be indicated in each SEEA matrix. In so far as the SEEA matrix can be presented with relatively complete basic classifications (especially in chapter V of the handbook), the numbers for classification items are placed to the left of the row descriptions and above or to the left of the column descriptions. If the basic classifications of the SEEA are applied in an incomplete manner, the numbers of classification items are given in parentheses after the row and column descriptions. The common row and column classifications of the SEEA are shown in annexes A and B with special reference to the versions of the SEEA that make use of them.

II. Environment-related disaggregation of the System of National Accounts (SNA)

A. From the SNA to the SEEA

1. Reformatting conventional accounts

93. The question of disaggregating (or aggregating) the monetary flows and assets of the SNA with respect to environmental elements is discussed in the present chapter with special reference to the monetary flows and assets connected with environmental protection activities and balance sheets of natural assets. It is useful to start the description of a possible disaggregation with a short review of those parts of the conventional SNA that form the conceptual basis for the development of the SEEA. This will also facilitate the description of SNA extensions proposed in chapters III-V. The relevant parts of the SNA are the supply and use table of produced goods and services, and the non-financial asset accounts which include the opening and closing balance sheets of produced assets and non-produced natural assets as well the changes therein as a result of capital formation and other changes in assets. These two segments of the SNA are combined in one table that constitutes basic version I of the SEEA, described in section A (2) below.

94. In section B, the disaggregation of the conventional SNA framework focuses on the identification of actual costs incurred to prevent or to restore the immediate negative impacts of economic activities on the natural environment and to prevent or compensate for further or indirect negative impacts of the repercussions of a deteriorated natural environment. These actual environmental costs include expenditures for environmental protection and expenditures for mitigating the damage (for example, to health) caused by the deterioration of environmental media. Such costs represent a prominent part of environment-related flows in the conventional SNA accounts. In section C, the asset and liability accounts of the SNA are described with regard to the flows and stocks of natural assets.

95. The concepts of the SEEA focus on environmental-economic interrelationships as far as they concern economic production and use of products. Therefore, the input-output framework of the SNA (supply and use tables) and the non-financial asset accounts are used as a starting-point for developing the SEEA. The supply and use tables show the supply of domestic and imported products (goods and services), their use for intermediate or final demand, and the value added connected with production in economic activities. The non-financial asset accounts comprise opening stocks at the beginning of the accounting period, price and volume changes during the period and closing stocks at the end of the period.

96. A complete picture of the monetary flows and assets connected with environmental concerns would necessitate a further breakdown of other accounts of the conventional SNA. The use of environmental functions not only has impacts on the production and use of goods and services but also affects the income and accumulation accounts. Environmental effects on those

accounts will not be pursued further in the present handbook. Some research has been carried out in this area by INSEE (1986a).

2. Basic SEEA matrix (version I)

97. The supply and use tables and non-financial asset accounts of the SNA are presented in one table as basic version I of the SEEA matrix, fully based on SNA concepts. This version is used as the starting-point for all other versions (II-V) in the handbook. In this chapter, basic version I of the SEEA will be disaggregated with respect to environment-related monetary flows and assets to yield version II of the SEEA. In version III (chapter III), physical flows are linked to these disaggregated monetary data. In versions IV and V (chapters IV and V), additional imputed monetary flows are introduced. Thus, the presentation of the different concepts of the SEEA starts from a common framework derived directly from SNA concepts. To link the different parts of the handbook, aggregates and indicators based on the concepts of the conventional SNA will be shown explicitly in all versions of the SEEA.

98. A summary description of version I of the SEEA is presented in table 2.1 (general concepts) and table 2.2 (numerical example). The presentation in general terms, and also the numerical example, will be used for all versions of the SEEA. The summary tables are further disaggregated in version II of the SEEA with respect to environment-related activities (section B, tables 2.3 and 2.4). A detailed description of non-financial asset accounts in version II is given in section C (tables 2.6 and 2.7).

99. The concepts of basic version I of the SEEA described in table 2.1 refer only to monetary data exclusively based on the SNA concepts. The different components of this type of SEEA matrix are referred to as A-matrices. Each A-matrix could be further disaggregated in rows or in columns. In some cases, the sign of the possible elements of the A-matrices are indicated below the matrices. Plus (+) means that only positive values are possible; minus (−) means that only negative values are recorded. If positive and negative elements are possible, this is also indicated below the matrices by a symbol (+, −). In addition, the numbers for the basic classifications covered by the rows and columns of the SEEA matrix (annexes I and II) are indicated in parentheses.

100. The numerical example shown in table 2.2 contains figures used throughout the handbook. The figures are based on the national accounting data of a developing country (see Bartelmus, Stahmer and van Tongeren, 1991). Further breakdowns of those data and additional imputations (chaps. IV and V) have been estimated as plausibly as possible but do not reflect the reality of any specific country. The country studies that have been initiated to test the SEEA concept will provide further information that might be useful for achieving an improved version of the numerical example in a more advanced version of the handbook.

101. The SEEA matrix has been developed as a synthesis of the supply and use tables and the non-financial asset accounts of the SNA (Bartelmus, Stahmer and van Tongeren, 1991). Rows

Table 2.1 Version I of the SEEA: SNA concepts (summary table) - general concepts

		1.1 Domestic production of industries	2 Final consumption		3 Non-financial assets (uses and stocks of assets)			4 Exports	5 Total uses	
			2.1 Individual	2.2 Collective	3.1.1 Produced assets of industries		3.2 Non-produced natural		Domestic origin	Foreign origin
					3.1.1.1 Man-made	3.1.1.2 Natural				
		1	2	3	4	5	6	7	8	9
1	Opening stocks (1)				A	A	A			
	Use of products of industries (2.1)									
2	Domestic production (2.1.1)	A	A	A	A	A	A	A	A	
3	Imports (2.1.2)	A	A		A	A	A	A		A
4	Use of produced fixed assets (3.3.1)	A (+)			A (-)	A (-)				
5	Net value added/NDP (4.2.2)	A								
6	Gross output of industries (5.1)	A								
	Other volume changes (6)									
7	Due to economic decisions (6.1)				A (+,-)	A (+,-)	A (+,-)			
8	Due to natural and multiple causes (6.2)				A (+,-)	A (+,-)	A (+,-)			
9	Revaluation due to market price changes (7)				A (+,-)	A (+,-)	A (+,-)			
10	Closing stocks (8)				A	A	A			

Note: A-matrices denote monetary data (SNA concepts).

Table 2.2 Version I of the SEEA: SNA concepts (summary table) - numerical example

(Monetary units)

		1	2 Final consumption		3 Non-financial assets (uses and stocks of assets)			4 Exports	5 Total uses	
					3.1.1 Produced assets of industries		3.2 Non-produced natural			
		1.1 Domestic production of industries	2.1 Individual	2.2 Collective	3.1.1.1 Man-made	3.1.1.2 Natural			Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9
1	Opening stocks (1)				991.3	83.1	1756.4			
	Use of products of industries (2.1)									
2	Domestic production (2.1.1)	184.1	148.7	42.5	61.8	1.4	7.3	71.6	517.4	
3	Imports (2.1.2)	39.9	26.3		6.2	0.0		2.1		74.5
4	Use of produced fixed assets (3.3.1)	26.3			-23.0	-3.3				
5	Net value added/NDP (4.2.2)	267.1								
6	Gross output of industries (5.1)	517.4								
	Other volume changes (6)									
7	Due to economic decisions (6.1)				0.0	0.0	7.0			
8	Due to natural and multiple causes (6.2)				-25.3	0.0	-4.1			
9	Revaluation due to market price changes (7)				138.1	12.6	410.5			
10	Closing stocks (8)				1149.1	93.8	2177.1			

2-6 of the matrix form a sub-matrix containing all data presented in the use and disposition tables of the SNA. The sub-matrix comprises production accounts of industries (column 1) and product flow accounts (rows 2, 3 and 6) subdivided by products, both of which identify the products by origin (domestic output: row 6/ column 1; imports: row 3/column 9) and by destination (intermediate consumption, final consumption, capital formation, exports: rows 2 and 3/ columns 1-7). Gross output of industries (row 6) could be further disaggregated by products. Such a "make" matrix with cross-classification by product and industry links the domestic production of industries (column 1) with the use of domestic products (row 2). Columns 4-6 of the SEEA matrix contain the non-financial asset accounts of the SNA comprising opening stocks (row 1), volume and price changes during the accounting period (rows 2-4, 7-9) and closing stocks (row 10). The interface between the two data sets (rows 2-6 and columns 4-6) comprises gross capital formation (rows 2 and 3) and consumption of fixed capital or depreciation (row 4), called "use of produced fixed assets" in the SEEA to distinguish it from the depreciation of non-produced natural assets due to their use by economic activities (row 2, column 6).

102. The further breakdown of data on production and product flows is based on the classifications used in the SNA. For further disaggregating the production activities of industries, the International Standard Industrial Classification of All Economic Activities (ISIC) (United Nations, 1990) can be applied. According to the SNA, industries are involved not only in market production activities but also in non-market production ones. Moreover, ISIC does not separate market from non-market activities but presents similar types of activities (for instance, health services) under the same item, irrespective of whether those activities are marketed or not. Statistical units of industries are establishments or establishment-type units. The product classification in the SEEA corresponds to the provisional Central Product Classification (CPC), (United Nations, 1991b). Further extensions of the ISIC and the CPC that would identify environment-related production activities and products are described in section B (2) below.

103. Explanations of the derivation of net domestic product (NDP) (row 5) are given in the next subsection (A (3)). The contents of other volume changes of assets (rows 7 and 8) are described in section C, which also contains more information on different types of non-financial assets (table 2.1, columns 4-6) as recorded in the SEEA.

104. Final consumption is subdivided into individual and collective consumption (see revised SNA (United Nations, 1992, chap. IX)). Individual consumption comprises consumption of goods and services acquired by individual households, whether paid for by them or not. Individual consumption comprises household consumption expenditure and those parts of the final consumption of government and non-profit organizations acquired by households. Collective consumption comprises consumption of services provided to the community as a whole, or to a particular section of the community, and deemed to be acquired and used by all members of that community. This subdivision of final consumption is applied for environmental accounting because it allows the comprehensive description of the impacts of household consumption activities.

105. The SNA data of the numerical example (table 2.2) can give an idea of the importance of some aggregates only. The inputs of domestic production (column 1) are intermediate inputs (184.1 + 39.9), consumption of fixed capital (26.3) and net value added which in the example is identical with net domestic product (NDP: 267.1). The total supply of products (591.9) comprises the gross output of industries (517.4) and imports (74.5). The disposition of those products is shown in rows 2 and 3 of table 2.2: intermediate consumption (184.1 + 39.9 = 224.0), final consumption (148.7 + 26.3 + 42.5 = 217.5), gross capital formation (61.8 + 1.4 + 7.3 + 6.2 = 76.7), including land improvement (7.3), and exports (71.6 + 2.1 = 73.7). The opening stocks of non-financial assets amount to 2,830.8 (991.3 + 83.1 + 1,756.4), and the closing stocks to 3,420.0 (1,149.1 + 93.8 + 2,177.1). The difference is caused by volume changes and by revaluations due to market price changes (138.1 + 12.6 + 410.5 = 561.2). The volume changes comprise net capital formation (61.8 + 1.4 + 7.3 + 6.2 − 23.0 − 3.3 = 50.4) and other volume changes (7.0 − 25.3 − 4.1 = − 22.4). Thus, the rise in the value of non-financial assets in the accounting period is caused mainly by increasing prices in this (illustrative) data set.

3. Territorial concepts in the SNA and the SEEA

106. The production and household consumption activities described in the SNA framework refer to the economic territory (United Nations, 1992, chap. XIV). The economic territory of a country consists of the geographical territory, including its airspace, territorial waters and continental shelf, over which the country enjoys exclusive rights or over which it has, or claims to have, jurisdiction with respect to fishing and mineral rights below the seabed. The economic territory also includes territorial enclaves in the rest of the world (used, for instance, for diplomatic or military purposes by the Government concerned) and excludes territorial exclaves of other countries in the geographical territory controlled.

107. The final result of production activities in the economic territory is measured by the net or gross domestic product (NDP or GDP) at market prices. For the sake of simplicity, no distinction is made in the SEEA between net domestic product and net value added. This is not quite correct because NDP includes taxes on imports, value-added taxes and other product taxes, all or some of which are not included in the valuation of output and value added of each industry depending on whether a basic price or producer price concept is applied. The net value added is the difference between output and intermediate consumption plus consumption of fixed capital. The specific size of the difference between NDP and net value added depends on the chosen price concepts. In the SEEA, no special reference is made to differing market price concepts.

108. In an integrated environmental and economic accounting system, the ideal solution would be to describe economic activities and their relations to the natural environment with reference to the geographical territory. Such linkages between national economic and environmental accounting data can normally be realized only if compromises are accepted. The concept of the economic territory used in the national accounts will normally be very similar to the concept of the geographical territory. In this case, it may be acceptable to use the concept of economic

territory in the SEEA in conjunction with the economic territory in the SNA. If the territorial enclaves or exclaves are quite large, it may be advisable to correct the data of the national accounts to achieve compatibility with the environmental data related to the geographical territory.

109. In any case, it would be difficult to separately identify and describe in the SEEA the economic-environmental interrelationships of residents outside the geographical territory or those of non-residents within the geographical territory. The data available can normally be used only for recording the direct impacts of all economic activities on the natural environment of the geographical territory, and do not permit separate recording of the repercussions on all individuals who stay in the territory but are non-residents (for example, tourists, technical assistance personnel and diplomats) and on all those who reside temporarily outside the geographical territory but are residents thereof.

110. The above restriction implies that the SEEA refers to the (modified or unmodified) concept of net (or gross) domestic product, which is generated by national producers located in the geographical territory of the country. Further research is necessary to determine how the concept of net (or gross) national income could be introduced in environmental accounting. The income concept refers to all residents, that is, producers and others. Such an income concept would not only take into account the immediate environmental impacts of production activities taking place within the geographical territory of the country. Indeed, it would make adjustments for environmental impacts incurred as a result of production outside the territory, eliminate environmental impacts of domestic production activities incurred by other countries and add the effects of past environmental impacts of domestic and external production activities currently being incurred by residents of the country.

B. Disaggregation of flow accounts

1. Environment-related defensive activities

111. As described above, the externalities of economic activities may lead to loss of environmental functions. Economic growth has been considered to be connected with an increasing percentage of activities aimed at avoiding the effects of externalities or restoring/repairing negative impacts (Olson, 1977; Leipert, 1989). If those trends continue they may eventually lead to a reorientation of economic activities towards environmental protection. A detailed analysis of economic production activities, of their impacts on the natural environment and of those impacts' environmental repercussions on human health and well-being would require the identification of such activities as purport to defend against a deterioration of the environmental situation and its repercussions on human health and well-being (Leipert, 1991). Such defensive action was described above as involving actual environmental protection and environmental damage costs (section B (2)).

112. The following give an indication of the scope and content of environment-related defensive activities as perceived by some authors (Leipert, 1986; Klaus, 1989):

(a) Preventive environmental protection:

- (i) Changes in the characteristics of goods and services, changes in consumption patterns;
- (ii) Changes in production techniques;
- (iii) Treatment or disposal of residuals in separate environmental protection facilities;
- (iv) Recycling;
- (v) Prevention of degradation of landscape and ecosystems;

(b) Environmental restoration (reactive environmental protection):

- (i) Reduction or neutralization of residuals;
- (ii) Changes in spatial distribution of residuals, support of environmental assimilation;
- (iii) Restoration of ecosystems, landscape and so on (if not mentioned elsewhere);

(c) Avoidance of damages from repercussions of environmental deterioration:

- (i) Evasion activities;
- (ii) Screening activities;

(d) Treatment of damages caused by environmental repercussions:

- (i) Repairs of buildings, production facilities, historical monuments and so on;
- (ii) Additional cleaning activities;
- (iii) Additional health services;
- (iv) Other compensatory activities.

113. The uncertainties of the impacts of the economy on the natural environment and the risks of the irreversibilities of natural deterioration call for anticipatory or preventive action (World Commission on Environment and Development, 1987). Restructuring of production activities and changes in consumption patterns oriented towards better environmental compatibility are listed above as examples of preventive action. Residuals of economic activities like wastes, waste water and air pollution could be prevented from reaching the environment or could at least reach it in a less harmful form by recycling or treatment in environmental protection facilities. In so far as the natural environment cannot be protected against economic impacts, restoration activities that relieve the burden on nature caused by economic activities could be undertaken To the extent that the negative impacts of the economy on the environment cannot be avoided or restored, the economic or physiological use of the deteriorated (polluted) environment could cause damage or welfare losses for the users themselves (for example, through diseases). Activities of avoiding these damages are evasion (for example, change in permanent residence) or screening (for example, installation of special windows for noise abatement). To the extent that damages cannot be avoided, damage treatment such as repair, cleaning and use of health services may become necessary.

114. Figure IV presents different environment-related defensive activities in a simplified flow diagram. In so far as integrated prevention activities (1) cannot prevent the emission of residuals, separate prevention techniques (2) could be used. Remaining treated or untreated residuals affect the natural environment. This influence can be diminished by restoration activities (3) or by internal natural processes (assimilation) (4). If those activities cannot prevent a decrease in environmental quality, negative repercussions on economic activities, especially on consumption activities, may occur. Those repercussions could be avoided at least in part by evasion or screening activities (5). The remaining impacts (6) can cause damages that could be addressed by treatment activities (7).

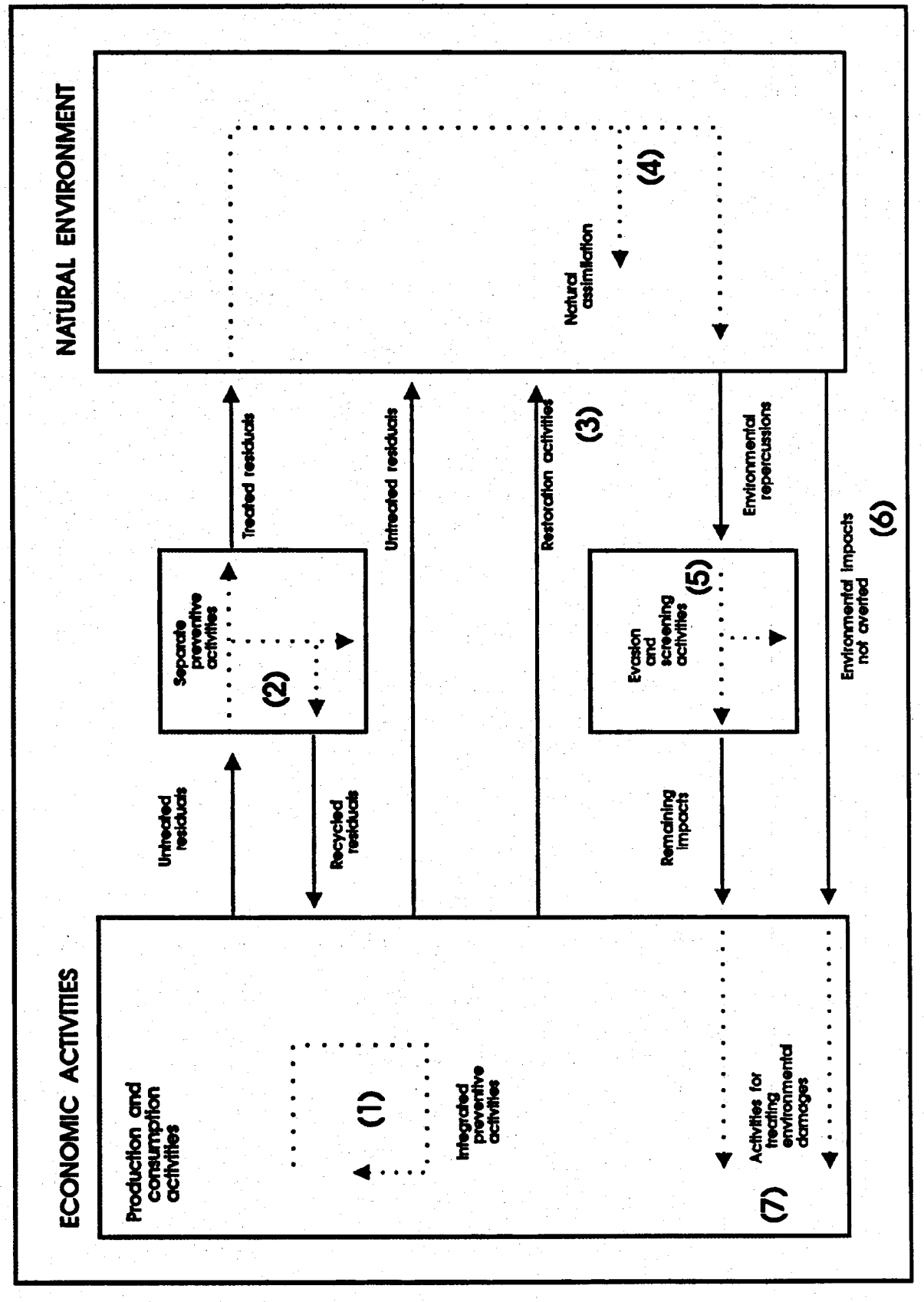
115. Prevention and restoration activities are called environmental protection activities in the SEEA. Normally it will be impossible to identify the whole range of those activities. In many cases, the existence of prevention activities can be determined only if special environmental protection facilities can be identified. However, while environmental protection efforts usually start with separate protection activities, at a later stage those activities are replaced by integrated environmental protection activities that often require lower protection costs. Thus, a diminution in the number of separate protection activities could be a misleading indicator for the degree of environmental protection. In that case, data on the trend of emissions of pollutants caused by economic activities can be used as an indirect measure of the success of separate and integrated environmental protection efforts.

116. The costs incurred when negative environmental impacts are not avoided by damage treatment carried out by households and industries are identified in versions II and V of the SEEA as environmental repercussion costs. In many cases, however, estimating that part of the damage costs caused by environmental impacts is problematic. Health damages, for example, are often caused by a combination of environmental and non-environmental factors (genetic, psychosomatic etc.). In the following subsection, special attention is given to environmental protection activities. Version II of the SEEA matrix, described in subsection B (3) below, will deal with both the costs of environmental protection activities and those due to dealing with environmental repercussions (consequential damages).

2. Environmental protection activities

117. The present subsection deals with the disaggregation of the flow and asset accounts of the SNA in order to identify the monetary data connected with environmental protection services (see also Uno, 1991a). This disaggregation refers to production activities and products of different industries, to capital formation and to the stocks of produced assets produced or used for environmental protection purposes. Annex C presents a draft classification of environmental protection activities (CEPA). CEPA was developed on the basis of the Draft Economic Commission for Europe (ECE) Standard Statistical Classification of Environmental Protection Facilities and Expenditures (United Nations, Economic Commission for Europe, 1992a) and of the classification of characteristic activities of the European System for the Collection of Economic Information on the Environment (SERIEE) Statistical Office of the European

Figure IV. Environment-related defensive activities



Communities (EUROSTAT, 1991). The draft CEPA thus reflects mainly the environmental conditions and priorities of industrialized countries. Further review and discussion involving developing countries are needed before recommending the CEPA's general application in environmental accounting. However, individual country studies might find the draft CEPA useful as a starting-point in classifying environmental protection activities and expenditures.

118. Environmental protection activities by industries can represent three different types of production activities:

(a) Main production activities. Environmental protection activities can be the main production of establishments or establishment-type units. Such activities can comprise the supply of goods (recycling) or of services. These goods and services are marketed or non-marketed products of environmental protection, delivered to other establishments (inter-establishment flows of the same enterprise). Such activities are called external environmental protection activities. They are identified as specific production activities in separate columns of the SEEA matrix, version II (see below). A broad classification of these activities is included in ISIC, Rev. 3 (United Nations, 1990). Recycling activities are recorded as constituting a separate two-digit category (ISIC 37). Environmental protection services are included in ISIC division 90, entitled "Sewage and refuse disposal, sanitation and similar activities". That division could be further subdivided as follows, using the main categories of CEPA:

90.1	Protection of ambient air and climate
90.2	Protection of ambient water (excluding groundwater)
90.3	Prevention, collection, transport, treatment and disposal of wastes
90.4	Protection of soil and groundwater
90.5	Noise abatement
90.6	Other environmental protection services not elsewhere classified (n.e.c.)
90.7	Sanitation and similar services

Division 90 of the ISIC should include environmental protection activities 1.1, 1.2, 1.3, 5 and 6 of CEPA (annex C). Other environmental protection activities are included partly in ISIC, Rev. 3, division 73 (research and development), and partly in ISIC, Rev. 3, division 75 (public administration and defence: compulsory social security). Further considerations are necessary to obtain a complete breakdown of all ISIC divisions with respect to environmental protection activities. Furthermore, an additional disaggregation of ISIC, Rev. 3, division 90, could be considered. In addition to the ISIC breakdown, a distinction may be introduced between environmental protection activities carried out by central, state and local Governments, private non-profit institutions and private

enterprises. Also, the distinction between marketed or non-marketed production is significant with respect to applying different valuation concepts (cost versus market values);

(b) Secondary activities. Environmental protection activities can also be carried out as secondary activities of establishments or establishment-type units. In this case, the output of those activities that are marketed or non-marketed products are delivered to other establishments. The outputs represent external environmental protection products that are produced as secondary output. These environmental protection activities are allocated as secondary production to the industry to which the respective establishments belong according to their main production. In this case, the inputs of environmental protection activities are not separated, whereas their output is shown explicitly;

(c) Ancillary activities. Environmental protection activities can also be ancillary activities of establishments or establishment-type units. In this case, environmental protection activities serve only the internal purposes of the establishment in question. They are therefore called internal environmental protection activities.

119. In order to assess the full impact of environmental policies, be it through regulation or market (dis)incentives, environmental protection activities need to be fully identified irrespective of their internal or external character. Obviously internal activities are more difficult to measure, and possibilities of their coverage in integrated accounting deserve further discussion. Ancillary activities are recorded in national accounts only with their inputs (intermediate consumption, consumption of fixed capital, compensation of employees): They have no output. The services of ancillary activities support the production of the main (or secondary) product of the respective industries. Normally, ancillary activities are only services. But exceptions are possible: Recycling of goods for own use (reuse) should be recorded as an ancillary environmental protection activity.

120. In the SNA, ancillary activities are not separated from the main activities of the respective establishments. A separation of environmental protection expenditures, however, could be carried out on the basis of a functional classification of expenditures as discussed in a separate SNA chapter (United Nations, 1992, chap. XVIII) on functional analysis that contains a description of functional classifications of expenditures for government, households, non-profit institutions and market producers. The Classification by Purpose of Selected Outlays of Market Producers (COMPP) contains an item called "Outlays on pollution abatement and control". That Classification was based on a proposal made in 1975 for a breakdown of the inputs of industries by purpose (United Nations, Economic Commission for Europe, 1975).

121. In the case of ancillary environmental protection activities, version II of the SEEA (tables 2.3 and 2.4) disaggregates the inputs of the respective establishments and shows the inputs of the different environmental protection services in special columns that are close to those of the respective main activities. As already mentioned, only inputs are shown; outputs of ancillary activities remain zero even after their separate presentation. The value of inputs is balanced by

a negative operating surplus. In version V of the SEEA (chap. V), the internal protection services are externalized and shown as separate production activities that deliver their (gross) output to the establishment they belong to.

122. Ancillary environmental protection activities could be identified by cross-classifying the units carrying out those activities by the ISIC category of their main activities and the ISIC category related to environmental protection activities (in which the proposed breakdown of ISIC 90 derives from CEPA). Additionally, recycling activities could be taken into account in the latter breakdown. The resulting cross-classification is presented below. It includes two elements that are distinguished by using an oblique stroke: a two-digit division number of ISIC, characterizing the main (or secondary) activity, and the number for the ISIC classification of ancillary activities carried out by the units. For example, treatment of waste water under industry "Manufacture of textiles" would obtain the code 17/3.

ISIC../1	Main production (including all inputs for the ancillary activities except of environmental protection activities
ISIC../2	Protection ambient air and climate
ISIC../3	Protection of ambient water (excluding groundwater)
ISIC../4	Prevention, collection, transport, treatment and disposal of wastes
ISIC../5	Protection of soil and groundwater
ISIC../6	Noise abatement
ISIC../7	Other environment protection services

123. As already mentioned, the product classification applied in the SNA is the CPC. The output of recycling activities (ISIC 37) are products of different CPC divisions, and the outputs of environmental protection services (ISIC 90) belong mainly to CPC division 94, entitled "Sewage and refuse disposal, sanitation and other environmental protection services". In the CPC, this division is subdivided into:

9401	Sewage services
9402	Refuse disposal services
9403	Sanitation and similar services
9404	Cleaning services of exhaust gases
9405	Noise abatement services
9406	Nature and landscape protection services
9409	Other environmental protection services n.e.c.

124. In the SEEA, version II, the products of external environmental protection activities (ISIC 37 or 90) are part of the domestic gross output of industries produced as main or secondary production. If those products are delivered by the rest of the world, they are part of imports. The CPC extended in further detail with respect to environmental protection services can be applied to the classification of gross output and imports as well as to the classification of uses

of external environmental protection services (including recycling) in intermediate consumption and final consumption of households or exports.

125. If households do not buy complete environmental protection services as final products but only purchase the materials for producing such services themselves, it might be necessary to subdivide individual consumption into two separate items: one showing expenditures for own production of environmental protection services together with external environmental protection services bought, and the other representing remaining individual consumption. In this context, the Classification of Individual Consumption by Purpose (COICOP) (United Nations, 1992, chap. XVIII) could be applied additionally.

126. Collective consumption also includes environmental protection services of the government. Those services could be shown separately by using the Classification of the Functions of Government (COFOG) (United Nations, 1980; United Nations, 1992). The relevant classification item is mainly COFOG 07.3: Sanitary affairs and services including pollution abatement and control. A more comprehensive description, in a revised COFOG, of the environmental protection activities of the government is planned.

127. Regarding fixed capital formation, the SNA distinguishes capital goods and industries using capital goods. If ISIC production activities are disaggregated with regard to environmental protection activities, it seems useful to disaggregate fixed capital formation in the same way, as proposed below in the SEEA, version II. The extended ISIC classifications for environmental protection activities could be applied. Such further breakdown of fixed capital formation could serve as one data basis among others for estimating the value of fixed assets employed for environmental protection and the consumption of fixed capital corresponding to those assets.

3. Accounting for environmental protection and related activities (SEEA, version II)

128. Version II of the SEEA matrix is presented in table 2.3 (general concepts) and table 2.4 (numerical example). The tables are derived from version I through disaggregation and explicit recording of the monetary data connected with environment-related activities. The concepts applied correspond to the conventional SNA concepts (see also section A above).

129. The domestic production of industries (columns 1-4) is subdivided into production activities producing environmental protection services (including recycling) as main (or secondary) production (column 1) and as ancillary activity for their own use (columns 2 and 3), and main (or secondary) production activities not related to environmental protection (column 4). When industries react to the repercussions stemming from a deteriorated natural environment, namely, in the case of diseconomies generated by activities of other producers and consumption activities, the so-called repercussion costs incurred to respond to these external impacts are recorded separately in the table (column 3) from the costs of internal environmental protection activities (column 2). In practice, this separation may be difficult to make, as data may not be available in such detail.

130. The value of the gross output of external environmental protection services as main production is shown as part of the gross output matrix by product and industry (table 2.3: row 11, column 1; in table 2.4: 36.2). In the numerical example, it is assumed that the establishments included in industries producing external environmental protection services do not produce secondary products (table 2.4, row 12, column 1: 0.0). Furthermore, it is assumed in the numerical example that external environmental protection services are not produced as secondary production of other industries (table 2.4, row 11, column 4: 0.0). Thus, the total value of external environmental protection activities is identical to the total gross output of the industries producing them as main production (36.2).

131. The total value of the inputs of internal environmental protection activities are counterbalanced by a negative operating surplus (table 2.4, column 2: 31.7). The same procedure has been applied for environmental repercussion costs incurred to respond to environmental impacts caused by other industries (table 2.4, column 3: 19.6). The explicit recording of the costs of internal environmental protection services and the repercussion costs of industries correspondingly reduces the input data under other production (column 4). Aggregation of the input data of other industries by row (columns 2-4) leads to the generation of the original input values for those industries. It has to be stressed that such a subdivision of the inputs of industries by purpose could be realized not only for the total of all other industries (as shown in tables 2.3 and 2.4) but also for specific industries (for instance in a breakdown by two-digit ISIC numbers).

132. External environmental protection services are used as intermediate inputs of industries (table 2.4, row 2, column 4: 22.4), and for purposes of individual consumption (column 5: 8.8) and of collective consumption (column 8: 5.0). The numerical example assumes that the collective consumption of environmental protection services reflects the output value of environmental restoration activities. Foreign trade in environmental protection services is explicitly recorded (imports in row 4; exports in row 2, column 14). In the numerical example, both exports and imports have zero values.

133. Individual consumption is shown in a breakdown by three elements (columns 5-7): consumption of environmental protection services, consumption expenditures resulting from environmental repercussions, and consumption for other purposes. In the numerical example, it has been assumed that the environmental protection activities of households consists only of services bought (table 2.4, row 2, column 5: 8.8). Households do not produce environmental services themselves; thus, no additional inputs of other products are shown (rows 3 and 5, column 5: 0.0). Expenditures of households with respect to environmental repercussions could comprise, for instance, health expenditures or cleaning costs (rows 3 and 5, column 6: 11.9 + 0.8).

134. The accounts of man-made assets of industries (tables 2.3 and 2.4: columns 9-11) are subdivided by their use for environmental protection purposes. Thus, the disaggregation of man-made assets corresponds to the subdivision of the production activities of industries (tables 2.3 and 2.4: columns 1, 2 and 4).

Table 2.3 SEEA matrix with environment-related activities (version II): general concepts

		1.1 Domestic production of industries				2 Final consumption				3 Non-financial assets (uses and stocks of assets)					4 Ex-ports	5 Total uses
		External environmental protection services (including recycling) ISIC 37, 90	Other industries ISIC 01-36, 40-85, 91-99			2.1 Individual consumption			2.2 Collective consumption	3.1.1 Produced assets of industries				3.2 Non-produced natural assets		
										3.1.1.1 Man-made			3.1.1.2 Natural			
			Internal environmental protection	Environmental repercussions	Other production	Environmental protection	Environmental repercussions	Other consumption		External environmental protection services	Other industries: Internal environmental protection	Other industries: Other purposes				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									A	A	A	A	A		
	Use of products of industries (2.1)															
	Domestic origin (2.1.1)															
2	External environmental protection services (including recycling)	A	A		A	A			A						A	A
3	Other products	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Imports (2.1.2)															
4	External environmental protection services (including recycling)	A	A	A	A	A										A
5	Other products	A	A	A	A	A	A	A		A	A	A	A		A	A
6	**Use of produced fixed assets of industries (3.3.1)**	A (+)	A (+)	A (+	A (+)					A (-)	A (-)	A (-)	A (-)			
	Net value added/NDP (4.2.2)															
7	Net taxes on production (4.2.2.1)	A	A	A	A											
8	Compensation of employees (4.2.2.2)	A	A	A	A											
9	Net operating surplus (4.2.2.3)	A (+,-)	A (-)	A (-)	A (+,-)											
10	**Gross output of industries (5.1)**	A			A											
11	External environmental protection services	A			A											
12	Other products	A			A											
13	**Other volume changes (6)**									A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)		
14	**Revaluation due to market price changes (7)**									A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)		
15	**Closing stocks (8)**									A	A	A	A	A		

Note: A-matrices denote monetary data (market values).

Table 2.4 SEEA matrix with environment-related activities (version II): numerical example

(Monetary units)

		1.1 Domestic production of industries				2 Final consumption				3 Non-financial assets (uses and stocks of assets)					4 Exports	5 Total uses
			Other industries ISIC 01-36, 40-85, 91-99			2.1 Individual consumption			2.2 Collective consumption	3.1.1 Produced assets of industries				3.2 Non-produced natural assets		
										3.1.1.1 Man-made			3.1.1.2 Natural			
		External environmental protection services (including recycling) ISIC 37,90	Internal environmental protection	Environmental repercussions	Other production	Environmental protection	Environmental repercussions	Other consumption		External environmental protection services	Other industries: Internal environmental protection	Other industries: Other purposes				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									20.8	75.3	895.2	83.1	1756.4		
	Use of products of industries (2.1)															
	Domestic origin (2.1.1)															
2	External environmental protection services (including recycling)	0.0	0.0		22.4	8.8			5.0						0.0	36.2
3	Other products	13.8	17.7	13.4	116.8	0.0	11.9	128.0	37.5	0.7	2.1	59.0	1.4	7.3	71.6	481.2
	Imports (2.1.2)															
4	External environmental protection services (including recycling)	0.0	0.0		0.0	0.0										0.0
5	Other products	2.1	0.2	2.0	35.6	0.0	0.8	25.5		0.0	0.3	5.9	0.0		2.1	74.5
6	**Use of produced fixed assets of industries (3.3.1)**	1.3	4.8	2.5	17.7					-1.3	-4.8	-16.9	-3.3			
	Net value added/NDP (4.2.2)															
7	Net taxes on production (4.2.2.1)	2.0	0.3	0.0	34.1											
8	Compensation of employees (4.2.	13.0	8.7	1.7	70.3											
9	Net operating surplus (4.2.2.3)	4.0	-31.7	-19.6	184.3											
10	**Gross output of industries (5.1)**	36.2			481.2											
11	External environmental protection services	36.2			0.0											
12	Other products	0.0			481.2											
13	**Other volume changes (6)**									-0.8	-0.5	-24.0	0.0	2.9		
14	**Revaluation due to market price changes (7)**									3.0	5.8	129.3	12.6	410.5		
15	**Closing stocks (8)**									22.4	78.2	1048.5	93.8	2177.1		

4. Actual environmental costs

135. The actual expenditures connected with environment-related activities are called actual environmental costs. They comprise environmental protection costs and repercussion costs. Environmental protection costs can be subdivided into avoidance (prevention) costs and restoration costs, and repercussion costs into avoidance and (damage) treatment costs. Those cost items correspond to the different environment-related activities described above, namely defensive activities (section B (1) and environmental protection activities (section B (2)).

136. Actual environmental costs do not include the gross capital formation of environmental protection facilities (table 2.3, rows 3 and 5, columns 9 and 10) and of produced assets used for damage avoidance or treatment activities: only the economic depreciation of those assets is included (tables 2.3 and 2.4, row 6, columns 1, 2 and 3). Environmental expenditures, on the other hand, usually include capital formation (capital expenditures) and running (operational or current) costs (for example, INSEE 1986a).

137. In table 2.5, actual environmental costs are subdivided by type of costs and by activity incurring those costs. The data can be derived from table 2.4. The total actual environmental costs of production amount to 78.7; those of household consumption to 21.5.

138. In version IV of the SEEA (chap. IV), actual environmental costs are further disaggregated. All actual environmental costs are *borne* by the units that are financing the costs of environment-related activities. Those units have not necessarily *caused* the environmental problems connected with their efforts at prevention or restoration and whose repercussions (consequential damages) they try to avoid or mitigate (Bartelmus and van Tongeren, forthcoming). For instance, households could bear the costs of environmental repercussions (damages) caused by the production activities of industries. Furthermore, the government could restore the natural environment degraded by other economic activities (negative repercussion costs).

C. Disaggregation of non-financial asset accounts

139. In the revised SNA, the asset and flow accounts are presented in an integrated accounting framework (United Nations, 1992: the asset accounts are described in chapter XIII, and the changes of assets during the accounting period, in chapters X and XII). There are earlier descriptions of the concepts of asset accounts (United Nations, 1977b, 1979).

140. The environment-related parts of the SNA non-financial asset accounts are shown in the SEEA in a more disaggregated version. Other, non-environment-related parts of those accounts are recorded only on a highly aggregated level. The integration of the non-financial asset accounts into the SEEA matrix was described above in section A. More detailed information is given below on the classifications of the SNA asset accounts in the SEEA (sections C (1) and

Table 2.5. Actual environmental costs: numerical example
(Monetary units)

Costs	Production activities	Household consumption activities	Total
External environmental protection	27.4	8.8	36.2
Prevention	22.4	8.8	31.2
Restoration	5.0		5.0
Internal environmental protection	31.7		31.7
Prevention	31.7		31.7
Restoration	0		0
Environmental repercussions	19.6	12.7	32.3
Total	78.7	21.5	100.2

C (2)). On the valuation methods applied, see section C (3). Furthermore, the SNA non-financial asset accounts in the SEEA are presented in a detailed scheme that also represents a part of the SEEA matrix, version II (section C (4)). The general concepts of this scheme are shown in table 2.6, and a numerical example based on the figures used throughout the handbook is given in table 2.7.

1. Classification of non-financial assets in the SEEA

141. A draft classification of non-financial assets (CNFA), proposed for use in the SEEA, appears in annex D. The CNFA is derived from the corresponding classification of the revised SNA (United Nations, 1992, annex IV, part I: Classifications). The main purpose of the special SEEA asset classification is to describe the classification of natural assets in greater detail. The CNFA is used throughout this handbook.

142. Listed below in the text box are those assets that are explicitly shown in the column classification of the SEEA matrix. The column classification code is entered in parentheses and the corresponding SNA code has been identified wherever feasible.

143. The SNA classification (AN) has been modified to identify explicitly those parts of the classification that refer to natural assets. Thus, the produced assets (CNFA 1) are subdivided into man-made assets (CNFA 1.1) and cultivated assets (CNFA 1.2); the non-produced natural assets (CNFA 2) are subdivided into non-produced natural assets (CNFA 2.1) and intangible non-produced assets (CNFA 2.2), and a breakdown of land is introduced to identify soil explicitly.

144. In addition to natural assets, man-made produced assets (CNFA 1.1) are identified separately in the SEEA classification, as the handbook also deals explicitly with environmental impacts on produced man-made assets such as buildings, roads and dams, and is also concerned with the environmental deterioration caused by those man-made produced assets such as land, water and air. Intangible assets are included only for completeness' sake, that is to say, intangible produced assets such as computer software and mineral exploration are included with man-made assets, and intangible non-produced assets such as patents, leases and the like have been presented as a separate asset category. They are not dealt with in the handbook tables, however. Moreover, financial assets are outside the scope of the handbook.

145. Consumer durables are introduced into the asset accounts of the SNA only as a memorandum item, and they also are not treated as an integral part of CFNA in the SEEA. However, they are included in several of the tables as constituting part of a comprehensive description of the physical accounts of the SEEA and as a basis for estimating the residuals generated when they are discarded. In the SEEA accounts presented in monetary terms, the stock of consumer durables is given a monetary value only when an extended concept of production activities of households is being introduced (version V, chap. V).

CNFA		SNA
1	Produced assets (3.1)	AN.1
1.1	Man-made assets (3.1.1.1)	AN.111 (excluding AN.1114, AN.1221)
Memorandum item:	Consumer durables (3.1.2)	AN.m
1.2	Cultivated assets, including work in progress (living biota) (3.1.1.2)	AN.1114, AN.1221
2	Non-produced assets (3.2)	AN.2
2.1	Non-produced natural assets	AN.21
2.1.1	Wild biota (3.2.1)	AN.213
2.1.2	Subsoil assets (proved reserves) (3.2.2)	AN.212
2.1.3	Land (with ecosystems and soil) (3.2.3, 3.2.5)	AN.211
2.1.3.1	Soil (3.2.5.1)	
2.1.3.2	Land under cultivation (including corresponding ecosystems) (3.2.5.2)	AN.211
2.1.4	Water (3.2.3)	AN.214
2.1.5	Air (3.2.4)	
2.2	Intangible non-produced assets (leases, goodwill, etc.)	AN.22

146. A detailed classification of biological and other non-produced natural assets in the CNFA may be further developed on the basis of the categories of the CPC (United Nations, 1991b). It should be emphasized, however, that the CNFA and the CPC are different, particularly with regard to biological and other non-produced natural assets, as the CPC deals only with products that are *produced* by human activities and not with non-produced minerals and non-cultivated biological assets such as wild animals and plants.

147. The distinction between produced and non-produced biological assets (CNFA 1.2 and 2.1.1) has already been mentioned. According to the SNA, the natural growth of biota in agriculture, forestry and fishery is treated as production if human cultivation is involved. Natural growth of non-cultivated biota is treated as other volume changes in assets which are not taken into account in the calculation of GDP. There are many borderline cases that are particularly relevant for the SEEA. Animals in cultivated forests, for example, are treated as wild non-produced biota, while fish in fish-ponds are treated as produced biological assets. Furthermore, it often seems difficult to distinguish between cultivated and non-cultivated forests. There are

different degrees of economic influence on forests, which may complicate the distinction between cultivated and non-cultivated ones. Further conventions on these borderline cases need to be developed for the purposes of environmental accounting.

148. The classification of land with regard to land use (CNFA 2.1.3) is derived from the ECE Standard Statistical Classification of Land Use (see United Nations, Economic Commission for Europe, 1989a). Soil (CNFA 2.1.3.1) is added as a classification item in the SEEA even though no monetary data on stocks can be recorded. The use of soils is different from that, for example, of sand and stone (CNFA 2.1.2.3.1) extracted by the mining industry. Soil is shown, therefore, in connection with land, not mineral resources. Furthermore, the different land areas are classified in the SEEA with the terrestrial and aquatic ecosystems connected with them, that is, as ecozones (see INSEE, 1986b; Weber, forthcoming). From an ecological point of view, a separation of land and water from their associated ecosystems is not suitable. Possible consequences of double counting in physical accounting seem to be acceptable because the physical parts of nature are shown in a different context. In monetary accounting, however, double counting should be avoided because the valuation of natural assets may refer to different functions of the same asset that are mutually exclusive.

149. The distinction between cultivated and other types of land could also be difficult, requiring further conventions. In the case of forests and other wooded land, the distinction between cultivated and non-cultivated forest land should be made compatible with the distinction between forests as produced and as non-produced biological assets. Further considerations are necessary in the case of recreational land. Following the recommendations of the ECE Standard Statistical Classification of Land Use, only those areas are classified as recreational land that have been developed especially for recreational purposes (for example, sport fields, public parks, public beaches and camping sites). National parks should be classified as uncultivated land because the protection and not the economic use of these areas could be considered their main function.

150. The breakdown of subsoil assets in the CNFA corresponds to the divisions of the CPC. A more detailed classification could be derived from further breakdowns of the CPC. Furthermore, subsoil assets may be subdivided with respect to whether or not they are already economically developed. Developed subsoil assets are those proved reserves "that can be recovered through existing wells and facilities and by existing operating methods" (Martinez and others, 1987, p. 7). From an economic point of view, the distinction between developed and non-developed subsoil assets is important because the exploitation costs of developed subsoil resources differ considerably from the costs of those that have not yet been developed. From an ecological point of view, this distinction indicates the degree to which the natural environment has already been prepared for potential exploitation.

151. Water is registered both as an item of land classification, referring to water areas square kilometres (km^2) and separately in terms of water quantities cubic metres (m^3).

152. Air is introduced as an asset even though no monetary value can be applied to it. This classification item is therefore used in physical accounting only (version III, chap. III) and in estimating imputed environmental costs of using air as a receptor of residuals (versions IV and V of the SEEA).

2. Classification of other volume changes of non-financial assets in the SEEA

153. A comprehensive description of other volume changes of assets that are not taken into account in the calculation of GDP in the SNA, but are included in the non-financial asset accounts of the SNA, is given in chapter XII (Other changes in asset accounts) of the revised SNA. The SNA Classification of other volume changes is included as part of classification K, entitled "Other accumulation entries", which is presented in the *Revised System of National Accounts*, chapter XIII, annex, table XIII.2. This classification has been used to develop a Classification of other volume changes (COVC) of non-financial assets for versions II and III of the SEEA (annex E). In the SEEA, versions IV and V, the other volume changes of non-produced assets due to economic decisions (COVC 1) are treated as reflecting a concept of capital accumulation of non-produced natural assets. The introduction of the capital accumulation concept and the corresponding modification of the COVC in the SEEA aim at a more comprehensive and detailed description of the volume changes of natural assets due to economic decisions.

154. The following are the major categories of the proposed COVC, presented in detail in annex E.

COVC (SEEA)		SNA
1.	Other volume changes of non-produced natural assets due to economic decisions (6.1)	
1.1	Other volume changes of non-produced natural assets due to economic use (6.1.1)	K.61, K3-part, K62-part
1.2	Other volume changes of non-produced natural assets due to other economic decisions (6.1.2)	K3-part, K62-part, K12.22-part
2.	Other volume changes of non-financial assets due to natural and multiple causes, n.e.c.	K5, K7, K2, K8, K4, K9, K12-part

155. Other volume changes of non-financial assets are subdivided in the COVC into those of non-produced natural assets due to economic decisions (COVC 1) and those of produced and non-produced assets due to natural and multiple causes n.e.c. (COVC 2). This distinction involves the assumption that it is possible to identify the specific causes of volume changes. If causes cannot be determined (and this may often be the case), the volume changes can only be associated with classification item 2.3 (other volume changes n.e.c.) and thus remain outside capital accumulation.

156. Volume changes of non-produced natural assets due to economic decisions consist of those due to economic use (COVC 1.1) and those due to other accumulation (COVC 1.2).

Volume changes of non-produced natural assets due to economic use are of special importance in the SEEA because they reflect the impacts of economic activities on the natural environment. In so far as the use of nature by economic activities is connected with environmental deterioration, the SEEA (in version IV) imputes environmental costs corresponding to a decrease in the volume of natural assets. Thus environmental deterioration is treated in a manner similar to that of decreases in the volume of produced assets due to their use in production, which are normally reflected in the production and capital accounts of the SNA as a decrease in inventory or consumption of fixed capital (use of produced fixed assets).

157. Volume changes of non-produced natural assets due to economic use (COVC 1.1) can be further disaggregated by type of economic use (quantitative or qualitative) and by economic impacts on natural assets as follows:

(a) Depletion of non-produced natural assets. The depletion of non-produced natural assets (COVC 1.1.1) reflects the quantitative use of wild biota, subsoil assets and water;

(b) Land quality changes due to changes in land use. The changes in land quality due to changes in land use (COVC 1.1.2) involve the immediate impacts on land quality (for example, on existing ecosystems) of economic activities connected with change in land use and corresponding infrastructure development. The expenditures for land improvement are already recorded as part of gross capital formation (see United Nations, 1992, chap. X). Thus, the market value of changes in land quality, recorded as other volume changes, can only reflect the difference between the value of land improvement and the change in the market value of land due to the corresponding quality change. From an ecological point of view, land improvement often occurs in parallel with the destruction of ecosystems and landscape, which is valued negatively (see version IV of the SEEA);

(c) Land quality changes due to land use practices and pollution. The degradation of land quality due to recurrent (improper) land use practices and pollution (COVC 1.1.3 and part of 1.1.4) comprises decrease in soil quality (COVC 1.1.3.1) from salination, water logging or nutrient losses, diminishing value of land due to soil erosion (COVC 1.1.3.2) and changes in soil quality due to contamination with residuals (part of COVC 1.1.4);

(d) Changes in quality of other natural assets. The changes in quality of non-produced natural assets caused by the discharge of residuals into the natural environment are recorded as a separate item (COVC 1.1.4) because those changes in quality are of special importance in environmental accounting.

158. Increase in the value of non-produced natural assets as a result of the restoration of the natural environment (COVC 1.1.5), for instance by reconstructing destroyed ecosystems, has similarities to land improvement as treated in the SNA (as gross capital formation). However, the aims of land improvement activities and those of restoration activities are usually quite

different. Land improvement activities are undertaken to increase the economic productivity of land; restoration activities, on the other hand, often decrease economic efficiency. Thus, the impacts of land improvement activities on the market value of land will normally be positive, whereas restoration activities could lead to a decrease of market values. From an ecological point of view, the valuation of land improvement might be negative, while land restoration might generate positive values.

159. Volume changes of non-produced natural assets due to other economic decisions (COVC 1.2) comprise volume changes connected with the appearance or disappearance of natural assets as assets used in economic activities. These volume changes, which are included as part of capital accumulation, do not involve any physical changes in the assets due to the impacts of economic activities. They include:

(a) Discoveries and related accumulation estimates. Volume changes that imply changes in the totals of the natural assets accounted for (COVC 1.2) are discoveries of natural resources (COVC 1.2.1.1) and new estimates due to changed technical and economic preconditions for exploiting natural resources, or to new estimation methods (COVC 1.2.1.2). Since the costs of exploration of subsoil assets are already recorded as gross capital formation, volume changes due to new finds have to be reduced by the same amount. Also included in this category is the conversion of land areas covered with virgin forests to agricultural or urban land;

(b) Reclassification. Volume changes of natural assets connected only with the shift in a certain volume from one classification item to another, without a modification in volume totals for the specific asset (COVC 1.2.2), occur as a second type of volume change due to other economic decisions. An example of this is the change in land use. In this case, the value of the land area is shifted from its original use to a new type of use at its former value. The increase (or decrease) in land value connected with the new type of use is not recorded in this category, but treated, as already mentioned, as a change in land quality due to changes in economic use (COVC 1.1). In so far as the new type of economic use involves a recurrent degradation in land quality, the change in quality is described under a third item (COVC 1.1.3).

160. Other volume changes of non-financial assets due to natural and multiple causes (COVC 2) comprise all volume changes that cannot be clearly associated with economic decisions. The net natural growth of non-produced biological assets (COVC 2.1) and the catastrophic losses due to technological, natural and political events (COVC 2.2) are recorded explicitly here. Also included in this category are catastrophic losses due to technological accidents (COVC 2.2.2), such as the Chernobyl nuclear reactor disaster, oil spills and other industrial accidents (Bhopal). They are not part of capital accumulation, as they are not based on economic decisions.

161. Other volume changes n.e.c. (COVC 2.3) comprise all other volume changes of non-financial assets. This item contains the acquisitions less disposals of non-produced non-financial assets (K.2), economic appearance of produced assets (K.4), uncompensated seizures (K.8), other volume changes in non-financial assets and liabilities n.e.c. (K.10) and a part of the changes in classifications and structure (part of K.12).

162. COVC also contains information on the direction of volume changes: (−) denotes a decrease, and (+) an increase, and (+, −) indicates that both increases and decreases are possible. In changes in classification (COVC 1.2.2), the total volume of assets remains unchanged but the volume of the specific type of asset affected by the reclassification does of course change. The row classification of the SEEA matrix (CR) is recorded in parentheses for the main items of the COVC in annex E.

3. Market valuation of non-financial assets

163. A detailed description of the different valuation methods for non-financial assets, which is partly based on the *Provisional International Guidelines on the National and Sectoral Balance-Sheet and Reconciliation Accounts of the System of National Accounts* (United Nations, 1977b), is given in the SNA (United Nations, 1992, chap. XIII). Based on those *Guidelines*, three main approaches can be distinguished for the market valuation of stocks of natural assets (Hartwick, 1990, 1991, forthcoming; Levin, forthcoming; Rymes, forthcoming), involving respectively:

(a) Actual market prices of natural assets. This type of market valuation can be applied if market transactions involving the type of assets concerned are representative enough for their prices to be used for valuing the whole stock of assets. The use of actual market prices applies especially to land transactions. In most cases, other natural assets are traded very infrequently, or not at all;

(b) Present (discounted) value of expected net proceeds. Net proceeds are defined as the net operating surplus that could be associated with the use of natural assets, diminished by a normal operating profit that could have been earned if the funds invested in the use of the assets concerned had been used for alternative activities carrying a similar degree of risk (OECD, 1986, p. 6). This concept is very similar to that of economic rent of natural assets. In the case of depletable natural resources, net proceeds have also been referred to as net prices (see below). The present value of expected net proceeds can be calculated by estimating the future net proceeds and discounting these income flows by a discount rate that reflects the risk of future earnings and the preferences for present versus future income flows;

(c) Net prices multiplied by the relevant quantity of the stock of natural assets. This valuation method has been applied in the case of depletable natural assets (Repetto and others, 1989; Solórzano and others, 1991). In this case, the net price (net proceeds) of the asset is the actual market price of the depleted raw material minus actual exploitation

costs including a normal rate of return of the invested produced capital. The net price is then multiplied by the total quantity of depletable stock of the corresponding natural asset. This stock comprises only the proved reserves that are exploitable under present economic conditions and thus have a positive net price. The net price method could be applied in the cases of wild biota, subsoil assets and water as long as these natural assets are considered economically exploitable ones. It can be shown that the net price method leads to the same results as the present valuation method if the natural assets are used in an economy with long-run competitive market equilibrium (Landefeld and Hines, 1985, p. 14).

164. The advantage of the first and third method is the possibility of using observable data on market prices and exploitation costs. However, the net price method is a simplification of the second method, assuming that future discounted income flows, generated by the use of the funds that become available, can be neglected (Bartelmus, Lutz and Schweinfest, 1992, annex 4). For practical reasons (for example, arbitrary choice of a discount rate), some authors advocate the use of actual price data (Reich, forthcoming; Thage, forthcoming). There is some uncertainty regarding the estimation of the normal profit element in the net price, particularly when the operating surplus (before subtraction of the normal operating profit) is already relatively small. In this case, the net price could become negative after deduction of a normal profit. This result need not be misleading, however, as it may reveal that (world) market prices of depleted raw materials are so low that even a normal return on invested capital cannot be achieved.

165. The above valuation methods for estimating stock values can also be applied for valuing volume changes of natural assets in the accounting period. The choice of a suitable valuation method depends especially on the type of economic use of those natural assets. In the case of depletion of natural assets (COVC 1.1.1) such as wild biota, subsoil assets or water, the net price method could be applied by calculating the value of depletion, that is, multiplying net price by the depleted quantities of the natural assets concerned. Examples of depleting wild biota include overfishing in the ocean or in coastal waters, and non-sustainable logging in tropical forests. In the case of depletion of forests, the net price concept is very close to the concept of stumpage value which amounts to timber sale proceeds less costs, *inter alia*, of logging, transportation and processing (Repetto and others, 1989, p. 20). When depleted raw materials are not marketed but used for own-account consumption (for instance in the case of water), the net proceeds foregone by exhausting the (water) reserves in a non-sustainable manner could be calculated with the help of similar methods.

166. In the case of changes in land quality due to changes in economic use or recurrent influences of economic use (COVC 1.1.2, 1.1.3), actual market prices for different qualities of land should be applied as much as possible. If such data are available, differences of market prices due to different qualities of land could be used to estimate the value of qualitative changes in land areas. If observable market prices are not available or not representative, a (discounted) flow of additional or foregone net rents of land due to quality changes (including soil erosion) has to be calculated. In the case of land and other natural assets contaminated by toxic residuals of economic activities (COVC 1.1.4), the market value of land might become zero (or even

negative) because the cleaning costs could exceed the (discounted) future net rents from using the area for economic purposes.

167. For the depletion of (exhaustible) mineral resources the so-called user cost method has been proposed. This method avoids the application of negative net prices (see above) by subdividing the actual operating surplus into two parts: depletion or user costs which should be invested to achieve a constant flow of income in the future, even after the complete exploitation of the natural resources, and a remaining true income element (El Serafy, 1989, 1991, forthcoming; Hartwick and Hageman, 1993). It can be shown that both the user cost and net price methods are simplifications of a general principle of valuing the depreciation of assets due to economic uses (Bartelmus, Lutz and Schweinfest, 1992, annex 4).

4. Accounting for non-financial assets (SEEA, version II)

168. The accounting scheme presented in tables 2.6 (general concepts) and 2.7 (numerical example) is derived from the SEEA matrix, version I (tables 2.1 and 2.2). The different types of non-financial assets are shown in columns 1-9 of the tables. These columns correspond to columns 4-6 in table 2.1. The rows of the accounting schemes record stock data (table 2.6, rows 1 and 19), and volume and price changes of assets during the accounting period (rows 2-18). These rows correspond to row 1 (opening stocks), row 10 (closing stocks) and rows 2-9 (volume and price changes) in table 2.1.

169. The column classification of table 2.6 comprises two types of produced and seven types of non-produced (natural) assets. The produced assets are subdivided into man-made and natural assets. Intangible non-produced assets (CNFA 2.2) which do not belong to the natural assets are shown together with man-made assets (table 2.6, column 1). Produced natural assets (column 2) comprise only living plants and animals whose growth is controlled by the agriculture, forestry and aquaculture industries.

170. The classification of non-produced natural assets in table 2.6 (columns 3-9) corresponds to the CNFA (the non-financial assets classification of the SEEA). Thus, it comprises elementary categories of natural assets (wild biota, subsoil assets, water and air) as well as complex assets that combine different elementary assets (land areas, including water areas, with their connected anorganic and organic components). Such a type of presentation may result in double counting because the ecozones (land with ecosystems) contain area assets as well as elementary natural assets like wild biota, water and air that constitute ecosystems.

171. The occurrence of double counting depends on the type of accounting framework applied. In physical accounting (SEEA, version III), elementary assets are described separately and also as part of ecozones, without the necessity of aggregation. In monetary accounting, described here (version II), double counting should be avoided. Thus, the ecosystems are subdivided into their different elements and recorded only as elementary assets (wild biota, subsoil assets, water, air, land area). In tables 2.6 and 2.7, the natural asset land (columns 7-9) is recorded without

Table 2.6 Non-financial assets accounts of the SEEA (version II): general concepts

		3.1.1 Produced assets of industries CNFA 1		3.2 Non-produced natural assets CNFA 2.1						
								Land (including ecosystems) CNFA 2.1.3		
		Man-made CNFA 1.1 2.2	Natural CNFA 1.2	Wild biota CNFA 2.1.1	Subsoil assets CNFA 2.1.2	Water CNFA 2.1.4	Air CNFA 2.1.5	Soil CNFA 2.1.3.1	Land areas: Cultivated CNFA 2.1.3.2	Land areas: Uncultivated CNFA 2.1.3.3
		1	2	3	4	5	6	7	8	9
1	Opening stocks (1)	A	A	A	A	A			A	A
2	Use of products of industries (2.1)	A	A		A				A	
3	Use of produced fixed assets (3.3.1)	A (-)	A (-)							
	Other volume changes (o.v.c.) (6)									
	O.v.c. of non-produced natural assets due to economic decisions COVC 1									
	O.v.c. of non-produced assets due to economic uses 1.1									
4	Depletion 1.1.1			A (-)	A (-)	A (-)				
5	Changes in land quality due to changes in land use 1.1.2								A (+,-)	
	Degradation of land (except by residuals) 1.1.3									
6	Soil erosion 1.1.3.2								A (-)	
7	Other 1.1.3.1/3								A (-)	
8	Discharge of residuals 1.1.4					A (-)			A (-)	A (-)
9	Restoration 1.1.5			A (+)		A (+)			A (+)	A (+)
	O.v.c. of non-produced assets due to other economic decisions 1.2									
	Discovery and adjustments 1.2.1									
10	Discovery 1.2.1.1			A (+)	A (+)	A (+)				
11	Adjustments of volume 1.2.1.2			A (+,-)	A (+,-)	A (+,-)				
12	Changes in classification and structure 1.2.2								A (+,-)	A (+,-)
	Other volume changes due to natural or multiple causes n.e.c. COVC 2									
13	Net natural growth (increase) 2.1			A (+,-)	A (+,-)	A (+,-)			A (+,-)	A (+,-)
	Catastrophic losses 2.2									
14	Natural causes 2.2.1	A (-)	A (-)	A (-)		A (-)			A (-)	A (-)
15	Technological (economic) causes 2.2.2	A (-)	A (-)	A (-)		A (-)			A (-)	A (-)
16	Political events 2.2.3	A (-)	A (-)	A (-)					A (-)	A (-)
17	Other volume changes n.e.c. 2.3	A (+,-)	A (+,-)	A (+,-)		A (+,-)			A (+,-)	A (+,-)
18	Revaluation due to market price changes (7)	A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)			A (+,-)	A (+,-)
19	Closing stocks (8)	A	A	A	A	A			A	A

Note: A-matrices denote monetary data (market values).

Table 2.7 Non-financial assets accounts of the SEEA (version II): numerical example

(Monetary units)

		3.1.1 Produced assets of industries CNFA 1		3.2 Non-produced natural assets CNFA 2.1						
								Land (including ecosystem) CNFA 2.1.3		
		Man-made CNFA 1.1 2.2	Natural CNFA 1.2	Wild biota CNFA 2.1.1	Subsoil assets CNFA 2.1.2	Water CNFA 2.1.4	Air CNFA 2.1.5	Soil CNFA 2.1.3.1	Land areas	
									Cultivated CNFA 2.1.3.2	Uncultivated CNFA 2.1.3.3
		1	2	3	4	5	6	7	8	9
1	Opening stocks (1)	991.3	83.1	65.4	261.9	12.0			1366.7	50.4
2	Use of products of industries (2.1)	68.0	1.4		2.7				4.6	
3	Use of produced fixed assets (3.3.1)	-23.0	-3.3							
	Other volume changes (o.v.c.) (6)									
	Other volume changes of non-produced natural assets due to economic decisions COVC 1									
	O.v.c. of non-produced assets due to economic uses 1.1									
4	Depletion 1.1.1			-2.1	-8.0	-1.5				
5	Changes in land quality due to changes in land use 1.1.2								0.0	
	Degradation of land (except by residuals) 1.1.3									
6	Soil erosion 1.1.3.2								-1.1	
7	Other 1.1.3.1/3								0.0	
9	Discharge of residuals 1.1.4					-2.0			-6.5	-1.6
9	Restoration 1.1.5			0.0		1.0			1.0	0.0
	O.v.c. of non-produced assets due to other economic decisions 1.2									
	Discovery and adjustments 1.2.1									
10	Discovery 1.2.1.1			0.0	14.2	0.0				
11	Adjustments of volume 1.2.1.2			0.0	13.6	0.0				
12	Changes in classification and structure 1.2.2								3.4	-3.4
	Other volume changes due to natural or multiple causes n.e.c. COVC 2									
13	Net natural growth (increase) 2.1			1.8	0.0	0.9			0.0	0.0
	Catastrophic losses 2.2									
14	Natural causes 2.2.1	-25.3	0.0	-0.5		0.0			-4.3	-2.0
15	Technological (economic) causes 2.2.2	0.0	0.0	0.0		0.0			0.0	0.0
16	Political events 2.2.3	0.0	0.0	0.0					0.0	0.0
17	Other volume changes n.e.c. 2.3	0.0	0.0	0.0		0.0			0.0	0.0
18	**Revaluation due to market price changes (7)**	138.1	12.6	11.1	28.9	1.2			357.5	11.8
19	**Closing stocks (8)**	1149.1	93.8	75.7	313.3	11.6			1721.3	55.2

the corresponding ecosystems. The valuation refers to more complex assets only if separate values cannot be estimated for elementary assets; in this case, double counting is avoided. Such a procedure may also be applied when the value of buildings cannot be separated from that of the underlying land. In this case, the disadvantage of the combined recording is that produced and non-produced assets are recorded together and, as a result, no comprehensive land accounts can be established. Similarly, the influence of soil quality on the more comprehensive concept of land quality is reflected in the market values of the respective land areas.

172. In a comprehensive classification of natural assets, air and soil are shown as identifiable assets despite the fact that no monetary valuation can be applied. The presentation of tables 2.6 and 2.7 should facilitate the comparison with asset accounts comprising both physical and monetary data (SEEA, version III).

173. The row classification of the accounting scheme describes in more detail the other volume changes of non-financial assets, which are not taken into account in the SNA in the calculation of GDP. The different types of other volume changes were described in the last subsection by means of a special classification (COVC).

174. In table 2.7, the depletion of non-produced assets is calculated in terms of market values for wild biota, subsoil assets and water (row 4: − 2.1, − 8.0, − 1.5). Depletion of produced natural assets is shown as use of produced fixed assets (consumption of fixed capital, row 3, column 2: − 3.3) or as decrease in inventories (row 2, column 2: 1.4).

175. Changes in land quality can be brought about by land improvement (part of capital formation) (table 2.7, row 2, column 8: 4.6) or by land use changes, reflecting a further change in market values recorded as other volume changes (in the numerical example, row 5: zero value). Changes in market values of land due to soil erosion or other changes in soil quality are shown in rows 6 and 7 (in the numerical example: 0.0 and − 1.1). The discharge of residuals into the natural environment can also influence the market value of water and land (row 8: − 2.0, − 6.5, − 1.6). Identifiable influences on the values of produced assets are reflected as use of produced fixed assets (consumption of fixed capital) (row 3: part of − 23.0 and − 3.3).

176. Volume changes of non-produced assets that are caused by restoration activities and reflected not as capital formation but only as current costs are recorded for wild biota, water and land (row 9: 0.0, 1.0, 1.0, 0.0). The exploitable volume of natural assets like wild biota, subsoil assets and water will depend not only on depletion or restoration activities but also on the degree of knowledge about their existence. The availability of those assets can thus be extended by discoveries and by the economic conditions under which they may be exploited (rows 10 and 11: 14.2, 13.6). The market value of volume changes due to new discoveries of natural assets has to be diminished by the value of capitalized exploration costs (row 2, column 4: 2.7) which are already recorded as capital formation.

177. Volume changes of non-produced assets due to changes in classification (including land use changes) reflect the shifts of natural assets between quality classes and main types of use,

for example, in the accounting scheme, classification changes are shown only in the case of land (shifts between cultivated and uncultivated land, row 12 : 3.4, − 3.4).

178. Changes in market values of non-produced assets due to net natural increase are recorded as other volume changes (row 13: 1.8, 0.9). The natural growth of produced biota is treated as increase of inventories or as gross fixed capital formation (row 2: 1.4). Catastrophic losses can decrease the volume and therefore the market value of nearly all types of non-financial assets (rows 14-16: − 25.3, 0.0, − 0.5, 0.0, − 4.3, − 2.0). Subsoil assets will normally remain unaffected, though in some cases even the amount of subsoil assets depletable under economic conditions could be influenced by earthquakes or eruptions.

179. Other volume changes n.e.c. (row 17; in the numerical example: zero value) may constitute an important item in natural asset accounting when it is difficult to identify the specific reason for the volume changes (and corresponding changes in market values) of natural assets. In these cases, the item is used for balancing purposes.

180. Particularly in countries with high inflation rates, the revaluation of non-financial assets due to market price changes (holding gains and losses) will play an important role in explaining the differences between stocks at the beginning and stocks at the end of the accounting period (row 18).

III. Linkage of physical and monetary accounting

A. Physical accounting systems

181. In chapter I of the handbook, the importance of physical data as an integral part of the SEEA has been stressed (subsection B (3) therein). In the present chapter, the general considerations of chapter I are elaborated. Section A gives a short description of two prototypes of environmental accounting in physical terms. Section B shows how the physical accounts of version III of the SEEA can be derived from these two accounting frameworks and linked with version II which deals with environmental accounting in monetary terms on the basis of the conventional SNA. Section C outlines possible extensions of version III by introducing the flow accounts of products, non-produced raw materials, residuals and natural asset accounts.

1. Materials/energy balances

182. The concepts and methods of materials/energy accounting were developed in the late 1960s and early 1970s (Kneese, Ayres and d'Arge, 1970; Isard, 1969; Isard and others 1968, 1972). The following description of these methodologies is based on the draft guidelines for statistics on materials/energy balances (United Nations, 1976) and on a more detailed elaboration by Ayres (1978).

183. Materials/energy balances provide detailed information on the material input of an economy delivered by the natural environment, the transformation and use of that input in economic processes (extraction, conversion, manufacturing, consumption) and its return to the natural environment as residuals (wastes and so on). The accounting concepts involved are founded on the first law of thermodynamics, which states that matter (mass/energy) is neither created nor destroyed by any physical process. Economic activities can be described as generating throughput of materials/energy that do not change mass but that increase unavailable energy (second law of thermodynamics, law of entropy).

184. The basic idea connected with materials/energy accounts is sketched in figure V. Materials/energy balances describe raw material input (1), transformation processes within the economy (2) and flows of residuals resulting from economic uses of materials back to the environment (3). They exclude transformation processes within the natural environment (4).

185. In table 3.1, a more detailed scheme of the concepts of materials/energy balances is given. This scheme shows material flows and transformations within the domestic economy and their connections, in condensed form, with the domestic environment and the rest of the world. Material changes within the domestic economy refer to production and consumption processes as well as to use of produced assets.

Figure V. Interrelationships between the economy and the natural environment (simplified scheme)

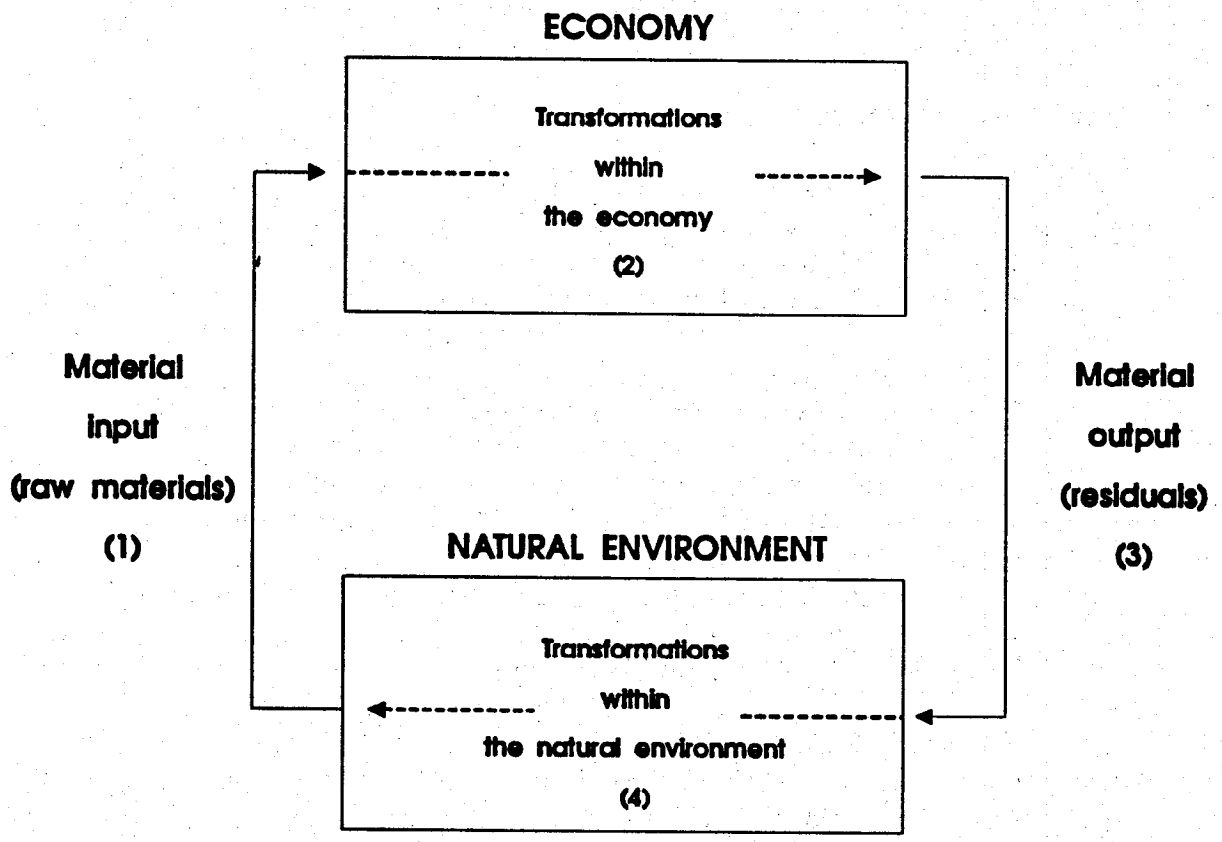


Table 3.1 Materials/energy balances: physical accounts

		Domestic economy							Domestic natural environment (non-produced)	Rest of the world	
		Economic activities (processes)			Produced assets						
		Environmental protection activities	Other production activities of industries	Household activities	Environmental protection	Other production purposes	Consumer durables	Produced biota		Economic transactions	Natural environment (non-produced)
		1	2	3	4	5	6	7	8	9	10
	1 Input/destination										
1	1.1 Opening stocks				X	X	X	X			
2	1.2 Use of (non-produced) raw materials	X	X	X					X		
3	1.3 Use of products	X	X	X	X	X	X	X		X	
4	1.4 Destination of residuals	X			X				X		X
	2 Transformation (extraction, conversion, manufacturing)	↓	↓	↓	↓	↓	↓	↓			
	3 Output/origin										
5	3.1 Closing stocks				X	X	X	X			
6	3.2 Origin of (non-produced) raw materials								X		X
7	3.3 Supply of products	X	X	X		X		X		X	
8	3.4 Origin of residuals (all causes)	X	X	X	X	X	X	X		X	

186. Material/energy flows (rows 2-4 and 6-8) are classified according to three categories: (non-produced) raw materials which are material inputs extracted from the natural environment; (material) products, which are the intended main result of production processes; and residuals, which are (usually unwanted) by-products of production and consumption. In addition, the material stocks of products at the beginning of the accounting period (opening stocks) and at the end of the accounting period (closing stocks) are presented (rows 1 and 5).

187. In table 3.1, material transformations are shown for three types of activities and four types of assets (columns 1-7). Transformation processes of flows are described for environmental protection activities (including recycling), for other (main or secondary) production activities of industries and for household activities. Household activities comprise activities that provide new material products (for example, cooked meals) that are similar to the products resulting from production processes of industries, or that have a more consumptive character (for example, recreational activities).

188. Transformation processes of material stocks show the material changes of those stocks within the accounting period. Produced assets are subdivided into the following categories: assets for environmental protection purposes, assets for other (main or secondary) production purposes of industries (except produced biota), consumer durables that are used for consumption purposes of households, and produced biota that are grown under the control of agriculture, forestry and fishery.

189. The domestic natural environment contains all natural assets (biological assets, land, subsoil assets, water, air) except those resulting from controlled natural growth (produced biota). The economic transactions of the rest of the world refer to transactions with other countries. The natural environment of the rest of the world contains not only the natural environment of foreign countries but also the areas outside the jurisdiction of specific countries (international waters, outer space).

190. The first seven columns of table 3.1 show material changes within the domestic economy. Columnwise, the mass of material inputs (rows 1-4) equals the mass of total outputs (rows 5-8). In particular, total supply or origin and use or destination are equal for raw materials, products and residuals. Because of possible changes of materials into energy, this equality does not hold for the weights of inputs and that of outputs. Columns 8-10 do not show the same balances because the description is incomplete: The presentation is limited to material flows to or from the domestic economy. Identities can also be observed for the rows of raw materials, products and residuals: total origin and use of raw materials, total supply and use of products, and total origin and destination of residuals are equal.

191. Further comments are necessary with regard to different characteristics of the inputs and outputs (marked with an X) of the transformation processes shown in table 3.1. Environmental protection activities are characterized by inputs of residuals that are collected, transported or treated. All economic activities transform raw materials and products into other products and residuals. The material balances of produced assets reflect identities that include the opening

stocks of assets, assets produced in the accounting period, assets not being used further and treated as residuals and closing stocks. The decrease in inventory stocks of produced goods is treated as supply of products (row 7). In the case of assets used for environmental protection, the stored residuals of controlled landfills are part of the material volume of those assets. In this case, additional residuals will be discharged because stored residuals normally enter the natural environment gradually over time.

192. The domestic environment is shown as a source of natural resources and as a recipient of residuals. The economic transactions of the rest of the world comprise imports and exports of goods. The natural environment outside the domestic economy is used as a sink for residuals (for example, wastes disposed of in the oceans) or as a source of natural resources (for example, ocean fish).

2. Natural resource accounting

193. The present subsection focuses on the specific structure of natural resource accounts including elements (ecozones) of natural patrimony accounts (Aaheim, Lone and Nyborg, forthcoming; Alfsen and Lorentsen, 1989; Cornière, 1986; OECD, 1985; Theys, 1989). Further reference to natural patrimony accounts (Weber, forthcoming; INSEE, 1986b), especially concerning their actor accounts and linkage matrices with respect to the different parts of natural patrimony accounts, will be made below in the context of describing the general structure of version III of the SEEA (section B).

194. Natural resource accounting deals with stocks and stock changes of natural assets, which comprise biological assets (produced or wild), subsoil assets (proved reserves), water, air and land areas (including water areas) with their terrestrial and aquatic ecosystems (ecozones). Biological natural assets are living plants and animals of economic importance. It is useful to present biological assets twice in natural resource accounts: as simple biotic resources (especially from the point of view of endangered species) and as part of complex ecosystems (Gilbert, 1990). Land areas comprise, therefore, not only the area itself but also related ecosystems. Soil is treated together with land. Subsoil assets are included only in so far as they comprise proved reserves (identification highly probable, extraction economically and technically possible). Water and air are taken into account in so far as they are (actually or potentially) used or affected by economic activities. Owing to the absence of clear asset boundaries, accounting with respect to air is limited to indicating changes in air quality in particular regions.

195. In natural resource accounting, measurement in both physical and monetary units would be necessary to obtain a more comprehensive picture of the changes in natural assets. Physical data are usually measured in units of weight. Other possible units are number (for example, of species) and area (land). Qualitative measures could supplement quantitative measures, for example, in recording inventories of natural resources (United Nations, 1991a). Such inventories may comprise data on the constituents of the environmental media of land, water and air, as well

as on quality classes of those media with regard to type of use or ecosystem characteristics. The combined changes in asset quality and quantity are called volume changes.

196. Table 3.2 shows physical stocks of natural resources at the beginning of the period, changes during this period and stocks at the end of the accounting period. The presentation is simplified to reveal important categories of change, indicated by an X.

197. Possible changes within the accounting period are increases, decreases and adjustments (similarly in Cornière, 1986, p. 50). Increases in natural resources comprise gross natural increase (for example natural increase by reproduction, increase in area due to natural influences), discovery of resources, and area increase due to development of resources (for example, dams). Decreases in natural resources include depletion due to natural causes (natural mortality of animals, effects of natural disasters), depletion for economic purposes and land area decreases due to economic decisions (for example flooding for hydropower development). Adjustments refer to revisions of estimates of resources due to changes in certain conditions of use (available techniques, price level, extraction costs). Furthermore, new estimates might be necessary because of improved estimation methods and so forth.

198. Quantitative and qualitative characteristics of natural resources and changes therein are typically assessed in inventories of natural resources. The matter of the compilation of those inventories and related databases are addressed by systems of environment statistics. For a detailed discussion of concepts, methods and problems of measurement, see, for example, the methodologies developed by the Statistical Division of the United Nations Secretariat (United Nations, 1988, 1991a).

B. Physical accounts (SEEA, version III)

1. Concepts

199. In the physical accounts of the SEEA, the concepts of materials/energy and natural resource accounting are combined and translated into the language of national accounts. Materials/energy and natural resource accounting can be viewed as constituting complementary information systems: Materials/energy accounts focus on the economy and show natural inputs, their transformation within economic processes and their return to the natural environment. Natural resource accounts describe in particular that part of the natural environment that is economically used (and affected) by economic activities, and show the changes in natural assets in so far as those changes are important from an economic point of view (figure V).

200. Use of the information contained in materials/energy balances and natural resource accounts for the SEEA is limited to recording physical flows from natural assets to the economy (use of natural assets) and flows back to the natural environment (residual flows). The SEEA does not attempt to provide a comprehensive picture of the transformation processes within the

Table 3.2 Natural resource accounts: physical accounts

		Biological assets		Sub-soil assets (proved reserves)	Water		Air		Land (including ecosystems)		
									Cultivated		Un-cultivated (area)
		Produced	Wild		Quantities	Qualities (constituents)	Quantities	Qualities (constituents)	Soil	Area	
		1	2	3	4	5	6	7	8	9	10
1	1 Opening stocks	X	X	X	X	X		X	X	X	X
	+2 Increase										
2	2.1 Gross natural increase	X	X	X	X				X	X	X
3	2.2 Discovery of resources		X	X	X						
4	2.3 Area increase by economic influence									X	X
	-3 Decrease										
5	3.1 Decrease due to natural causes	X	X	X	X				X	X	X
6	3.2 Depletion due to economic causes	X	X	X	X				X		
7	3.3 Area decrease by economic influence									X	X
	+/-4 Adjustments										
8	4.1 Technical improvements		X	X	X						
9	4.2 Changes in prices, costs		X	X	X						
10	4.3 Improved estimation methods	X	X	X	X				X	X	X
11	=5 Closing stocks	X	X	X	X	X		X	X	X	X

economy. Data requirements and knowledge of (alternative) production and consumption processes would make such an effort quite unrealistic at the national level.

201. It may be useful to describe the flows of natural resource inputs, products and residuals in a breakdown by type of input and output. However, existing classifications of production and consumption activities are typically not detailed enough to provide such information. In many countries, a breakdown of activities by industry according to the ISIC classification (United Nations, 1990) seems to present disaggregation at the only attainable level. However, for certain processes that are particularly important from an economic or environmental point of view (for example, energy production and consumption, or production of chemicals) more detailed process analysis might be called for. A detailed classification of individual production and consumption processes as required by materials/energy balances is therefore not proposed at the present stage of development of the SEEA.

202. The SEEA does not include proposals for comprehensive natural resource accounting either. For instance, regional components of the natural environment, which are significant for a comprehensive description of that environment and its changes within the accounting period, are not part of the core accounts of the SEEA. Such accounts could be linked with the SEEA via regional natural resource accounts. A further limitation of the SEEA is its focus on the use of the natural environment by economic activities. Flows and transformations within the natural environment are not described in the SEEA.

203. A consequence of these limitations is that residuals of economic activities are treated mainly as emissions, which are recorded at the moment of their leaving economic activities. The processes of transformation and assimilation of residuals within the natural environment are not described. The effects of environmental stresses caused by residuals are shown only as changes in the quality of air, water and soil over the time-span of the accounting period, the time-lags with respect to the experiencing of those effects by human beings and environmental systems being largely neglected. The dynamics of environmental transformations have been dealt with in ecological models, supported by environment statistics and indicators, and are not further elaborated here.

204. The application of the concepts of materials/energy balances and natural resource accounting to developing the SEEA in physical terms does not imply that the concepts of the conventional SNA have to be modified. Rather, the physical accounts of the SEEA aim at extending the SNA without modifying the monetary flow and asset accounts of the SNA. Two types of linkage between the physical part of the SEEA and the (monetary) SNA are possible:

(a) Monetary data, according to the SNA, can be described in terms of their counterparts in physical terms. Compatibility is obtained by ensuring that corresponding items in both systems have the same definitions and classifications;

(b) Physical data in the SEEA may describe facts that are not part of the conventional SNA. In this case, definitions and classifications can be developed with greater freedom.

Linkage of the physical data with monetary accounts could be obtained by bridging matrices that applied compatible concepts at the interface between the SEEA and the SNA.

205. In table 3.3, the physical accounts of the SEEA and their links with the conventional flow and asset accounts of the SNA are shown in a simplified SEEA matrix. This accounting framework is called version III of the SEEA. The physical data are denoted by B-matrices, which are shown together with the corresponding monetary data (A-matrices) already described in chapter II. B-matrices that contain data on the time use of economic units are indicated with an asterisk (B^*). Physical data on land use (in areal measures) are recorded as B^{**}. Those matrices are shown explicitly because time and space are important dimensions in environmental analysis. The signs (+,−) in parentheses are those of the elements of corresponding matrices. Section B (2) deals with possible further breakdowns and extensions of the SEEA, version III, and their links with monetary accounts. This section thus gives an overview of the physical accounts in the SEEA and their relationships with materials/energy and natural resource accounts.

206. The SEEA differs from materials/energy balances in two main respects:

(a) Materials/energy transformation processes are introduced in an aggregated manner only. Production activities are not shown for processes but only for industries with establishments as the unit of classification;

(b) Complete asset accounts of domestic natural assets (in so far as they are used or affected by economic activities) are presented in the SEEA including not only the materials/energy stocks in the domestic economy but also the changes therein. The concepts of natural resource accounting are applied for those accounts.

207. The SEEA differs in two respects from natural resource accounting frameworks (table 3.2) and comprehensive natural patrimony accounting frameworks:

(a) Rather than providing a detailed spatial description of the transformation processes within the natural environment, the SEEA is limited to relatively simplified asset accounts. Those assets show stocks of assets at the beginning and at the end of the accounting period and changes therein within that period;

(b) The description of the stocks and changes in natural assets is supplemented by a comprehensive presentation of economic activities, their use of natural resources and their production of residuals.

208. The column classification of the physical accounting framework of the SEEA (table 3.3) corresponds to that of version II of the SEEA matrix and is similar to the column classification of materials/energy balances (table 3.1). The production activities of industries (column 1) have the same classification in the SEEA and the SNA (ISIC). As already described in chapter II,

Table 3.3 SEEA matrix with linked physical and monetary accounting (version III): summary

		1 Domestic production of industries	2 Final consumption		3 Non-financial assets (uses and stocks of assets)			4 Exports	5 Total uses	
					3.1.1 Produced assets of industries		3.2 Non-produced natural		Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9
1	Opening stocks (1)		B (+)		B (+) A	B (+) A	B** (+) A			
2	Use of products of industries (2.1)	B (+) A	B (+) A	A	B (+) A	B (+) A	A	B (+) A	B (+) A	B (+) A
	Use of non-produced natural assets (3.1)									
3	Depletion of non-produced natural assets (3.1.1)	B (+)	B (+)				B (-)	B (+)		B (+)
4	Use of land etc. (3.1.2)						B** (+,-)			
5	Discharge of residuals (3.1.3)	B (-)	B (-)		B (-)	B (-)	B (+)	B (+)		B (+)
6	Treatment of residuals (3.2)	B (+,-)	B (-)		B (+,-)	B (-)		B (+)		B (+)
7	Use of produced fixed assets (3.3.1)	A (+)			A (-)	A (-)				
8	Net value added/NDP (4.2.2)	B* (+) A	B* (+)							
9	Gross output of industries (5.1)	B (+) A								
	Other volume changes (6)									
10	Due to economic decisions (6.1.2: physical data only)		B (+,-)				B** (+,-) A			
11	Due to natural and multiple causes (6.2)		B (+,-)		B (+,-) A	B (+,-) A	B** (+,-) A			
12	Revaluation due to market price changes (7)				A (+,-)	A (+,-)	A (+,-)			
13	Closing stocks (8)		B (+)		B (+) A	B (+) A	B** (+) A			

Note: A-matrices denote monetary data (market values); B-matrices physical data.

some parts of the ISIC have to be further disaggregated (notably in the case of environmental protection activities). In comparison with materials/energy balances, they are aggregated and do not include household activities (except for marketed household work).

209. The individual consumption of households (column 2) comprises in both the SNA and the SEEA all purchases of households and that part of government consumption that can be associated with individual persons. In version III of the SEEA, the opening and closing stocks of consumer durables (rows 1 and 13, and column 2) are recorded in the column of final consumption in order to obtain a complete picture of all physical stocks. In materials/energy balances, consumption activities are treated in the same manner as production activities, and the assets of consumer durables are shown together with other produced assets. Collective consumption (column 3) only includes monetary data. One may consider recording the assets of military durables in physical terms even though military durables are not part of produced assets in the SNA.

210. Produced assets (columns 4 and 5) are defined and classified in the SEEA and in the SNA in the same way. The asset classification of the SNA has to be disaggregated only in the case of produced biological assets in order to achieve a comprehensive natural asset classification and to identify assets of environmental protection. In materials/energy balances, produced assets also comprise, as has already been mentioned, consumer durables. Non-produced natural assets (column 6) comprise all assets of the natural environment in so far as they are used or affected by economic activities; excluded from this column are the produced biological assets of agriculture and forestry. Contrary to materials/energy balances, not only the flows between the economy and the environment, but also the stocks of natural assets, are shown.

211. Exports include not only cross-boundary product flows to foreign economies (as in the SNA) but also flows representing the uses of, and the effects on, the natural environment of other countries by the domestic economy. Flows from the rest of the world to the domestic economy include only imports of products, which are recorded as a sub-item of total uses (column 9).

212. The integrated physical and monetary accounts of the SEEA comprise flow as well as asset accounts. Flow accounts are established for products, non-produced raw materials and residuals. In table 3.3, these three types of flow account are shown in rows 2 (product flow accounts), 3 (raw material flow accounts), and 5 and 6 (residual flow accounts). The SEEA does not aim at a complete description of all materials/energy flows in the economy. Thus, the description of inputs and outputs in physical terms will normally be incomplete and their totals will not necessarily be identical. For the purpose of analysing specific environmental-economic interrelationships, flow accounts for selected products, raw materials or residuals could be developed.

213. Product flow accounts (row 2) show the supply and use of products as described in section A of chapter I of the handbook. Different types of use are shown in columns 1-7, the origin of products is recorded in columns 8 and 9. In this scheme, contrary to that of

materials/energy balances, household production is excluded. Further information on product flows is given in subsection B (2) (a).

214. Raw material flow accounts (row 3) give a picture of the origin and destination of the flows of material inputs from the natural environment to the economy. Those flows imply a quantitative (temporary or permanent) decrease in natural assets for economic purposes. Raw materials of domestic origin are transferred from the accounts of non-produced natural assets (column 6) to those of the economic activities that exploit them (columns 1 and 2). If domestic natural assets of one country are purchased or exploited and used by units of other countries, the raw materials are included as exports and imports of products (row 2, columns 7 and 9). If fish are caught in international waters or minerals are exploited from the seabed, this is treated as depletion of non-produced natural assets of the rest of the world and recorded under the importing industry (column 1) and as a sub-item of total uses of foreign origin (column 9). Further details are described in subsection B (2) (b).

215. In materials/energy balances, all materials that are not classified as raw materials or products are considered residuals. In the SEEA, residuals (row 5) are defined as (generally unwanted) by-products of economic activities. Such definition excludes those residuals that are emitted when produced assets are destroyed by natural causes (natural disasters). These materials are shown not in row 5, but in row 11. The above-mentioned treatment is in line with the calculation of maintenance costs for environmental assets' absorbing the residuals of economic activities (SEEA, version IV). Residual flow accounts (rows 5 and 6) show the different sources of residuals and also present their destinations, which include treatment or storage in environmental protection facilities, or disposal in the natural environment (domestic or foreign). Further information is given in subsection (B) (2) (c).

216. Residual flow accounts are subdivided according to the destination of residuals. With respect to residuals that are treated further (column 1) or stored in environmental protection facilities (column 4), residual flows are shown in row 6 of table 3.3. Residuals that are discharged, without or after treatment or controlled storage, into the domestic (column 6) or foreign (column 7) natural environment are recorded in row 5. Residuals could originate from different domestic economic activities (columns 1 and 2) or from the disposal of produced assets, for example wrecks of motor cars (columns 4 and 5). Residuals can also have a foreign origin (column 9). As mentioned above, time-lags between discharge of residuals and ultimate loading of the environment are a major problem in assessing the full flow or cycle of residual matter.

217. The physical asset accounts of the SEEA, version III, comprise accounts for produced and non-produced assets. Those accounts take into account, as far as possible, the concepts of natural resource accounting. In table 3.3, asset accounts are shown in columns 4-6. Physical accounts for consumer durables are included in the column for individual consumption in order to obtain a complete picture of the physical stocks of products (rows 1 and 13, column 2). Physical accounts aim at a complete description of the stocks at the beginning of the accounting period (opening stocks), the changes within this period (increases and decreases due to economic decisions and natural causes) and the stocks at the end of the period (closing stocks). Asset

accounts should comprise information not only on asset quantities but also on qualitative characteristics. This is especially important in the case of the natural media, land, water and air, which are the sink for many of the residuals of economic activities.

218. The accounts of produced assets (table 3.3, columns 4 and 5) comprise:

(a) Opening stocks (row 1);
(b) Increase by gross fixed capital formation and increase of inventory stocks (row 2);
(c) Increase in stocks of produced assets due to storage of residuals for environmental protection (row 6);
(d) Decrease in inventory stocks of products (row 2);
(e) Decrease in produced assets as a consequence of scrapping assets used in production (rows 5 and 6);
(f) Capital consumption (depreciation) of fixed assets (row 7);
(g) Volume changes due to other causes, especially natural ones (row 11);
(h) Revaluation due to market price changes (row 12);
(i) Closing stocks (row 13).

219. The assets of produced biota (column 5) have a hybrid character because they are both produced and natural. Their natural growth is treated as production and added as capital formation to work in progress on cultivated assets (row 2: capital formation). In estimating such production, it is taken into account that owing to the weather and other circumstances, a part of agricultural product is normally lost during the process of natural growth and not available at the time of harvest. Such losses are deducted from output. Other losses caused by natural disasters (drought and flooding, among others) are generally taken into account in the same manner by revising previous production estimates. In exceptional circumstances, such losses may be recorded as other volume changes (row 11).

220. The contents of the accounts of non-produced natural assets (column 6) have already been described in the context of natural resource accounting. Detailed information on those accounts is given in subsection B (2) (d). In what follows, only the differences between the SEEA and natural resource accounts in describing the changes in assets during the accounting period are discussed (compare table 3.3 with table 3.2).

221. The discharge of residuals of economic activities into the natural environment (table 3.3, row 5) normally has a qualitative influence on natural assets (especially land, water, air). Resource accounts as described in table 3.2 do not register a quantitative change but could register a change in the quality of the stocks of natural assets. In order to trace the flow of residuals in the SEEA, however, the accumulation of residuals is recorded and treated as constituting a quantitative increase in stocks. Such an increase usually involves a qualitative decrease in the stock of natural assets.

222. The decrease in non-produced natural assets by economic activities is referred to in the SEEA as "Depletion of non-produced natural assets" (table 3.3, row 3). In version III of the SEEA matrix, this depletion is, in physical terms, treated as part of uses of products and non-produced assets. In monetary terms the depletion is treated (following the SNA) as part of other volume changes of non-produced natural assets (rows 10 and 11). Those include:

(a) Other volume changes due to economic decisions (causes) (row 10 of table 3.3), including the discovery of new resources (row 3 in table 3.2), area increases and decreases due to economic influences (rows 4 and 7 in table 3.2), and adjustments due to technology improvements, to changes in prices and costs and to improved estimation methods (rows 8-10 in table 3.2). The monetary data (A-matrices) shown in row 10 of table 3.3 also comprise market values of depletion and degradation of natural assets. These volume changes are recorded as cost in the production accounts of the SEEA (rows 3-5) (version IV.1 of the SEEA (chap. IV));

(b) Other volume changes due to natural and multiple causes (row 11 of table 3.3), corresponding to the items of natural resource accounting in rows 2 and 5 in table 3.2.

223. The B^*-matrices in row 8 of table 3.3 denote the time use of resident individuals with respect to their activities as employed persons in production units and in activities of household consumption. These data could be linked with the spatial and quality data of the natural asset accounts (see the B^{**}-matrices in column 6 of table 3.3) to obtain, as far as statistics permit, a comprehensive picture of the environment-related living conditions of the population. Those living conditions are affected not only by the quality of the environmental media but also by the length of time people are exposed to the quality changes in the media.

224. Table 3.3 also contains information on the linkages between physical and monetary data. As version III of the SEEA strictly follows the monetary accounting system of the SNA, corresponding physical and monetary data are only presented together for the product flow accounts (rows 2 and 9) and the asset accounts at market values (rows 1, 2 and 10-13). The use of non-produced assets is shown only in physical units in the upper part of the table (rows 3 and 4). In version III, use of non-produced assets valued at market values remains included as part of "Other volume changes due to economic decisions (causes)" (row 10) in line with SNA treatment. Parallel treatments of physical and monetary data on uses of non-produced assets will be presented only in version IV of the SEEA, where new concepts of capital accumulation and environmental costs are introduced.

225. The structure of the SEEA matrix can be compared with the natural patrimony accounting (NPA) approach whose concepts were developed mainly in France (INSEE 1986b; Weber, forthcoming). The actor accounts of NPA correspond to the accounts of production and consumption activities. In table 3.3, this part comprises columns 1-4. The (natural) element accounts of NPA are presented in the SEEA as specific natural asset accounts (excluding land, including ecosystems), (column 5 and part of column 6). The ecosystem (ecozone) accounts of the NPA correspond to the land accounts of the SEEA that are part of the non-produced natural

asset accounts of table 3.3 (column 6). These accounts are described in detail in subsection B (2) (d). The row and column totals of the linkage matrices of the NPA that connect the different parts of the accounting framework are presented in the SEEA as flow accounts of products, raw materials and residuals (rows 2-6 in table 3.3). The SEEA, however, has a more limited scope than the NPA, as the SEEA does not aim at comprehensiveness in physical accounting but focuses on those data that are required for describing the main environmental-economic interrelationships and for linking the economic data of national accounts with physical data bases.

2. Accounts of physical flows and stocks

226. The description of the main flow and stock accounts presented in the previous subsection is elaborated on below, with particular emphasis on the further classification of physical flow and stock data underlying the monetary accounts of versions IV and V of the SEEA.

(a) Product flow accounts

227. In the product flow accounts (table 3.4), supply and use of products are presented in terms of physical units (normally units of weight such as tons). These data correspond to the monetary values already included in the conceptual framework of the SNA and described in chapter II of this handbook.

228. Product flows describe the origin and destination of raw materials in different economic transformation processes leading up to the final product. Product flow accounts can also help analyse the causes of residuals discharge, for example, by describing energy flows and their use in different production/consumption activities, and by estimating air pollution connected with energy consumption. Possibilities for linking product flows with flows of raw materials and residuals within an input-output framework are described in section D of chapter V.

229. Product flow accounts consist of four important data groups which are linked together:

(a)		Domestic output;
(b)	+	Imports of products;
(c)	-	Exports of products;
(d)	=	Domestic use of available products (for intermediate consumption by different production activities, final consumption and capital formation).

230. The monetary data, recorded as A-matrices in table 3.4, correspond to the rows showing the use of domestic and imported products as set forth in table 2.3 on the SEEA, version II. For each type of product, a special row (subdivided, if necessary, by domestic and foreign origin of the product) can be explicitly introduced. In table 3.4, the flows of domestic and imported

Table 3.4 SEEA matrix with linked physical and monetary accounting (version III): product and raw material flows

		1.1 Domestic production of industries			2 Final consumption		3 Non-financial assets (uses and stocks of assets)								4 Exports	5 Total uses
							3.1.1 Produced assets of industries		3.2 Non-produced natural assets							
		Agriculture, forestry, fishing (ISIC 01 - 05)	Mining, electricity, water (ISIC 10 - 14, 40, 41)	Other industries	2.1 Individual	2.2 Collective	3.1.1.1 Man-made	3.1.1.2 Natural	3.2.1 Wild biota	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (ecozones) 3.2.5.1 Soil	3.2.5 Land (ecozones) 3.2.5.2 Area		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)				B		B A	B A	B A	B A	B A	B	B	B** A		
	Use of products of industries (2.1)															
	Domestic production (2.1.1)															
2	Natural growth products	B A	B A	B A	B A			B A							B A	B A
3	Other	B A	B A	B A	B A		B A			A				A	B A	B A
	Imports (2.1.2)															
4	Natural growth products	B A	B A	B A	B A			B A							B A	B A
5	Other	B A	B A	B A	B A		B A								B A	B A
	Use of non-produced natural assets (3.1)															
	Depletion of domestic assets (3.1.1.1)															
6	Wild biota	B (+)			B (+)				B (-)							
7	Subsoil resources		B (+)							B (-)						
8	Water	B (+)	B (+)	B (+)	B (+)						B (-)					
9	Use of air, wind etc.	B (+)	B (+)	B (+)	B (+)							B (-)				
10	Soil erosion										B (+)		B (-)	B (+)		
	Depletion of foreign assets (3.1.1.2)															
11	Wild biota	B (+)														B (+)
12	Use of land etc (3.1.2)													B** (+,-)		
13	Discharge of residuals (3.1.3)	B (-)	B (-)	B (-)	B (-)		B (-)	B (-)			B (+)	B (+)	B (+)		B (+)	B (+)
14	Treatment of residuals (3.2)	B (-)	B (-)	B (+,-)	B (-)		B (+,-)	B (-)							B (+)	B (+)
15	Use of produced fixed assets (3.3)	A (+)	A (+)	A (+)			A (-)	A (-)								
16	Net value added/NDP (4.2.2)	B* A	B* A	B* A	B*											
17	Gross output of industries (5.1)	B A	B A	B A												
	Other volume changes (6)															
18	Due to economic decisions (6.1) 6.1.2: physical data only				B (+,-)				B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B	B** A		
19	Due to natural and multiple causes (6.2)				B (+,-)		B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B	B** A		
20	Revaluation due to market price changes (7)						A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)			A		
21	Closing stocks (8)				B		B A	B A	B A	B A	B A	B	B	B** A		

Note: A-matrices denote monetary data (market values); B-matrices physical data.

products in physical units are shown for natural growth products and other products. The supply of products is recorded in column 15 (total uses). It comprises the domestic output of the accounting period (rows 2 and 3) and the imports of products (rows 4 and 5). The destination of products is shown in columns 1-14. Natural growth products, increase, in a first step, fixed capital or inventories of produced biota (rows 2 and 4, column 7), which are subsequently reduced at the moment of harvesting, cutting or slaughtering by consuming industries (intermediate consumption, consumption of fixed capital) or households (intermediate or final consumption).

231. Comprehensive product flow accounts would require a detailed classification of products. In many cases, highly specific materials (for example, certain heavy metals or chemicals) cause environmental problems. The five-digit coding system of the CPC, which is the basic classification for products in the SNA as well as in the SEEA, is insufficient for analysing the environmental impacts of specific products.

232. Further environment-related expansions are needed in the following divisions of the CPC:

01 - 04	Agriculture, forestry and fishery products *Applications: natural resource accounts, product flow accounts*
11 - 18	Ores and minerals; electricity, gas and water *Applications: natural resource accounts, product flow accounts (energy balances etc.), residual flow accounts*
33	Coke oven products; refined petroleum products; nuclear fuel *Applications: product flow accounts (energy balances)*
34	Basic chemicals *Applications: product flow accounts, residual flow accounts*
39	Wastes or scraps *Applications: product flow accounts, residual flow accounts*
41	Basic metals *Applications: product flow accounts, residual flow accounts*

(b) Flow accounts of non-produced natural raw materials

233. In table 3.4, special attention is paid to the flows of non-produced natural raw materials. Those raw materials are the primary material inputs of economic activities obtained by exploiting natural assets. The flows of raw materials can be disaggregated by type of material. A special classification of raw materials could be developed that should correspond as closely as possible to the product flows classified in the CPC. This would facilitate a simultaneous analysis of the flows of raw materials and the flows of related products in input-output analyses (section D of chapter V below). Rows 6-10 of table 3.4 present the broad categories of such a classification. These categories could be further broken down as follows:

(a) Wild biota:
  (i) Plants and products of plants (except forest products);
  (ii) Animals and animal products (except aquatic animals);
  (iii) Products of forests;
  (iv) Fish and other aquatic animals;

(b) Subsoil resources:
  (i) Coal and lignite, peat;
  (ii) Crude petroleum and natural gas;
  (iii) Uranium and thorium ores;
  (iv) Metal ores;
  (v) Stone, sand and clay;
  (vi) Other minerals;

(c) Water;

(d) Air, wind, natural heat:
  (i) Air;
  (ii) Wind;
  (iii) Natural heat;

(e) Soil (erosion).

234. The origin of non-produced raw materials exploited for economic use is presented in table 3.4 (columns 8-11) under non-produced natural assets (biological assets, subsoil assets, and the environmental media of water and, to a limited extent, air). Table 3.4 also provides the amount of soil erosion of cultivated land (row 10, column 12). In so far as non-produced raw materials originate from natural assets that belong neither to the domestic economy nor to the territory of other countries, such as fish caught in the ocean, the above-mentioned uses of natural resources are shown in row 11 of table 3.4. It is assumed in the table that such uses are limited to wild biota. If natural assets are exploited in other countries and then imported, they constitute products and are thus part of the imports of goods and services (rows 4 and 5).

235. The destination of raw materials is either intermediate consumption for further transformation by production units (establishments belonging to industries) or direct consumption by households. In the case of soil erosion, quantitative changes are recorded only in asset accounts. Soil erosion diminishes the quantity of soil of cultivated land and increases the volume of other natural assets, like uncultivated land or water. Non-produced raw materials are not exported directly to the rest of the world. If they leave the country they are assumed to have already become a product.

236. Production activities that use non-produced natural assets are agriculture, hunting and forestry (ISIC 01, 02), fishing (ISIC 05), mining and quarrying (ISIC 10-14) and collection, purification and distribution of water (ISIC 41). Non-produced raw materials are also used in consumption of households. They may include biological resources (for example, firewood),

directly abstracted drinking-water and inhaled air. In the SEEA, version V, household activities are described in more detail.

(c) Residual flow accounts

237. Residuals are the unwanted by-products of economic activities (production, household consumption). In some cases, they can be sold for recycling purposes. In other cases, they are used without payment for recycling or transformed by environmental protection activities incurring additional costs. Ultimately, the natural environment is burdened with all materials. Residuals comprise solid, liquid, gaseous and vaporous materials. Their measurement at different stages of the pollution-contamination sequence (emission, loading, ambient concentration, exposure, contamination) is the task of environmental monitoring and environment statistics (see, for example, United Nations 1988, 1991a).

238. In many cases, the borderline between the main output and the residuals of production processes cannot be sharply drawn. The criterion whether the outputs of production can be marketed or not is not applied in identifying residuals within the framework of the SEEA. The SEEA proposes to describe all residuals of the economic process in a common framework independent of the question whether or not they are produced for intended use (and treated as products in the SNA). Division 39 of the CPC (wastes or scraps) comprises the domestic or imported wastes and scraps that are marketed. In monetary accounts, these materials should be included in the flows of products. In physical accounts, they could be shown together with non-marketed residuals.

239. Table 3.5 shows the origin and destination of residuals in physical units within the framework of version III of the SEEA. Residuals are categorized in the table according to their state or condition, namely solid, liquid, gaseous, and so on (rows 6-18). Further characteristics for the classification of residuals (pollutants) could be their physical and chemical composition. Various classifications have been proposed by the Economic Commission for Europe (United Nations, Economic Commission for Europe 1989b, 1989c, 1990, 1991b, 1992b).

240. The flows of residuals are subdivided in table 3.5 with regard to their destination, that is, their discharge into the natural environment or into environmental protection facilities. Residuals that are discharged without or after treatment or storage in environmental protection facilities into the natural environment (water, air or soil), are described in rows 6-12 of table 3.5. The shift of residuals from origin to destination is shown by indicating their origin with a minus sign (−) and their destination with a plus sign (+). With respect to residuals that are treated or stored in environmental protection facilities, corresponding flows are described in rows 13-18 of table 3.5. Their origin is again marked with a minus sign and their destination in environmental protection facilities with a plus sign. A further distinction could be made with regard to the domestic or foreign origin of residuals.

Table 3.5 SEEA matrix with linked physical and monetary accounting (version III): residual flows

		1.1 Domestic Production of industries					2 Final consumption	3 Non-financial assets (uses and stocks of assets)						4 Exports	5 Total uses	
		Recycling	Waste treatment and disposal	Protection of ambient water, ground water and soil	Protection of ambient air and climate, other environmental protection activities	Other industries		3.1.1 Produced assets of industries		3.2 Non-produced natural assets						
								3.1.1.1 Man-made	3.1.1.2 Natural	3.2.1 Wild biota 3.2.2 subsoil	3.2.3 Water	3.2.4 Air	3.2.5 Land (soil, area)		Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**						B	B A	B A	B A	B A	B	B** A			
	Use of products of industries (2.1)															
2	Wastes or scraps 39	A				A	A							A	A	A
3	Other 01-38 41-99	B A	B A	B A	B A	B A	B A	B A	B A	A			A	B A	B A	B A
	Use of non-produced natural assets (3.1)															
4	Depletion of natural assets (3.1.1.1)		B (+)	B (+)		B (+)	B (+)			B (-)	B (-)	B (-)	B (+,-) B** (+,-)	B (+)		B (-)
5	Use of land, landscape etc. (3.1.2)															
	Discharge of residuals (3.1.3)															
6	Solid wastes	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)		B (+)		B (+)	B (+)		B (-)
7	Liquid wastes	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)		B (+)		B (+)	B (+)		B (-)
8	Cooling water					B (-)					B (+)					
9	Other waste water	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)		B (+)		B (+)	B (+)		B (-)
10	Solid particles	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)				B (+)				
11	Inorganic gases	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)				B (+)				
12	Organic gases	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)	B (-)				B (+)				
	Economic treatment, storage of residuals (3.2)															
13	Solid wastes	B (+,-)	B (+,-)	B (-)	B (-)	B (-)	B (-)	B (+,-)	B (-)							B (+)
14	Liquid wastes	B (+,-)	B (+,-)	B (-)	B (-)	B (-)	B (-)	B (+,-)	B (-)							B (-)
15	Other waste water	B (+,-)	B (-)	B (+,-)	B (-)	B (-)	B (-)	B (-)	B (-)							
16	Solid particles	B (-)	B (-)	B (-)	B (+,-)	B (-)	B (-)	B (-)								
17	Inorganic gases	B (-)	B (-)	B (-)	B (+,-)	B (-)	B (-)	B (-)								
18	Organic gases	B (-)	B (-)	B (-)	B (+,-)	B (-)	B (-)	B (-)								
19	**Use of produced fixed assets (3.3)**	A (+)	A (+)	A (+)	A (+)	A (+)		A (-)	A (-)							
20	Net value added/NDP (4.2.2)	B* A	B* A	B* A	B* A	B* A	B*									
21	**Gross output of industries (5.1)**	B A	B A	B A	B A	B A										
22	**Other volume changes, revaluation (6/7, except 6.1.1 (physical data))**						B	B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B** A (+,-)			
23	**Closing stocks (8)**						B	B A	B A	B A	B A	B	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data.

241. The column classification of the scheme is similar to that of other versions of the SEEA. Environmental protection activities are disaggregated to identify residual flows for recycling, treatment or disposal purposes. Internal and external environmental protection activities are not separated so as to simplify the description of residual flow accounts. Residuals also contain marketed wastes and scraps (CPC division 39). The row classification of discharged or treated/stored residuals (table 3.5, rows 6-18) has already been discussed above. The domestic origin of residuals could be production, final consumption of households or economic assets. Furthermore, marketed or non-marketed residuals could be imported from the rest of the world.

242. The residuals originating from produced assets could have differing characteristics. Economic assets themselves become residuals after their normal economic lifetime or because of unforeseen events like natural disasters or wars. Liquid or solid wastes are partly disposed of in controlled landfills. Those wastes are eventually discharged into the natural environment. The residuals of controlled landfills that enter the natural environment (soil, groundwater, air) within the accounting period are considered part of the residuals of produced assets.

243. The destination of residuals includes environmentally sound uses such as reuse or recycling, treatment and disposal by environmental protection activities. To a great extent, however, residuals are discharged directly into the natural environment. Environmental protection activities of households are also taken into account. A further disaggregated scheme could show those activities in a separate column of the final consumption of households (subsection B (3) in chapter II of the handbook). As input of land areas, controlled landfills of wastes are shown in the column under man-made produced assets (of industries), and uncontrolled "landfills", in other words, waste dumps, in the column under land (soil, area). If residuals are discharged into other components of the natural environment, they are shown as input of domestic environmental assets (soil, water, air) or as "exports" to the foreign environment.

244. If residuals are inputs of environmental protection activities (+), they eventually become —whether unchanged or treated—an output (−) of those activities. After treatment, the residuals of the environmental protection facilities are recycled, treated again, disposed of or discharged into an ambient medium: soil, water or air. Similar to product flows as treated in national accounts, some residuals have an intermediate character (reflecting reuse, recycling, treatment and so on), some are stored like the stocks of products and some leave the domestic economy (exports). If residuals are treated, both the untreated inputs and the treated outputs are shown. In the case of residual disposal, notably the collection and transportation of wastes, the same wastes are recorded twice, as input and output of the disposal activities. This is adequate treatment, especially for physical flow accounts. In monetary accounts, such activities (trade, transportation) could be shown on a net basis.

(d) Asset accounts

245. The physical asset accounts in the SEEA do not aim at completeness. Opening and closing stocks in physical terms should be calculated in so far as such data support the analysis

of environmental-economic interrelationships, especially in the compilation of imputed environmental costs (version IV of the SEEA). A comprehensive picture of the natural environment could be given in overall frameworks of environment statistics, such as the Framework for the Development of Environment Statistics (FDES), (United Nations, 1984) and the framework of natural patrimony accounting (INSEE, 1986b, Weber, forthcoming). The concepts of physical accounting in the SEEA take into account, as far as possible, the definitions and classifications of those frameworks to facilitate linkages between monetary accounting and physical data bases.

246. The links between the non-financial asset accounts in monetary terms (version II of the SEEA, particularly subsection C (4) of chapter II and table 2.6) and the SEEA asset accounts of version III are described in an expanded table 3.6. The column classification of table 3.6 and the corresponding table on asset accounts in monetary terms (table 2.6) are identical. The row classification of table 2.6 is extended by introducing six rows showing the volume changes connected with the use of non-produced assets in physical terms (table 3.6, rows 3-8). The classification of other rows is the same in tables 3.6 and 2.6. (in table 2.6, rows 1-19; in table 3.6, rows 1 and 2, 9-25).

247. Physical data on the economic use of the natural environment are treated differently from the corresponding monetary data in table 3.6. This treatment is the same as that explained above for table 3.3. Physical data are recorded as uses of non-produced natural assets (3.1) in the flow accounts that connect the asset accounts of the SEEA with the activity accounts (production activities of industries, household consumption activities). Monetary data corresponding to these economic uses of the natural environment remain, in version III of the SEEA, part of other volume changes, in line with the treatment in the SNA. In version IV, presented in chapter IV, a concept of capital accumulation has been introduced that extends the traditional SNA concept of capital formation. Correspondingly, the monetary values of the economic uses of the natural environment are shifted from other volume changes to uses of non-produced assets accounts.

248. The depletion of wild biota, subsoil assets and water is shown in rows 3 (physical data) and 10 (monetary data). Physical flows of soil erosion are described in row 4 as flows from the asset soil (column 7) to the natural asset water or land (columns 5, 8 and 9). The corresponding monetary values are changes in market values of cultivated land due to soil erosion (row 12, column 8).

249. Degradation of land connected with changes in land use can usually be described in physical terms as changes in land areas, classified by type of land cover, and this often also implies a description of the type of ecosystems connected with the areas (table 3.6, row 5, columns 8 and 9). The corresponding monetary data on changes in market values due to changes in land quality resulting from changes in land use are shown in row 11. The change in land use is recorded in monetary terms in two steps: (a) shift from one type of use to another which implies only a classification change and has no impacts on the total market value of land (row 18), and (b) immediate changes in land quality connected with change in land use

Table 3.6. Non-financial assets accounts of the SEEA with monetary and physical data (version III)

			3.1.1 Produced assets of industries CNFA 1		3.2 Non-produced natural assets CNFA 2.1						
			Man-made CNFA 1.1 2.2	Natural CNFA 1.2	Wild biota CNFA 2.1.1	Subsoil assets CNFA 2.1.2	Water CNFA 2.1.4	Air CNFA 2.1.5	Land (including ecosystems) CNFA 2.1.3		
									Soil CNFA 2.1.3.1	Land areas: Cultivated CNFA 2.1.3.2	Land areas: Uncultivated CNFA 2.1.3.3
			1	2	3	4	5	6	7	8	9
1	Opening stocks (1)		B A	B A	B A	B A	B A	B	B	B** A	B** A
2	Use of products of industries (2.1)		B A	B A		A				A	
	Use of non-produced natural assets (3.1)										
	Depletion (3.1.1.1)										
3	Wild biota, subsoil assets, water				B (-)	B (-)	B (-)				
4	Soil erosion						B (+)		B (-)	B (+)	B (+)
	Degradation of land (3.1.2)										
5	Connected with changes in land use									B** (+,-)	B** (+,-)
6	Due to economic use (except soil erosion)									B** (+,-)	B** (+,-)
7	Discharge of residuals (3.1.3)		B (-)	B (-)			B (+)	B (+)	B (+)		
8	Economic treatment of residuals (3.2)		B (-)	B (-)							
9	Use of produced fixed assets (3.3)		A (-)	A (-)							
	Other volume changes (o.v.c.) of non-produced natural assets due to economic uses	COVC 1									
	O.v.c. of non-produced assets due to economic uses	1.1									
10	Depletion	1.1.1			A (-)	A (-)	A (-)				
11	Changes in land quality connected with changes in land use	1.1.2								A (+,-)	
	Degradation of land (except by residuals)	1.1.3									
12	Soil erosion	1.1.3.1								A (-)	
13	Other	1.1.3.3								A (-)	
14	Discharge of residuals	1.1.4					A (-)			A (-)	A (-)
15	Restoration	1.1.5			A (+)		A (+)			A (+)	A (+)
	O.v.c. of non-produced assets due to other economic causes	1.2									
	Discovery and adjustments	1.2.1									
16	Discovery	1.2.1.1			B A (+) (+)	B A (+) (+)	B A (+) (+)				
17	Adjustments of volume	1.2.1.2			B A (+,-)	B A (+,-)	B A (+,-)				
18	Changes in classification and structure	1.2.2								A (+,-)	A (+,-)
	Other volume changes due to natural or multiple causes n.e.c.	COVC 2									
19	Net natural increase	2.1			B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)
	Catastrophic losses	2.2									
20	Natural causes	2.2.1	B A (-) (-)	B A (-) (-)	B A (-) (-)		B A (-) (-)		B (-)	B** A (-) (-)	B** A (-) (-)
21	Economic causes	2.2.2	B A (-) (-)	B A (-) (-)	B A (-) (-)		B A (-) (-)		B (-)	A (-)	A (-)
22	Political events	2.2.3	B A (-) (-)	B A (-) (-)	B A (-) (-)					A (-)	A (-)
23	Other volume changes n.e.c.	2.3	B A (+,-)	B A (+,-)	B A (+,-)		B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)
24	Revaluation due to market price changes (7)		A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)			A (+,-)	A (+,-)
25	Closing stocks (8)		B A	B A	B A	B A	B A	B	B	B** A	B** A

Note: A-matrices denote monetary data (market values); B-matrices physical data.

(involving, for example, deterioration of ecosystems, establishment of an economic infrastructure) which may lead to higher market values (row 11, column 8).

250. Degradation of land due to recurrent land use practices—for example, agricultural or recreational use (except soil erosion)—could be described through categorizing of land areas by quality class (for example, quality of soil, quality of ecosystems). Thus, land areas have to be cross-classified by type of appearance (with additional information on type of use, if necessary) and by type of quality of soil and ecosystems (row 6, columns 8 and 9, which would contain the necessary B^{**} matrices). The corresponding monetary data on market value changes are recorded in row 13 (column 8).

251. The physical flows of residuals (row 7) reflect only the immediate discharge from domestic activities into the natural environment during the accounting period. The direct recipients of the residuals are the environmental media: air, water and soil (columns 5-7). Changes in the market values of water or land due to the discharge of residuals (row 14, columns 5, 8 and 9) reflect the quality changes of these natural assets in the accounting period. The quality change could be brought about by the discharge of residuals of present economic activities, or, in the case of time-lags between emissions and quality changes, of past ones. The residuals degrading the domestic environment can be of domestic as well as of foreign origin. Thus, the physical counterpart of the changes in market values (row 14) are not the residual flows in the accounting period (row 7) but quality indicators of the stocks of natural assets at the beginning and the end of the reporting period (rows 1 and 25, columns 5, 8 and 9). These quality indicators could be based on variation in ambient concentrations of residuals in water and soil.

252. Discoveries and volume changes due to natural or multiple causes (rows 19-22) are shown in monetary as well as physical terms as "Other volume changes". The item "Other volume changes n.e.c." (row 23) is used as a balancing item if it is not possible to associate volume changes that have occurred in the accounting period with specific types of causes. Finally market price changes of assets that affect only the nominal level of non-financial assets, are shown as "revaluation due to market price changes" (row 24 of table 3.6). This item corresponds to the item "nominal holding gains/losses" (K.11) in the SNA.

IV. Imputed environmental costs

A. Imputed environmental costs in the SEEA: overview

1. Costs caused and costs borne

253. Environmental costs are the costs that are connected with the actual or potential deterioration of natural assets due to economic activities. As already mentioned in chapters II and III, those costs can be viewed from the perspective of two different concepts (Bartelmus and van Tongeren, forthcoming), namely:

(a) Costs caused, that is, costs associated with economic units actually or potentially causing environmental deterioration by their own activities;

(b) Costs borne, that is, environmental costs borne by economic units independent of whether they have actually caused or might potentially cause environmental deterioration.

254. These two concepts correspond to two possible questions regarding the impacts of economic activities on the environment:

(a) Should the analysis focus on the immediate environmental impacts of economic activities of a specific country in a specific time-period independently of the question at which time and in which country those impacts will cause environmental deterioration;

(b) Should the analysis focus on the state of the environment and its effects on human well-being in a specific country in a specific time-period independently of the question which economic activities have caused environmental deterioration and when.

If the first approach is followed, cost-caused concepts are needed; with the second, there is a need for cost-borne ones.

255. As already discussed, the relationships among economic activities causing environmental deterioration, and the repercussions of the deteriorated natural environment on the population and its activities, are complex and therefore difficult to measure and analyse. The impacts of economic activities on the natural environment do not follow administrative boundaries and the environmental deterioration involved often entails a substantial time-lag (in the cases, for example, of climate change and decrease in the extent of the ozone layer). That time-lag becomes even more pronounced if effects on human health and well-being are to be assessed. The description of immediate impacts on the natural environment in a specific country during a specific time period thus may not always reveal the full risk to the environment and to people within and beyond the boundaries of that country.

256. The SEEA focuses on the question of who is responsible (accountable) for deterioration of the natural environment. This implies that the association of environmental costs with the economic activities causing environmental deterioration is given high priority. The reasons lie with the relevance of accountability in integrated policies and management for sustainable development (World Commission on Environment and Development, 1987) and with data availability, which is usually more established for immediate environmental impacts than for consequential effects on human beings and ecological systems. However, besides the question of who is responsible for environmental stress, that of who is suffering in response to the deterioration of nature has also to be raised (Friend and Rapport, 1979; United Nations, 1984). As shown below, such analysis introduces further problems of measurement and valuation.

257. Costs caused are assessed by applying a maintenance cost valuation concept. Maintenance costs are those costs that are required to prevent or mitigate a deterioration of the natural environment. This concept reflects the requirements for achieving a country's economic development under the constraints of maintaining the natural environment quantitatively and qualitatively intact.

258. By contrast, the costs-borne concept would tend to apply valuation methods that are consistent with the values accorded to environmental impacts by the economic agents (households, establishments) themselves. In the case of production activities, the costs borne are estimated in the SEEA only in so far as they reflect actual or imputed *market values*. Thus, only those costs are taken into account. The use of the cost-borne concept implies that elements of other volume changes, shown in the accumulation accounts of the SNA, are treated as cost and thus integrated with the production accounts of the SNA.

259. In estimating the effects of environmental impacts on human welfare (health, well-being), methods of contingent valuation (namely the willingness-to-pay approach and similar methods) have been proposed. Such valuation could be seen as a substitute for missing market valuations of the burden caused by the deteriorated quality *inter alia*, of air, water, land and ecosystems (OECD, 1989; Schulz and Schulz, 1989; Pearce, Markandya and Barbier, 1989; Peskin, 1991, forthcoming) and borne by households and individuals. According to this approach, households could be questioned on the extent to which they are willing to reduce their income or consumption level to attain a natural environment not impaired by economic activities.

260. The imputations necessary for achieving comprehensive estimates of costs caused and costs borne are presented in the present chapter within the three versions of the SEEA that reflect three different valuation methods:

(a) Version IV.1: costs borne valued at market values. The first version describes the additional costs borne by industries. Those costs are estimated at market values and include only those costs associated with the valuation of natural and other assets whose value is affected by production activities. This version takes into account those cost elements that are already included in the conventional SNA but treated there as elements

of the accounts of other volume changes and not taken into account in the calculation of GDP;

(b) Version IV.2: costs caused valued at maintenance costs. The second version applies the maintenance cost concept. The imputed maintenance costs are treated as additional costs of economic activities and as a corresponding decrease in the value of the natural and other assets immediately affected;

(c) Version IV.3: costs borne valued at market and contingent values. The third version extends the cost-borne concept by taking into account not only additional imputed costs borne at market values by industry, but also costs borne at contingent values by households.

261. The concepts of environmental costs caused and costs borne are supplemented by the recording of the expenditures corresponding to restoration activities actually carried out. Such activities aim at the improvement of the natural environment and therefore partly or completely counteract the environmental impacts of economic activities. The restoration activities are valued on the basis of actual expenditures, which could be interpreted as constituting maintenance costs for correcting (reducing) the imputed costs caused, or as market values (when they reduce the imputed costs borne).

2. Imputed versus actual costs

262. Both the cost-caused and the cost-borne concept involve actual costs (which are already part of the conventional SNA, though they are not always shown explicitly) and imputed environmental costs, which are recorded as additional cost items in the SEEA. The different types of actual environmental costs are described in version II of the SEEA. In this subsection, they are compared with imputed environmental costs and categorized in a somewhat different manner.

263. Actual and imputed environmental costs can be categorized, according to the different types of uses of the natural environment, as:

(a) Depletion costs, which refer to the quantitative depletion of natural assets (for example, biological assets, subsoil assets and water) by economic activities. The depleted natural resources are used as raw materials in production or consumption;

(b) Degradation costs, which reflect the qualitative deterioration of the natural environment by economic activities. The qualitative impacts on the environment could comprise the deterioration of landscape and ecosystems caused by economic use or the discharge of residuals of economic activities into the natural environment. Degradation costs could refer to the costs caused by economic activities or to those related to the effects of a degraded nature borne by industries and households. Actual restoration costs that improve

environmental quality may diminish current or past degradation costs. They can be viewed as expenditures that reduce current (imputed) costs caused or current costs borne (generated in current or past accounting periods).

264. Table 4.1 gives an overview of the different types of environmental costs that are taken into account in the SEEA. The different items are illustrated by the numerical example of the SEEA. An overview of the different types of costs valuation methods is given below. Further details are discussed in section B below.

265. As far as possible, imputed environmental costs caused are valued at maintenance costs. They reflect, apart from correction items for restoration benefits (row 5 of table 4.1), costs caused by own economic activities of industries and households. Restoration refers to government activities assumed to counteract current costs caused only in the same amount (5.0).

266. The depletion of natural assets (17.5 and 0.7) is valued at the (hypothetical) imputed costs required to reduce the depletion process in order to regain the previous quantitative level of natural assets. This concept can be applied in the case of biological or cyclical (water) assets, where depletion could be offset by natural growth or replenishment. In the case of subsoil assets, depletion could in most cases only be reduced through more efficient use or changing production and consumption patterns. The remaining reduction would have to be counterbalanced by the accumulation of other types of assets, compensating for future income losses while ensuring environment-friendly production (for example, Hueting, Bosch and de Boer, 1991). The degradation of natural assets could be valued at the costs necessary for preventing or mitigating environmental impacts caused by the spatial use of land (9.0 and 0.8) or the discharge of residuals (33.3, 13.3, 5.1, 2.3).

267. Imputed depletion costs borne (11.3 and 0.3) reflect the depletion of natural assets caused and borne by own activities of industries and households. The difference between depletion costs caused and costs borne can be assessed by comparing the results of the different valuation methods (maintenance cost versus market values).

268. Imputed degradation costs borne reflect the repercussions of the deteriorated natural environment on industries and households, partly counterbalanced by restoration activities of the government (increase in market value of assets due to restoration: − 2.0). Environmental effects can be caused by own or other economic activities. Repercussion costs borne by industries reflect the decrease of the market values of natural assets due to the use of land (in the example, caused by soil erosion: 1.1) and to the qualitative deterioration of natural assets by pollution (10.1). Those market values are part of other volume changes in versions II/III of the SEEA. Furthermore, the repercussion costs of households (for example, health or recreational effects) as a consequence of the qualitative deterioration of landscape and ecosystems (12.3) and of pollution of environmental media (63.0) are taken into account. They are valued by the contingent valuation method.

Table 4.1 Imputed and actual environmental costs of economic activities in the SEEA: numerical example

(Monetary units)

		Imputed environmental costs		Actual environmental costs	
		Production activities of industries	Household consumption activities	Production activities	Household consumption activities
		1	2	3	4
	Costs caused	59.9	17.1	54.1	8.8
1	Depletion costs [a/]	17.5	0.7	0.0	0.0
	Degradation costs				
	Prevention costs [a/]				
2	Use of land etc.	9.0	0.8	0.0	0.0
	Discharge of residuals				
3	Current activities	33.3	13.3	47.7	7.7
4	Use of produced assets	5.1	2.3	6.4	1.1
5	Restoration costs [b/]	-5.0	0.0		
	Costs borne	20.5	75.6	78.7	21.5
6	Depletion costs [a/]	11.3	0.3	0.0	0.0
	Degradation costs				
	Prevention costs [b/]				
7	Use of land etc.			0.0	0.0
	Discharge of residuals				
8	Current activities			47.7	7.7
9	Use of produced assets			6.4	1.1
	Repercussion costs [b/]				
10	Use of land etc.	1.1	12.3	0.0	0.0
11	Discharge of residuals	10.1	63.0	19.6	12.7
	Restoration costs [a/]				
12	Non-market producers	0.0		5.0	
13	Others	-2.0		0.0	0.0

a/ Caused by own economic activities.

b/ Caused by own and other economic activities.

269. The actual expenditures to prevent environmental deterioration (47.7, 7.7, 6.4 and 1.1) are at the same time costs caused and costs borne for the economic units that are actually or potentially deteriorating the natural environment. Together with the restoration costs those costs are part of the costs of environmental protection (subsection B (4) of chapter II above).

270. In addition to prevention costs, actual costs borne comprise the actual costs (expenditures) resulting from the repercussions of environmental deterioration, that is, the environmental diseconomies caused by others (for example, additional depreciation of produced assets, cleaning costs, additional household expenditures for travelling to distant recreational areas, and additional health expenditures: 19.6 and 12.7) and actual restoration costs (5.0). These actual restoration activities lead, in the case of non-market producers (government) to corrections of imputed costs caused (assumed for the sake of simplicity to be equal to maintenance costs: − 5.0) and of imputed costs borne (change in the market values of natural assets: − 2.0). In the case of industries, imputed costs caused are calculated on a net basis, that is, by valuing net physical impacts only.

271. Environmental costs caused and borne are compared in table 4.2. Total costs caused amount, after corrections with regard to restoration activities, to 139.9. This total comprises actual expenditures to prevent environmental deterioration (62.9) and imputed costs reflecting the impacts of economic activities on the natural environment (18.2 + 63.8 − 5.0 = 77.0). Total costs borne (196.3) include costs of activities aimed at avoiding (preventing) environmental deterioration (62.9), costs connected with the depletion of natural assets (11.6), costs of repercussions of deterioration on the natural environment (32.3 + 86.5 = 118.8) and restoration costs (5.0 − 2.0). The last reflects an increase in actual costs borne (5.0), which is assumed to correspond to an increase in the market value of assets restored and thus to a decrease in imputed costs borne (− 2.0).

3. Extension of the SEEA matrix (version IV)

272. Version III of the SEEA, presented in chapter III, showed the conventional monetary data of the SNA in combination with physical data on economic-environmental interrelationships. The introduction of imputed environmental costs provides the monetary counterpart of physical flows, operating beyond the market-based valuation concepts of the SNA. Tables 4.3-4.8 present versions IV.1, 2 and 3 of the SEEA, which are derived from versions II and III by introducing such imputed environmental costs. The row and column classifications are identical for all the tables so as to facilitate the comparison of the different versions.

273. The accounting items created in connection with the introduction of imputed environmental costs are denoted as C-matrices. In version IV of the SEEA (tables 4.3, 4.5 and 4.7) the monetary data of rows 4-11 and 15-18 contain the C-matrices. A comprehensive description of economic-environmental interrelationships could be based on the combined use of conventional monetary data (A-matrices of version II), the additional physical data of version III (B-matrices) and monetary data on imputed environmental costs (C-matrices), as indicated

Table 4.2 Comparison of environmental costs caused and environmental costs borne: numerical example

(Monetary units)

	Costs caused	Costs borne
Depletion costs		
Actual	0.0	0.0
Imputed	18.2	11.6
Degradation costs		
Prevention costs		
Actual	62.9	62.9
Imputed	63.8	
Repercussion costs		
Actual		32.3
Imputed		86.5
Restoration costs		
Actual		5.0
Imputed	-5.0	-2.0
	139.9	196.3

in the tables. Version IV of the SEEA (compared with version III) contains additional rows. Those rows refer to monetary flows related to the introduction of imputed environmental costs (rows 11, and 15-18). They have no physical counterpart and were therefore not presented in version III.

274. Imputed environmental costs are shown for three types of uses of the natural environment: quantitative depletion of natural assets (rows 4 and 5); use of land, landscape etc. except as a sink for residuals (row 6); and use of the disposal function of the natural environment (rows 7-9). The actual or potential deterioration of the natural environment can be partly or completely mitigated by restoration activities (row 10) depending on the estimation of the cost of such deterioration (on a net or gross basis: subsection A (2) above).

275. In the new row ("Shift of environmental costs": row 11), imputed environmental costs of final uses (individual consumption (column 3) and use of produced assets (columns 5 and 6)) are transferred to domestic production of industries. This shift is introduced in order to account fully for the social cost of environmental degradation. This accounting convention permits the treatment in the SEEA of the production of residuals by household consumption as a negative output of household production. In version V of the SEEA, the concept of household production is introduced explicitly for the description of the costs and benefits of household activities. In version IV, such an extension of the production boundary of the SNA is avoided by means of the cost-shifting technique.

276. The imputed environmental costs recorded in rows 4-11 of the SEEA, version IV, increase the inputs of industries. It has been suggested that the quantitative depletion of natural assets be interpreted as a decrease in inventory stocks (El Serafy, 1989, forthcoming). Thus, the costs of depleting natural assets increase industries' intermediate consumption. However, from the perspective of the role of natural resources in production and income generation, their depletion could be interpreted also as a depreciation of fixed assets (Bartelmus, Lutz and Schweinfest, 1992). In particular, the use of the natural environment, resulting in the degradation of environmental quality, could be interpreted as a depreciation of natural assets analogous to consumption of fixed capital in the SNA.

277. The additional recording of imputed environmental costs leads, other things being equal, to a decrease in the net domestic product (NDP) of the economy. The net domestic product diminished by the imputed environmental costs of industries is called the environmentally adjusted domestic product or, for short, the eco domestic product (EDP) (row 15). Two main versions of EDP can be distinguished according to the valuation methods applied to environmental costs:

(a) EDP at market values. In version IV.1 of the SEEA, the compilation of EDP takes into account imputed environmental costs at market values only. That version can be considered the basic version with respect to introducing imputed environmental costs. The market valuation concept used in that version is consistent with the valuation concepts used in the conventional SNA. The data needed for estimating imputed

environmental costs are already contained in the traditional SNA framework as part of other volume changes;

(b) EDP at maintenance costs. In version IV.2 of the SEEA, the compilation of EDP takes into account imputed environmental costs at maintenance values, reflecting the cost-caused concept. The maintenance cost approach permits the inclusion of a wider range of (non-market) phenomena in the field of environment and is particularly significant in elaboration of strategies of sustainable development. That approach requires more complex assumptions and analyses (see, for example, Nyborg, forthcoming).

278. Version IV.3 of the SEEA takes into account imputed environmental costs with a combination of market and contingent valuation, reflecting the cost-borne concept. A corresponding concept of EDP at cost-borne values could thus in principle be derived from this version. However, the application of contingent valuation methods in national accounting is controversial, as it uses techniques of valuation that are based on the revealed preferences of individuals (section D). Such techniques have been applied with (limited) success in project or programme evaluation, and it remains to be seen if they can be extended to the assessing of (environmental) cost and benefits for the whole economy.

279. Versions IV of the SEEA, also contain information on conventional net value added/NDP (row 19 of the matrix). Consequently, comparisons of the different aggregates (EDP and NDP) can be made directly in the SEEA matrix without supplementary information. The balancing item between EDP (at market values) and conventional NDP is denoted as eco-margin (row 18 of the SEEA matrix). The eco-margins of different industries present imputed environmental costs at market values with negative signs.

280. The following are the relations between the EDP and NDP concepts used in versions IV.1, IV.2 and IV.3 (rows 15-19):

	EDP (versions IV.1, IV.2, IV.3)
±	Adjustments due to market valuation (for imputed environmental costs at market values) (only in versions IV.2 and IV.3)
=	EDP at market values (version IV.1)
+	Eco-margin
=	NDP

This presentation permits a demonstration of deviations from the generic SNA valuation concept of market values by means of an adjustment element introduced explicitly in row 16. The contributions of the different industries to the EDP are called environmentally adjusted value added or, for short, eco value added (EVA). For each industry, a transition from its EVA to its net value added (NVA) can thus be shown in the SEEA matrix.

281. In the SEEA, versions II and III, other volume changes due to economic decisions include the volume changes of natural assets connected with the depletion or degradation of those assets (at market values). These volume changes are now treated as cost in the production accounts. They are recorded as an increase in the inputs of industries (imputed environmental costs) and as a corresponding decrease in the volume of natural assets.

282. The other volume changes due to economic decisions are, in addition to being treated as cost, also recorded in version IV of the SEEA as part of an extended concept of capital formation that is called capital accumulation. Capital accumulation comprises volume changes in produced assets, accounted for as capital formation in the capital accounts of the SNA, and volume changes in non-produced natural assets due to economic causes. The latter volume changes comprise the depletion and degradation of natural assets (COVC 1.1) and also changes due to other economic decisions, including discovery, adjustments due to new estimates and changes in classification and structure (COVC 1.2). The changes due to uses of non-produced national assets are described in rows 4-10 of the SEEA matrix. The changes due to other economic decisions are recorded as "Other accumulation of non-produced assets" and are not taken into account in the calculation of EDP (row 21 of the SEEA matrix). The impacts of restoration activities (row 10) are treated as correction items that diminish degradation costs and thus decrease the value of depreciation of the natural assets.

283. Volume changes in natural assets due to economic depletion or degradation are shown in rows 4-10 and in columns 6-13. Those volume changes normally have a negative sign because they reflect a decrease in the value of those assets. This decrease in asset values corresponds to additional imputed environmental costs' having a positive sign in the accounts of industries or other economic activities. An exception to this treatment is made in the case of restoration activities. The imputed negative environmental costs correspond to a positive change in the values of natural assets.

284. The adjustments due to market valuation (row 16 of the extended SEEA matrix) that are introduced to show the transition from versions IV.2 and IV.3 of EDP to EDP at market values (version IV.1) also serve to adapt the data on volume changes due to economic depletion and degradation according to version IV.2 of the SEEA. The valuation of volume changes at maintenance costs is not consistent with the valuation concepts of other stock and flow data of natural asset accounts. The opening and closing stocks of assets as well as other volume changes that are not shifted to the production accounts are valued at market values throughout the SEEA. Thus, adjustment items are necessary to facilitate the transition from maintenance cost valuation to market valuation. Apart from cross-boundary flows (to the rest of the world) of imputed environmental costs and corresponding changes in natural assets, the adjustments of the EDP are balanced by the adjustments of asset values.

B. Imputed environmental costs at market values (SEEA, version IV.1)

285. Qualitative and quantitative changes at market values in non-produced assets due to economic use are recorded, outside the central production accounts in the SNA, as part of "Other volume changes of assets accounts". Some of those volume changes are treated in the SEEA, version IV, as imputed environmental costs within the production accounts and as volume changes of assets within the capital accounts. They include the following items of the proposed classification of other volume changes of non-financial natural assets (COVC: annex E): quantitative depletion (1.1.1), quality changes due to changes in land use (1.1.2), degradation of land due to economic use (except by residuals: 1.1.3), degradation due to residuals (1.1.4) and volume changes through restoration (1.1.5).

286. An overview of the corresponding changes of the SEEA has already been given in subsection A (3). The implications of introducing imputed environmental costs at market values are described in detail below. Table 4.3 shows the general concepts of this version of the SEEA; table 4.4 presents a numerical example. Concepts of market valuation for estimating imputed environmental costs have already been discussed in chapter II and are not elaborated further here.

287. The different types of volume changes of non-produced assets are partly regrouped in tables 4.3 and 4.4. Whereas the items on depletion, degradation due to discharge of residuals and restoration remain unchanged, items on quality changes due to changes in land use (COVC 1.1.2) and on degradation of land due to land use practices (except discharge of residuals: (COVC 1.1.3)) are combined under "use of land, landscape etc.". Degradation of land as a consequence of its restructuring (connected with changing its type of use) and degradation due to soil erosion are the most important elements in this regard.

288. In the case of market valuation, economic depletion of natural assets refers only to non-produced assets. Depletion of produced natural assets (produced biota) is treated as part of (negative) capital formation in the produced asset accounts (table 4.3, row 2: use of products of industries). Depletion of non-produced natural assets (table 4.3, rows 4 and 5) comprises depletion of wild biota (column 7), of subsoil assets (column 8) and of water (column 9). In the numerical example, depletion of domestic non-produced natural assets amounts to 11.6 (table 4.4, row 4, columns 7-9). The SEEA also takes into account depletion of natural assets outside national jurisdiction by domestic economic activities in so far as depletion is not recorded as import of products, that is, impacts on global commons such as fish in the ocean (table 4.3, row 5).

289. As already explained in the SEEA, version III, physical flows connected with soil erosion brought about by economic activities are treated as involving a decrease in soil and an increase in the soil of the area to which the soil has been transported by wind or water. The monetary counterpart of these quantitative flows is a decrease in the market value of cultivated land recorded as part of value changes with regard to use of land, landscape etc. (table 4.3, row 6).

Table 4.3 SEEA matrix: environmental costs at market values (version IV.1) - general concepts

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (uses and stocks of assets) *									4 Exports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets								
		Agriculture, forestry, fishing ISIC 0	Other industries ISIC 1 -9	2.1 Individual consumption	2.2 Collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural (living) biota	3.2.1 Wild biota (living)	3.2.2 Sub-soil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)				
												3.2.5.1 Soil	3.2.5.2 Areas			
													Cultivated	Uncultivated		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	B A	B A	B A	A	B A	B A		A				A		B A	B A
3	Imports (2.1.2)	B A	B A	B A		B A	B A								B A	B A
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)				B C (-) (-)	B C (-) (-)	B C (-) (-)		B (-)		B (+)	B C (+) (+)	
5	Foreign origin (3.1.1.2)	B C (+) (+)	B C (+) (+)													B C (+) (+)
6	Use of land, landscape etc. (3.1.2)	C (+)	C (+)										B** C (+,-) (-)	B** (+,-)		
7	Discharge of residuals (3.1.3)	C (+)	C (+)					C (-)		C (-)			C (-)	C (-)		
8	Domestic origin (3.1.3.1)	B (-)	B (-)	B (-)		B (-)	B (-)			B (+)	B (+)	B (+)			B (+)	
9	Foreign origin (3.1.3.2)									B (+)	B (+)	B (+)				B (+)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)							B C (+,-) (+)			B** C (+,-) (+)			
11	Shift in environmental costs (3.1.5)	C (+)	C (+)	C (-)												
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)	B (+,-)	B (-)	B (-)		B (+,-)	B (-)								B (+)	
13	Foreign origin (3.2.2)	B (+)														B (+)
14	Use of produced fixed assets (3.3.1)	A (+)	A (+)			A (-)	A (-)									
15	Eco value added/EDP (4)	C	C													
16	Adjustments due to market valuation (4.1)															
17	Eco value added/EDP at market values (4.2)	C	C													
18	Eco margin (4.2.1)	C (-)	C (-)													
19	Net value added/NDP (4.2.2)	B* A	B* A	B*												
20	Gross output of industries (5.1)	A	A													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
22	Other volume changes due to natural, multiple causes (6.2)			B (-)		B A (-)	B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
23	Revaluation due to market price changes (7)					A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)			A (+,-)	A (+,-)		
24	Closing stocks (8)			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		

Note: A-matrices denote monetary data (market values); B-matrices physical data; and C-matrices imputed environmental costs.

Table 4.4. SEEA matrix: environmental costs at market values (version IV.1) - numerical example

(Monetary units)

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (uses and stocks of assets)									4 Exports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets								
		Agriculture, forestry, fishing ISIC 0	Other industries ISIC 1-9	2.1 Individual consumption	2.2 Collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural (living) biota	3.2.1 Wild biota (living)	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)				
												3.2.5.1 Soil	3.2.5.2 Areas			
													Cultivated	Uncultivated		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)					991.3	83.1	65.4	261.9	12.0			1366.7	50.4		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	8.1	176.0	148.7	42.5	61.8	1.4			2.7			4.6		71.6	517.4
3	Imports (2.1.2)	1.1	38.8	26.3		6.2	0.0								2.1	74.5
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	2.1	9.2	0.3				-2.1	-8.0	-1.5					0.0	
5	Foreign origin (3.1.1.2)	0.0	0.0													
6	Use of land, landscape etc. (3.1.2)	1.1	0.0										-1.1			0.0
7	Discharge of residuals (3.1.3)	3.4	6.7					0.0		-2.0			-6.5	-1.6		
8	Domestic origin (3.1.3.1)															
9	Foreign origin (3.1.3.2)															
10	Restoration of natural assets (3.1.4)	-0.5	-1.5							1.0			1.0	0.0		
11	Shift in environmental costs (3.1.5)		0.3	-0.3												
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)															
13	Foreign origin (3.2.2)															
14	Use of produced fixed assets (3.3.1)	3.5	22.8			-23.0	-3.3									
15	Eco value added/EDP (4)	19.4	226.9													
16	Adjustment due to market valuation (4.1)															
17	Eco value added/EDP at market values (4.2)	19.4	226.9													
18	Eco-margin (4.2.1)	-6.1	-14.7													
19	Net value added/NDP (4.2.2)	25.5	241.6													
20	Gross output fo industries (5.1)	38.2	479.2													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							0.0	27.8	0.0			3.4	-3.4		
22	Other volume changes due to natural, multiple causes (6.2)					-25.3	0.0	1.3	0.0	0.9			-4.3	-2.0		
23	Revaluation due to market price changes (7)					138.1	12.6	11.1	28.9	1.2			357.5	11.8		
24	Closing stocks (8)					1149.1	93.8	75.7	313.3	11.6			1721.3	55.2		

In the numerical example, the decrease in the market value of cultivated land due to soil erosion amounts to −1.1 (table 4.4, row 6, column 12).

290. Use of land, landscape and ecosystems (table 4.3, row 6) also comprises other changes in quality due to changes in land use (for example, volume changes caused by urban instead of agricultural use) and changes in quality occurring in the course of a specific type of use (such as degradation of soil quality by inappropriate agricultural use, for example, cultivation of steep slopes). Expenditures connected with land improvement are recorded as capital formation in the context of product flows (table 4.3 and 4.4: row 2, column 12; in the numerical example: 4.6). If land improvement is connected with a change in quality, the difference between the value of the expenditures and the change in the market value of land may reflect that change in quality, which would be recorded in row 6 of table 4.3 and of table 4.4. This implies that the volume change of land recorded in row 6, column 12, could have a positive or negative value and that the corresponding imputed environmental costs would be correspondingly negative or positive. In the numerical example of table 4.4, it is assumed that change in land quality at market values due to change in economic use is equal to the expenditures for land improvement (4.6). Thus, the corresponding volume change is zero and only the effects of soil erosion are shown in row 6, column 12.

291. The degradation of non-produced natural assets caused by the discharge of residuals of economic activities is reflected in version IV.1 only to the extent that pollution leads to a decrease in the market value of those natural assets. In tables 4.3 and 4.4, that decrease is recorded in row 7, columns 7-13. In the numerical example, the market value of water is diminished by 2.0, the value of land areas decreased by 6.5 and 1.6. The volume changes of fixed produced assets due to the discharge of residuals into the natural environment (and from there on to fixed assets) are recorded, in so far as those changes are identifiable as resulting in costs of the use of produced fixed assets (tables 4.3 and 4.4, row 14). Those costs are part of actual repercussion costs already described in chapter II.

292. A distinction between volume changes of non-produced natural assets due to the discharge of residuals of domestic origin and those due to the discharge of residuals of foreign origin will normally not be possible. The change in market values only reflects costs borne independent of the origin of this degradation. Thus, volume changes and the corresponding imputed environmental costs at market values are shown only in row 7 of table 4.3 and of table 4.4 without further distinction by origin (rows 8 and 9).

293. The degradation of natural assets is partly counterbalanced by restoration activities. Those activities are recorded with their impacts on the market values of natural assets as positive items in tables 4.3 and 4.4, row 10, columns 9 and 11-13. In the numerical example, it is assumed that restoration comprises in part activities related to the cleaning of water (column 9: 1.0), as well as those connected with restoring cultivated or uncultivated areas (column 12: 1.0; column 13: 0.0).

294. The market values of volume changes of natural assets shown in columns 7-13 correspond to the imputed environmental costs (with opposite sign) in columns 1-3 of tables 4.3 and 4.4. Supplementary transition matrices could show the different types of volume changes in a cross-classification by industry (or household activity) incurring the imputed environmental costs and by type of asset whose market value is affected.

295. In the case of depletion, imputed environmental costs are distributed among depleting industries and household consumption activities. In the case of degradation of natural assets, the industry using the degraded natural assets (mainly land) bears the imputed environmental costs. In this case, the use of land does not include its disposal function (the storing of the residuals of economic activities), but only its use for production purposes (for example, as agricultural land). The measurement of the cost incurred as a result of the impairment of the disposal function of land (and other media) is the objective of the maintenance cost approach of the SEEA, version IV.2, described below. Natural assets that have a market value but are not used (owned) by a specific industry or households are allocated to the government.

296. In the numerical example, industries of agriculture, forestry and fishing (ISIC divisions 01, 02 and 05) have imputed environmental costs of 6.1 (see the value of the eco-margin in table 4.4, row 18, column 1). Those costs comprise the depletion of water and wild biota (2.1) (table 4.4, row 4, column 1), costs of soil erosion (1.1) and costs borne because of the decreasing value of polluted land (3.4). The imputed environmental costs are partly offset by restoration costs (−0.5). The environmentally adjusted value added (EVA) at market values of the agriculture, forestry and fishing industries amount to 19.4, which is 6.1 less than the net value added (NVA) of those industries (25.5).

297. Other industries (column 2 of tables 4.3 and 4.4: ISIC 1-9) have total imputed environmental costs amounting to 14.7, which comprises depletion costs of 9.2 and (borne) degradation costs due to pollution of 6.7. These costs are partly balanced by restoration activities (− 1.5). The imputed environmental costs of the household consumption are allocated to "other production" through the shifting procedure described above. Those costs consist of depletion costs only (0.3). EVA of other industries amounts to 226.9 which is 14.7 less than their conventional NVA (241.6).

C. Maintenance cost approach (SEEA, version IV.2)

1. Costing sustainability

298. The maintenance cost approach is closely related to the sustainability concepts described in chapter I. Maintenance costs are the additional imputed costs that would have been incurred if the domestic economic activities of an accounting period had been modified or their impacts mitigated in such a way as not to have impaired the long-term quantitative and qualitative levels of the domestic and worldwide natural environment.

299. This cost concept is based on the principle of accountability (responsibility) of economic activities not only to the population of the country concerned but to all persons affected by such activities, including those outside national borders. This principle is acquiring increasing importance because of the growing awareness of the interrelationship between economic activities and the natural environment at national and international levels. (See, for example, the Rio Declaration on Environment and Development adopted by the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 (United Nations, 1993, resolution 1, annex I).)

300. Additional imputed environmental costs are associated with the economic activities that are the immediate causes of environmental stress, leading to a qualitative or quantitative deterioration of the natural environment. The imputed environmental costs of depleting non-produced biological assets are mainly recorded as additional costs of the industries of agriculture, forestry and fishing. The costs of depleting subsoil assets are recorded as additional costs of the mining sector. The costs of the deterioration of the landscape and ecosystems through changes in land use are recorded in the cost accounts of the industries directly responsible for these activities. In the case of the use of the natural environment as a sink for economic residuals, the corresponding imputed environmental costs are associated with the economic activities immediately responsible for the transfer (emission) of residuals from the economy to the natural environment.

301. The concept of immediate responsibility is introduced for theoretical and statistical reasons. It is difficult to identify the economic activity that is ultimately responsible. Economic activities interact to a great extent and it is nearly impossible to trace the chain of economic dependencies and corresponding synergistic or antagonistic effects on the environment. It could be argued that the final demand for products is ultimately responsible for all stages of intermediate production and their environmental impacts. Following this argument, the environmental costs of different production activities should be associated, by using input-output models, with the final use of products. Such modelling is outlined in section D of chapter V. The accounting framework of the SEEA, however, deals by definition with the assessment of the economic-environmental interaction during the past accounting period. It is an information system that should avoid the inclusion of data that are the result of modelling. The analysis of environmental costs focuses, therefore, on the economic units immediately responsible for environmental impacts since those impacts can be readily identified, measured and attributed to the accounting period.

302. Imputed environmental costs are thus estimated only for the economic activities of the current accounting period. They do not reflect changes in the natural environment caused by economic activities of previous periods. Imputed environmental costs are associated with economic activities only to the extent that those activities do or might imply an additional deterioration of the natural environment. Those costs may reflect the costs of avoiding such impacts on the natural environment. The degree of deterioration and the necessary avoidance activities depend, of course, on the present state of the natural environment: Contamination of an environment with nearly exhausted regeneration capacity might imply imputed prevention or

restoration costs higher than those connected with contamination of a relatively pristine environment.

303. The concept of maintenance costs corresponds to the method of calculating the value of the depreciation of produced fixed assets. According to the depreciation method applied in the SNA, the costs of using fixed assets are calculated with the monetary amount necessary to keep the level of those fixed assets intact. The aim of this approach is to achieve a level of assets that allows the sustaining of the same level of income in the future. Thus, it could be argued that the methods of estimating the costs of using produced as well as natural assets are oriented towards a concept of sustainability. As already discussed in chapter I, such sustainability aims at a broader scope that includes the emergence of further environmental standards, besides the maintenance of income flows.

304. The concept of maintaining natural assets quantitatively and qualitatively can be expressed in terms of the sustainability of the following different functions of the natural environment that are distinguished throughout this handbook:

(a) Quantitative use of natural assets (for example, depletion of raw materials);

(b) Spatial and qualitative use of land, landscape, ecosystems (except as a sink of residuals);

(c) Disposal of natural assets (use of the natural environment for assimilating the residuals of economic activities).

305. Sustainability implies that only biological assets should be exploited to the extent that their use is balanced by natural growth (while the quality of their habitats is maintained). Similarly, the sustainability of water resources would require that only the amount of water balanced by natural inflows should be abstracted. In the case of exhaustible subsoil assets, full sustainability would lead to non-use and thus to a squandering of the resource. This is hardly acceptable and the objective should therefore be to reduce depletion by more efficient use or substitution.

306. Regarding the spatial and qualitative functions of land, landscape and ecosystems (except for their use as a sink for residuals), sustainability aims at conserving the quality of land and the natural parts of the landscape along with their existing ecosystems. In the case of the disposal function of the natural environment, sustainability standards have to be set so that potentially harmful residuals are discharged into the natural environment only when they do not cause a deterioration of natural assets or when they are transformed into substances with no harmful effects on living beings.

307. Measures of five types for preventing or restoring environmental deterioration by economic activities can be distinguished (see also Hueting, Bosch and de Boer, 1991):

(a) Reduction in economic activities or complete abstention from specific activities;

(b) Substitutions among the outcomes of economic activities, that is, production of other products or modification of household consumption patterns;

(c) Substitutions among the inputs of economic activities, without modifying their outcomes (outputs), *inter alia*, by applying new technologies;

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

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

308. The calculation method for imputed depletion costs depends on the specific type of activity considered. When depletion results in a reduction in economic production (for example, in the context of depletion of biota or water), the decrease in contributions to NDP caused by diminished production activities represents the imputed depletion cost. In the case of substitution, additional substitution costs could be used for calculating depletion costs. If new environment-friendly industries have to be established to avoid a decrease in output, incremental costs could be calculated for the purpose of estimating depletion costs. Alternatively, the allocation of a part of the operating surplus for alternative investment, to the extent that a constant and permanent flow of income is the objective, has been proposed (El Serafy, 1989).

309. In the case of the discharging of residuals, different types of activities could be carried out so that such discharging adhered to environmental standards. Those activities include reduction in production and household consumption, modifications in the composition of products and in consumption patterns, and technological changes for the purpose of introducing environment-friendly technologies, as well as end-of-pipe technologies. The choice of activities for calculating the imputed degradation costs of discharging residuals will depend on relative costs and efficiencies. Imputed prevention costs of industries should be based on the most efficient method for meeting environmental standards. The choice of activities will also depend on available technologies for reducing residual discharge. Depending on the activities chosen, the imputed environmental costs of discharging residuals can involve hypothetical cost elements like reductions in net value added, reductions in household consumption expenditures, substitution costs and environmental protection costs of treating or storing those residuals.

310. In the case of degradation of land, landscape and ecosystems (except by residuals), possible maintenance activities could include abstention from, reduction in and relocation of economic activities to relieve the pressures on land areas. In general, changes in land use could prevent further qualitative decreases or restore deteriorated land areas. The valuation of the corresponding costs range from losses in net value added and household consumption to additional costs of substitution, migration and restoration.

2. Maintenance costs in the SEEA

311. Version IV.2 of the SEEA matrix describes possibilities of recording the imputed maintenance costs in the SEEA framework. The general concepts of this version are shown in table 4.5, and the corresponding numerical example is presented in table 4.6. Rows 4-9 of those tables encompass the imputed environmental costs that would be necessary to maintain the natural assets quantitatively and qualitatively. Those costs correspond to the value of the depletion and degradation of natural assets shown in the columns of natural assets (rows 4-9, columns 6-13).

312. Imputed depletion costs (table 4.5, rows 4 and 5) refer not only to non-produced natural assets (wild biota, subsoil assets, water) but also to produced biota in so far as maintenance costs of depleting this type of biota differ from the market value of depletion. Such maintenance costs are calculated only if depletion exceeds natural growth (positive net depletion). In this case, maintenance costs with regard to net depletion as recorded in the SEEA (table 4.5, row 4, column 6) are determined as the difference between maintenance costs and the market value of net depletion. The incremental costs could be viewed as ecological depletion that is not reflected in the valuation of economic functions of produced (natural) assets. In the numerical example, those costs amount to 0.9, making up the difference between maintenance costs and market values.

313. Depletion costs of the non-produced natural assets cover depletion of wild biota (in the example: 3.7), subsoil assets (8.9) and water (4.7). Again, the maintenance costs of depleting natural assets are calculated only to the extent that depletion exceeds natural increase. Depletion costs are associated with agriculture, forestry, fishing (4.8: produced biota, wild biota and water), other industries (12.7: subsoil assets and water) and household consumption activities (0.7: wild biota and water). The depletion of natural assets at maintenance cost values also comprises the depletion of natural assets by domestic activities in areas outside national jurisdiction (for example, catching fish in the ocean). In tables 4.5 and 4.6, depletion of foreign natural assets is shown in row 5 (0.0).

314. Maintenance costs of using land, landscape and ecosystems are recorded in row 6 of tables 4.5 and 4.6. Maintenance costs of cultivated land (7.7) are calculated in the cases of soil erosion and restructuring of land, for example, change of agricultural land into land for urban development. Maintenance costs of uncultivated land (2.1) refer to the destruction of ecosystems of uncultivated areas by production activities and by recreational use of such land. Imputed degradation costs are associated with the following activities: agriculture, forestry, fishing (soil erosion, restructuring of land and destruction of ecosystems: 5.5), other industries (restructuring of land: 3.5) and household consumption activities (recreational use of uncultivated land: 0.8).

315. Degradation costs of discharging residuals into the natural environment are shown in rows 7-9 of tables 4.5 and 4.6. They consist of costs connected with residuals of current economic activities (columns 1-3: 6.2, 27.1 and 15.6) and residuals derived from, or caused by, produced assets, including the environmental protection facilities for controlled storage of residuals

Table 4.5. SEEA matrix: environmental costs at maintenance values (version IV.2) - general concepts

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (uses and stocks of assets)									4 Ex-ports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets								
		Agri-culture, forestry, fishing ISIC 0	Other industries ISIC 1-9	2.1 Individual con-sumption	2.2 Collective con-sumption	3.1.1.1 Man-made	3.1.1.2 Natural (living) biota)	3.2.1 Wild biota (living)	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)				
												3.2.5.1 Soil	3.2.5.2 Areas			
													Cul-tivated	Uncul-tivated		
		1	2	3		5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	B A	B A	B A	A	B A	B A		A				A		B A	B A
3	Imports (2.1.2)	B A	B A	B A		B A									B A	B A
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	B C (+) (+)	B C (+) (+)	B C (+ (+)			C (+,-)	B C (-) (-)	B C (-) (-)	B C (-) (-)		B (-)		B (+)	B (+)	
5	Foreign origin (3.1.1.2)	B C (+) (+)	B C (+) (+)													B C (+) (+)
6	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (+)									B** C (+,-) (-)	B** C (+,-) (-)		
7	Discharge of residuals (3.1.3)															
8	Domestic origin (3.1.3.1)	B C (-) (+)	B C (-) (+)	B C (-) (+)		B C (-) (+)	B C (-) (+)			B C (+) (-)	B C (+) (-)	B C (+) (-)			B C (+) (-)	
9	Foreign origin (3.1.3.2)									B C (+) (-)	B C (+) (-)	B C (+) (-)				B C (+) (-)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)	C (-)	C (-)					B C (+,-) (+)		C (+)	B** C (+,-) (+)	B** C (+,-) (+)		
11	Shift in environmental costs (3.1.5)	C (+)	C (+)	C (-)		C (-)	C (-)									
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)	B (+,-)	B (-)	B (-)		B (+,-)	B (-)								B (+)	
13	Foreign origin (3.2.2.)	B (+)				B (+)										B (+)
14	Use of produced fixed assets (3.3.1)	A (+)	A (+)			A (-)	A (-)									
15	Eco value added/EDP (4)	C	C													
16	Adjustment due to market valuation (4.1)	C (+,-)	C (+,-)	C (+)	C (+)		C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+)	C (+,-)
17	Eco value added/EDP at market values (4.2)	C	C													
18	Eco-margin (4.2.1)	C (-)	C (-)													
19	Net value added/NDP (4.2.2)	B* A	B* A	B*												
20	Gross output of industries (5.1)	A	A													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
22	Other volume changes due to natural, multiple causes (6.2)			B (-)		B A (-)	B A (-)	B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
23	Revaluation due to market price changes (7)					A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)						
24	Closing stocks (8)			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		

Note: A-matrices denote monetary data (market values); B-matrices physical data; and C-matrices imputed environmental costs.

Table 4.6. SEEA matrix: environmental costs at maintenance values (version IV.2) - numerical example

(Monetary units)

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (Uses and stocks of assets)									4 Exports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets								
		Agriculture, forestry, fishing ISIC 0	Other industries ISIC 1 - 9	2.1 Individual consumption	2.2 Collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural (living biota)	3.2.1 Wild biota (living)	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)				
												3.2.5.1 Soil	3.2.5.2 Areas			
													Cultivated	Uncultivated		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**					991.3	83.1	65.4	261.9	12.0			1366.7	50.4		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	8.1	176.0	148.7	42.5	61.8	1.4		2.7				4.6		71.6	517.4
3	Imports (2.1.2)	1.1	38.8	26.3		6.2	0.0								2.1	74.5
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	4.8	12.7	0.7			-0.9	-3.7	-8.9	-4.7						0.0
5	Foreign origin (3.1.1.2)	0.0	0.0													
6	Use of land, landscape etc. (3.1.2)	5.5	3.5	0.8									-7.7	-2.1		
7	Discharge of residuals (3.1.3)															
8	Domestic origin (3.1.3.1)	6.2	27.1	15.6		5.1	0.0			-14.3	-20.4	-14.6			-4.7	
9	Foreign origin (3.1.3.2)									-1.6	0.0	0.0				-1.6
10	Restoration of natural assets (3.1.4)	0.0	0.0	0.0	-5.0					3.0		2.0	0.0	0.0		
11	Shift in environmental costs (3.1.5)	0.3	21.9	-17.1		-5.1	0.0									
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)															
13	Foreign origin (3.2.2)															
14	**Use of produced fixed assets (3.3.1)**	3.5	22.8			-23.0	-3.3									
15	**Eco value added/EDP (4)**	8.7	176.4													
16	Adjustments due to market valuation (4.1)	-10.7	-50.5	0.0	5.0		0.9	1.6	0.9	15.1	20.4	12.6	1.1	0.5	4.7	1.6
17	Eco value added/EDP at market values (4.2)	19.4	226.9													
18	Eco-margin (4.2.1)	-6.1	-14.7													
19	Net value added/NDP (4.2.2)	25.5	241.6													
20	**Gross output of industries (5.1)**	38.2	479.2													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							0.0	27.8	0.0			3.4	-3.4		
22	Other volume changes due to natural, multiple causes (6.2)					-25.3	0.0	1.3	0.0	0.9			-4.3	-2.0		
23	**Revaluation due to market price changes (7)**					138.1	12.6	11.1	28.9	1.2			357.5	11.8		
24	**Closing stocks (8)**					1149.1	93.8	75.7	313.3	11.6			1721.3	55.2		

(column 5: 5.1; column 6: 0.0). The residuals of domestic origin (row 8) are assumed to have only an immediate degrading effect on the domestic environmental media of water (− 14.3), air (− 20.4) and soil (− 14.6).

316. Imputed environmental costs are associated with the environmental media that are the immediate recipients of the residuals generated by economic activities. Such treatment does not take into account the further destination of residuals which may transfer from one medium to another or pass the boundaries of the territory and affect a foreign natural environment. Where residuals are transported by domestic economic units to a place outside the country without further treatment or storage, a negative flow of exports is recorded (row 8, column 14: − 4.7). This flow represents the degradation of natural assets outside national jurisdiction due to exported residuals. When foreign residuals are transported into domestic territory and discharged into the natural environment outside of controlled environmental protection facilities, an import of residuals with negative values is shown (row 9, columns 9 and 15: − 1.6).

317. Flows of residuals not directly discharged into the natural environment but treated or stored in environmental protection facilities, recycled or reused are shown in physical terms only (rows 12 and 13 of table 4.5). The corresponding monetary flows representing the value of the recycled materials or of the respective environmental protection services are recorded as part of product flows (row 2).

318. Restoration activities diminish actual environmental impacts and reduce the physical flows of damaging residuals or of imputed prevention costs estimated in the absence of any restoration during the accounting period. Their impacts on natural assets lead to a smaller net decrease in volume changes in monetary terms (tables 4.5 and 4.6, row 10). In the numerical example of the SEEA, it is assumed that actual restoration costs (table 4.6, row 10, column 4: 5.0) reduce the imputed environmental cost by the same amount in the case of restoration by the government. In the case of other restoration activity (by industry or households) only "net" flows of residuals are valued (accounting for internal restoration). The governmental restoration activities include the improvement of water and soil quality (row 10, column 9: 3.0, column 11: 2.0). Imputed environmental costs of household consumption activities (0.7 + 0.8 + 15.6 = 17.1) are shifted in row 11 (− 17.1) to other industries (part of 21.9 in column 2) and imputed costs of produced assets (5.1) are shifted to industries using (or having used) those assets for production purposes (columns 1 and 2). These transfers are necessary for calculating the EVA of those (and all other) industries while at the same time maintaining the conventional cost and value-added concepts of the SNA.

319. The EVA of the different industries (tables 4.5 and 4.6, row 15) is compiled as the difference between their gross output and their costs in using products and assets. In the numerical example, the EDP amounts to 185.1 (8.7 + 176.4). In row 16 of tables 4.5 and 4.6, adjustments for environmental cost are included for the purpose of arriving at the EDP in market values. Imports of residuals (1.6) plus the adjustments of the EDP are balanced with the adjustments for capital accumulation and exports (row 16, columns 6-14). The EDP at market

values (row 17) amounts to 246.3, as calculated in version IV.1. This identity in the two versions also holds for the value of the eco-margin.

D. Contingent valuation of the imputed repercussion costs of households (SEEA, version IV.3)

320. Valuation of the repercussions of a deteriorated natural environment on households is normally based on methods of contingent valuation, especially on the so-called willingness-to-pay approach. The application of this approach beyond project evaluation (cost-benefit analysis) has been advocated for policy analysis (OECD, 1989; Pearce, Markandya and Barbier 1989; Pearce, Barbier and Markandya, 1990). An important part of the costs borne would have to be estimated by using such methods.

321. The contingent valuation method is not without controversy (Schulz and Schulz, 1989). It has been argued in particular that the amount of money that people are willing to pay to improve the natural environment does not necessarily correspond to the amount that they would actually pay (free-rider problem). Furthermore, there exists generally no fully developed knowledge of the quality of the natural environment and of the possible impacts, *inter alia*, on health. It is therefore difficult to translate environmental effects into monetary expenses. Willingness to pay will also depend on the income situation of the individuals questioned. The natural environment of the poor will often be worse than that of the rich because the latter can afford better housing in privileged areas of town or country. Nevertheless, the poor will be willing to pay less or even nothing because of budgetary limitations. The meaning of any aggregation of individual potential expenses across different income groups thus becomes questionable.

322. Nevertheless, it seems important in a democratic and participatory approach to take the opinions of the people into account, even if their knowledge of the natural environment is incomplete. The results of the contingent valuation method should of course not be taken as the only basis for judging the environmental situation and its effects on the population. Physical indicators of the quality of the environmental media (air, water, land) can provide significant information on potential environmental hazards (United Nations, 1988, 1991a). Use of the contingent valuation approach in environmental accounting is still in an exploratory stage. Further research and discussion are needed. The following proposals therefore provide only a generic framework for further experimentation with this valuation method and related accounting procedures.

323. With respect to applications of the contingent valuation method in the SEEA, one could ask people to what degree they are willing to reduce their consumption level. Households could consider which specific consumption activities and corresponding expenditures they are willing to reduce or abstain from. Of course, the households could also substitute for particular (environmentally unsound) activities less damaging ones, in other words, change their consumption patterns. In this case, the difference between the expenditures connected with

existing consumption activities and those connected with the offered change in such activities could be used to represent the value of the environmental quality lost.

324. This valuation approach should facilitate the linkage of environmental impacts with the aggregates of final consumption in the SEEA. Willingness to reduce the consumption level may depend, however, on the number and the order of environmental concerns raised. An increase in the number of environmental concerns may result in a decreased willingness to further reduce the level of consumption. In a first step, questionnaires should therefore ask for the maximum reduction in level of consumption that people would be willing to accept if all types of economic impacts on the different environmental media could be thereby avoided. In a second step, the respondents should reveal that proportion of the total amount of consumption foregone that they would allocate to the alleviation of specific environmental concerns. The survey participants should comprise all individuals who are residents of the country concerned and actually or potentially affected by the domestic natural environment.

325. The willingness to forgo consumption involves at least actual repercussion costs of households (for example, environment-related health expenditures, additional commuting and housing costs) (SEEA, version II). If such deterioration could be avoided, households would of course be willing to reduce their respective defensive expenditures. Studies on the willingness to reduce household consumption levels could therefore identify actual repercussion costs as part of the total amount of voluntary reductions and, in the second step, focus the questions on the willingness to pay for additional reductions.

326. Additional imputed repercussion costs, estimated by means of contingent valuation methods, could be related to analyses of time use by households (subsection A (1) of chapter V below). Environmental repercussions are connected with the use of the environmental media for consumption purposes during the course of the day. The quality of environmental media in the workplace will affect its occupants during the workday. The environmental quality of the housing area affects, *inter alia*, the health and well-being of the people during the time spent at home. Thus, the imputed repercussion costs of households could be distributed among the different production and consumption activities at different places. Such analysis would also facilitate the description of social factors affecting environmental services and losses in those services.

327. A complete picture of the distribution of imputed repercussion costs could be given only if the different household activities were recorded in detail. This is attempted in version V of the SEEA by introducing an extended concept of household production (chap. V). In the present chapter, the analysis of the repercussions of environmental deterioration is more limited. Additional imputed repercussion costs are recorded in two steps:

(a) In a first step, imputed repercussion costs are estimated for two types of environmental degradation: degradation of the landscape by inappropriate land use and environmental degradation by pollution;

(b) In a second step, these imputed repercussion costs are recorded as reduction in individual consumption and as additional costs of different economic activities of households. The costs are allocated according to the time use of households and the degree of environmental impacts on the households during the different time-periods. Imputed repercussion costs are allocated not only to households in relation to their effect on consumptive activities but also to industries that are affected, in order to allow a comprehensive calculation of EDP based on contingent valuations that takes into account all imputed costs borne by industries and households.

328. Imputed costs borne include imputed environmental costs primarily of industries and, in addition, imputed repercussion costs of households. They refer to repercussions from the degradation of the natural environment by economic activities. The depletion costs of households, including deforestation due to firewood collection, are recorded at market values. Thus, version IV.3 comprises the imputed environmental (depletion) costs of households according to version IV.1 and additional imputations based on contingent valuation methods. Version IV.3 is presented in tables 4.7 (general concepts) and 4.8 (numerical example). The only difference between tables 4.3/4.4 and tables 4.8/4.9 is the additional recording of imputed repercussion costs in columns 1-3.

329. In the numerical example, it is assumed that the total value of repercussion costs amounts to 88.0. Those costs consist of actual repercussion costs of households (12.7, the SEEA, version II, table 2.4, column 6) and additional imputed repercussion costs of households (75.3). Additional imputed costs comprise costs of the degradation of landscape (12.3) and those of the decrease in environmental quality due to pollution (63.0) (see also table 4.1).

330. Actual repercussion costs of households are already included in the values of individual consumption (column 3, rows 2 and 3). Imputed repercussion costs (rows 6 and 7) are shown as reduction in individual consumption (column 3: 12.3, 63.0) and as additional costs of the industries concerned (columns 1 and 2). The costs connected with repercussions on households during the time spent by their occupants in the industries of agriculture, forestry and fishing are recorded in column 1 (0.2, 0.3). The repercussion costs connected with worktime in other industries are shown in column 2 of the tables together with the imputed (and shifted) costs (at market values) connected with household consumption activities (12.1, 62.7).

331. The EDP (version IV.3) amounts to 171.0 (152.1 + 18.9). Adjustments due to market prices comprise only the imputed repercussion costs of households (75.3). Adjustments are made for the EVA of agriculture, forestry, fishing (− 0.5); for other industries (− 74.8); and, correspondingly, for individual consumption (+ 75.3). The EDP at market values amounts to 246.3 (226.9 + 19.4) (SEEA, version IV.1).

Table 4.7 SEEA matrix: environmental costs at market and contingent values (version IV.3) - general concepts

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (uses and stocks of assets)								4 Exports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets							
		Agriculture, forestry, fishing ISIC- 0	Other industries ISIC 1-9	2.1 Individual consumption	2.2 Collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural (living) biota	3.2.1 Wild biota (living)	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)			
												3.2.5.1 Soil	3.2.5.2 Areas		
													Cultivated	Uncultivated	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	B A	B A	B A	A	B A	B A		A				A		B A	B A
3	Imports (2.1.2)	B A	B A	B A		B A	B A								B A	B A
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)				B C (-) (-)	B C (-) (-)	B C (-) (-)		B (-)		B (+)	B C (+) (+)	
5	Foreign origin (3.1.1.2)	B C (+) (+)	B C (+) (+)													B C (+) (+)
6	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (-)									B** C (+,-) (-)	B** (+,-)		
7	Discharge of residuals (3.1.3)	C (+)	C (+)	C (-)				C (-)		C (-)			C (-)	C (-)		
8	Domestic origin (3.1.3.1)	B (-)	B (-)	B (-)		B (-)	B (-)			B (+)	B (+)	B (+)			B (+)	
9	Foreign origin (3.1.3.2)									B (+)	B (+)	B (+)				B (+)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)							B C (+,-) (+)		C (+)	B** C (+,-) (+)	B** C (+,-) (+)		
11	Shift in environmental costs (3.1.5)		C (+)	C (-)												
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)	B (+,-)	B (-)	B (-)		B (+,-)	B (-)								B (+)	
13	Foreign origin (3.2.2)	B (+)														B (+)
14	**Use of produced fixed assets (3.3.1)**	A (+)	A (+)			A (-)	A (-)									
15	**Eco value added/EDP (4)**	C	C													
16	Adjustments due to market valuation (4.1)	C (-)	C (-)	C (+)												
17	Eco value added/EDP at market values (4.2)	C	C													
18	Eco-margin (4.2.1)	C (-)	C (-)													
19	Net value added/NDP (4.2.2)	B* A	B* A	B*												
20	**Gross output of industries (5.1)**	A	A													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
22	Other volume changes due to natural, multiple causes (6.2)			B (-)		B A (-)	B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B (+,-)	B (+,-)	B** A (+,-)	B** A (+,-)		
23	Revaluation due to market price changes (7)					A (+,-)	A (+,-)	A (+,-)	A (+,-)	A (+,-)			A (+,-)	A (+,-)		
24	**Closing stocks (8)**			B		B A	B A	B A	B A	B A	B	B	B** A	B** A		

Note: A-matrices denotes monetary data (market values); B-matrices physical data; and C-matrices imputed environmental costs.

Table 4.8 SEEA matrix: environmental costs at market and contingent values (version IV.3) - numerical example
(Monetary units)

		1.1 Domestic production of industries		2 Final consumption		3 Non-financial assets (uses and stocks of assets)									4 Exports	5 Total uses
						3.1.1 Produced assets of industries		3.2 Non-produced natural assets								
		Agriculture, forestry, fishing ISIC 0	Other industries ISIC 1 - 9	2.1 Individual consumption	2.2 collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural (living) biota	3.2.1 Wild biota (living)	3.2.2 Subsoil assets	3.2.3 Water	3.2.4 Air	3.2.5 Land (including ecosystems)				
												3.2.5.1 Soil	3.2.5.2 Areas			
													Cultivated	Uncultivated		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**					991.3	83.1	65.4	261.9	12.0			1366.7	50.4		
	Use of products of industries (2.1)															
2	Domestic production (2.1.1)	8.1	176.0	148.7	42.5	61.8	1.4		2.7				4.6		71.6	517.4
3	Imports (2.1.2)	1.1	38.8	26.3		6.2	0.0								2.1	74.5
	Use of non-produced natural assets (3.1)															
	Depletion of natural assets (3.1.1)															
4	Domestic origin (3.1.1.1)	2.1	9.2	0.3				-2.1	-8.0	-1.5					0.0	
5	Foreign origin (3.1.1.2)	0.0	0.0													0.0
6	Use of land, landscape etc. (3.1.2)	1.1	0.0	-12.3				0.0		-2.0			-1.1	-1.6		
7	Discharge of residuals (3.1.3)	0.2 3.4 0.3	12.1 6.7 62.7	-63.0									-6.5			
8	Domestic origin (3.1.3.1)														-4.7	
9	Foreign origin (3.1.3.2)															
10	Restoration of natural assets (3.1.4)	-0.5	-1.5	0.0						1.0		0.0	1.0	0.0		
11	Shift in environmental costs (3.1.5)		-0.3	-0.3												
	Treatment of residuals (3.2)															
12	Domestic origin (3.2.1)															
13	Foreign origin (3.2.2)															
14	**Use of produced fixed assets (3.3.1)**	3.5	22.8			-23.0	-3.3									
15	**Eco value added/EDP (4)**	18.9	152.1													
16	Adjustments due to market valuation (4.1)	-0.5	-74.8	75.3									1.1		4.7	1.6
17	Eco value added/EDP at market values (4.2)	19.4	226.9													
18	Eco-margin (4.2.1)	-6.1	-14.7													
19	Net value added/NDP (4.2.2)	25.5	241.6													
20	**Gross output of industries (5.1)**	38.2	478.6													
21	Other accumulation of non-produced assets due to economic decisions (6.1.2)							0.0	27.8	0.0			3.4	-3.4		
22	Other volume changes due to natural, multiple causes (6.2)					-25.3	0.0	1.3	0.0	0.9			-4.3	-2.0		
23	**Revaluation due to market price changes (7)**					138.1	12.6	11.1	28.9	1.2			357.5	11.8		
24	**Closing stocks (8)**					1149.1	93.8	75.7	313.3	11.6			1722.4	55.2		

V. Possible extensions of the SEEA

332. Most parts of versions I-IV of the SEEA have been extensively discussed in seminars and expert group meetings or international conferences. Moreover, various elements of those versions have been tested in country studies (chap. VI). While certain aspects of those versions remain controversial, notably regarding the different valuations applied to environmental impacts and effects on human health and well-being, a certain degree of consensus on the feasibility and desirability of such approaches seems to have been reached.

333. Other approaches have engendered less agreement though they may gain in importance for particular areas of analysis such as that involving the linkage of social and demographic concerns with environmental ones. Some of those approaches are introduced below by indicating their possible linkage with the more established versions of the SEEA. Their incorporation into the core of the SEEA should thus be facilitated once further research and test applications prove their merits and feasibility. This might already be the case once the transition from the present interim publication to the final handbook is made. In other cases, incorporation of environmental concerns into satellite systems that focus on other subject areas such as household activity or informal sector accounting might be more appropriate.

334. The purpose of the following description of different possible extensions is therefore only to highlight key concepts and methodologies without attempting to do full justice to all possible ramifications and alternatives proposed to date. Four types of extension are discussed in sections A through D:

(a) Extension of the production boundary with regard to household activities;

(b) Introduction of environmental services as an output of productive activities of the natural environment;

(c) Externalization of internal environmental protection activities;

(d) Use of input-output tables for environmental analysis.

335. In section A the three versions of the SEEA presented in chapter IV are described in the context of an extended definition of household production. In section B, alternative versions of introducing environmental services are presented. Those versions are based on the versions of the SEEA discussed in section A. The externalization of internal environmental protection activities presented in section C is based on version IV.2 of the SEEA. The conversion of this (externalized) version into a symmetric input-output table and some applications in models of input-output analysis are discussed in section D.

A. Household activities and imputed environmental costs

1. Extended concepts of household production in the SEEA

336. A comprehensive description of the interrelationships between households and the natural environment would have to identify additional household activities (Seel, 1989). In this manner, impacts on the natural environment by households and repercussions of the deteriorated environment on household activities could be revealed. Internal household activities refer to subsistence and other non-market production activities for own consumption.

337. A satellite system of household production could describe household activities in terms of time use (Lützel, 1989). Time-budget studies may not only offer the necessary data basis for valuing household work but also provide important physical data (with time as the physical unit) for analysing household activities and their linkages to environmental problems (see also Faber and Proops, 1991). Time-use surveys have therefore been recommended for extending integrated environmental and economic accounting to cover unpaid productive work of households (see programme area D of chapter 8 of Agenda 21). The applications of time-budget data could also be further extended to the recording of those households' employment and consumptive activities (Juster, Courant and Dow, 1981). Those data could be linked with information on the environmental conditions under which household activities are carried out, facilitating further analyses of the social implications of environment-economy interactions.

338. In tables 5.1 and 5.2, three categories of household activities are distinguished:

(a) Activities of household members within establishments. Data on time use, and compensation of employees and employers in the corporate and general government sectors are shown in row 20 ("compensation of employees") and row 22 ("compensation of employers"). As already mentioned, time use is recorded as B^* in table 5.1;

(b) Production activities within the household sector. Marketed production of unincorporated enterprises in the household sector is shown in column 2 of table 5.1. Own-account production of goods (column 3) may comprise gathering of berries or other uncultivated crops, processing of forestry products, woodcutting and collection of firewood, hunting and fishing, carrying of water, processing of agricultural products, weaving, making of pottery, and production of furniture (United Nations, 1992, chap. VI, para. 21; see also Peskin, Floor and Barnes, 1992). This enumeration indicates that such household activities are of special importance for analysing the use and management of natural assets. Households are working in the respective producing units as own-account workers (row 21). Own-account production of services includes owner-occupier housing services and domestic services produced by paid employees;

(c) Household production activities outside the production boundary of the SNA. Those activities are shown as "other household production" in column 5 of tables 5.1 and 5.2. They are connected not with the immediate consumption of goods and services but with

Table 5.1 SEEA matrix with household production: market valuation of environmental costs (version V.1) - general concepts

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									B A	B A	B D	B** A			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	B A	B A	B A		B A	B A		B A	B A	B A	B A	A	B A	B A	B A
3	Marketed household products	B A	B A	B A		B A	B A			B A	B A	B A	A	B A	B A	B A
4	Own-account household products					B A	B A			B A		B A			B A	
	Use of other household output (2.2)															
5	Use of other household products (2.2.1)					B D	B D								B D	
6	Use of household consumption activities (2.2.2)							D							D	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)		B C (+) (+)	B C (+) (+)						B C (-) (-)	B C (+) (+)		B C (+) (+)
8	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (+)									B** C (-)			
9	Discharge of residuals (3.1.3)	B C (-) (+)	B C (-) (+)	B C (-) (+)		B C (-) (+)	B C (-) (+)			B (-)	B (-)	B C (-) (-)	B C (+) (-)	B (+)		B (+)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)	C (-)									C (+)			
11	Shift in environmental costs (3.1.5)															
12	Treatment of residuals (3.2)	B (+,-)	B (-)	B (-)		B (-)	B (-)			B (+,-)	B (-)	B (-)		B (+)		B (+)
13	Use of produced fixed assets (3.3)	A (+)	A (+)	A (+)		D (+)	D (+)			A (-)	A (-)	D (-)				
14	**Eco value added/EDP (4) (version V.1)**															
15	Adjustments due to market valuation (4.1)															
16	Eco value added/EDP at market values (4.2)	C (+,-)	C (+,-)	C (+,-)	A	C (+,-)	C (-)									
17	Eco-margin (4.2.1)	C (-)	C (-)	C (-)		C (-)	C (-)									
18	Net value added/NDP (4.2.2)	A	A	A	A	D										
19	Production taxes, net (4.2.2.1)	A	A	A												
20	Compensation of employees (4.2.2.2)	B* A	B* A		B* A											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			B* A		B* D	B*									
22	Compensation of employers, others (4.2.2.3.2)	B* A	B* A				B*									
23	**Gross output (5)**	B A	B A	B A	A	B D	D									
24	**Other accumulations: volume changes, revaluation (6/7)**									B A (+,-)	B A (+,-)	B D (+,-)	B** A (+,-)			
25	**Closing stocks (8)**									B A	B A	B D	B**			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.2 SEEA matrix with household production: market valuation of environmental costs (version V.1) - numerical example
(Monetary units)

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									991.3	83.1	367.7	1756.4			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	141.8	28.3	12.2		73.7	24.4		42.5	55.5	1.2	20.6	6.1	68.9	409.6	65.6
3	Marketed household products	31.2	8.8	1.7		15.7	5.4			9.3	0.2	4.9	1.2	4.8	74.3	8.9
4	Own-account household products					17.5	10.3			3.2		2.5			33.5	
	Use of other household output (2.2)															
5	Use of other household products (2.2.1)					35.7	236.9								272.6	
6	Use of household consumption activities (2.2.2)							281.3							281.3	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	8.0	1.2	2.1		0.3	0.0						-11.6	0.0		0.0
8	Use of land, landscape etc. (3.1.2)	0.8	0.2	0.1									-1.1			
9	Discharge of residuals (3.1.3)	8.5	0.9	0.7		0.0	0.0					0.0	-10.1			
10	Restoration of natural assets (3.1.4)	-2.0	0.0	0.0									2.0			
11	Shift in environmental costs (3.1.5)															
12	Treatment of residuals (3.2)															
13	Use of produced fixed assets (3.3)	18.7	5.2	2.4		18.0	4.3			-23.0	-3.3	-22.3				
14	**Eco value added/EDP (4) (version V.1)**															
15	Adjustments due to market valuation (4.1)															
16	Eco value added/EDP at market values (4.2)	202.6	29.7	11.3	3.0	111.7	0.0									
17	Eco-margin (4.2.1)	-15.3	-2.3	-2.9		-0.3	0.0									
18	Net value added/NDP (4.2.2)	217.9	32.0	14.2	3.0	112.0										
19	Production taxes, net (4.2.2.1)	31.2	4.6	0.6												
20	Compensation of employees (4.2.2.2)	77.9	12.8		3.0											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			13.6		112.0										
22	Compensation of employers, others (4.2.2.3.2)	108.8	14.6													
23	**Gross output (5)**	409.6	74.3	30.5	3.0	272.6	281.3									
24	**Other accumulations: volume changes, revaluation (6/7)**									112.8	12.6	22.6	434.2			
25	**Closing stocks (8)**									1149.1	93.8	396.0	2177.1			

the inputs needed to carry out such household production activities required for satisfying final household consumption. Those household production activities include employment-related activities for own use outside paid working hours such as family transport, house cleaning, food preparation, shopping, care for family members and other persons and unpaid voluntary work (Lützel, 1989);

(d) Consumption activities. All other household activities are called consumption activities (shown in column 6 of tables 5.1 and 5.2). The concept of human capital is not introduced in the SEEA because of conceptual and statistical (measurement) problems. Otherwise, several of the consumption activities would have characteristics of activities producing goods and services for the purpose of increasing the human capital of household members (in the areas, for example, of health and education). The time used for consumption purposes is recorded in rows 21 and 22.

339. In tables 5.1 and 5.2 it is assumed that household consumption activities also have an output value (column 6). This value comprises the value of intermediate (marketed or non-marketed) inputs and the consumption of consumer durables. The intermediate inputs comprise all household purchases that are not inputs of household production and the outputs of other household production activities as long as they are not used internally for still other household production activities. Consumption of consumer durables (row 13, column 6, of tables 5.1 and 5.2) comprises only the share of their uses in consumption activities. The uses for production purposes are recorded as inputs of other household production activities (row 13, column 5).

340. The output value of consumption activities also represents the value of individual consumption (column 7). In table 5.1, the additional gross output of other household production activities (column 5) and the outcome of household consumption activities (column 6) are denoted by the matrix symbol D. This symbol is also used to indicate the use of consumer durables (table 5.1, row 13, columns 5, 6 and 11).

341. In table 5.2, a numerical example is given for the purpose of introducing the extended concept of household production into the SEEA. In comparison with the traditional SNA figure, NDP (row 18, columns 1-4) is increased by the compensation of own-accounters' work (267.1 + 112.0 = 379.1). The output value of other household production activities (column 5: 272.6) is estimated by adding their intermediate inputs (142.6), their consumption of consumer durables (18.0) and the value of the compensation of own-account workers (112.0). The output value of consumption activities (column 6: 281.3) comprises intermediate inputs (277.0) and depreciation of consumer durables (4.3). The output of other household production activities is used as internal inputs of those activities (35.7) or of household consumption activities (236.9). The destination of the output of household consumption activities is individual consumption (281.3).

342. The treatment of consumer durables as capital instead of as consumption goods implies an extension of the asset accounts (column 11). In the numerical example, the opening stocks of consumer durables (367.7) are increased during the reporting period by gross capital

formation (28.0), decreased by depreciation (22.3) and modified by other volume changes and revaluations (22.6). Thus, the closing stocks amount to 396.0.

343. The following three subsections describe three versions of the SEEA with extended presentations of household activities. All are based on the version of SEEA presented in chapter IV.

2. Household activities and imputed environmental costs in market values (SEEA, version V.1)

344. Tables 5.1 and 5.2 present an extended SEEA matrix that associates imputed environmental costs at market values with the different types of household activities. This version (V.1) of the SEEA is derived from version IV.1. Total imputed environmental costs remain the same (20.8). The differences refer to the allocation of those costs to different activities.

345. Imputed environmental costs of industries (20.5) are distributed among the industries outside the SNA household sector (table 5.2, column 1, rows 7-10: 15.3) and the different types of production of the SNA household sector (table 5.2, columns 2-4, rows 7-10: 5.2). It is assumed that the production of domestic services does not imply environmental costs. Household own-account production of goods also encompasses depletion of natural assets (2.1). These depletion activities of households are particularly significant in developing countries.

346. Imputed environmental costs (at market prices) of other household activities will normally be relatively low. Version V.1 differs from version IV.1, in that those costs are shown not as costs of individual consumption (and in a second step shifted to the production of other industries) but as costs of domestic production (columns 5 and 6) or of the asset accounts of consumer durables (column 11). Imputed costs borne by households and caused by repercussions of the deterioration of the natural environment by production and consumption activities are taken into account in version V.3 of the SEEA (section C). Imputed costs of consumer durables reflect the decrease of their market values caused by the discharge of residuals.

347. EDP at market values amounts to 358.3 (table 5.2, row 16) which could be derived from the traditional NDP (row 18, columns 1-4: 267.1) by adding net value added of other household production activities (112.0) and subtracting imputed environmental costs (eco- margin: 20.8).

348. The allocation of environmental costs to consumption activities of households implies that those activities contribute to EDP. Generally this contribution would be negative, reflecting the decrease in the market values of natural assets caused by environmental deterioration due to household activities. In the numerical example of version V.1, the negative contribution is assumed to be zero, as the market values of natural assets in the example do not reflect the decrease in quality of those assets. It has, however, a (negative) value in versions V.2 and V.3, described in the following subsections, when valuations other than market values are used.

3. Household activities and imputed maintenance costs (SEEA, version V.2)

349. Version V.2 of the SEEA is derived from version IV.2, valuing imputed environmental costs at maintenance costs. Tables 5.3 and 5.4 show that total imputed environmental costs of domestic production at maintenance costs (see the totals of rows 15 and 17, columns 1-6, in table 5.4: 82.0) remain unchanged. As in the case of version V.1, only the distribution among the different household and industry activities is changed. Imputed environmental costs of individual consumption (17.1) are now shown partly as environmental costs of other household production activities (table 5.4, rows 7-9, columns 5 and 6: 14.8) and partly as additional environmental costs in the accounts of consumer durables (row 9, column 11: 2.3), and these are shifted to other household production activities in a second step (row 11, columns 5 and 6, and column 11).

350. EDP of version V.2 amounts to 297.1 (row 14 of table 5.4), which can be compiled by adding traditional NDP (267.1) and the net value added of other household production activities (112.0), then subtracting imputed environmental costs (82.0).

351. Environmental costs of other household activities amount to 17.1 (table 5.4, rows 7-11, columns 5 and 6). They are balanced by adjustment items (row 15: − 6.8, − 10.0) and by the eco-margin (− 0.3).

4. Household activities, imputed environmental costs at market values and imputed repercussion costs (SEEA, version V.3)

352. Tables 5.5 and 5.6 describe version V.3 of the SEEA, which corresponds (except for the extended incorporation of household activities) to version IV.3. It differs from version V.1 described above in that imputed repercussion costs of households valued at contingency values are incorporated in addition. Those costs are based on a modified approach to the willingness-to-pay method (see section D of chapter IV above for further explanations).

353. Imputed repercussion costs are associated with different production and consumption activities of households. It is assumed that households are willing to reduce their consumption level for the purpose of improving the quality of the natural environment they are exposed to not only during their housework and leisure time but also during their employment time. Thus, imputed repercussion costs are recorded in connection not only with other household activities (table 5.6, columns 5 and 6: 7.9 + 3.7 + 41.8 + 15.2 = 68.6), but also with the different household activities within production units of industries (columns 1-3: 0.7 + 5.3 + 0.5 + 0.2 = 6.7).

354. EDP (283.0) of version V.3 can be compiled by adding to the traditional NDP (267.1) the net value added of other household production activities (112.0) and subtracting not only environmental costs at market values (20.8) but also imputed repercusion costs (75.3). Imputed

Table 5.3 SEEA matrix with household production: maintenance cost valuation of environmental costs (version V.2) - general concepts

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)									B A	B A	B D	B** A			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	B A	B A	B A		B A	B A		B A	B A	B A	B A	A	B A	B A	B A
3	Marketed household products	B A	B A	B A		B A	B A			B A	B A	B A	A	B A	B A	B A
4	Own-account household products					B A	B A			B A		B A			B A	
	Use of other household output (2.2)															
5	Use of other household products (2.2.1)					B D	B D								B D	
6	Value of household consumption activities (2.2.2)							D							D	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)		B C (+) (+)	B C (+) (+)				C (+,-)		B C (-) (-)	B C (+) (+)		B C (+) (+)
8	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (+)		C (+)	C (+)						B** C (+,-) (-)			
9	Discharge of residuals (3.1.3)	B C (-) (+)	B C (-) (+)	B C (-) (+)		B C (-) (+)	B C (+)			B C (-) (+)	B C (+)	B C (-) (+)	B C (+) (-)	B C (+) (-)		B C (+ (-)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)			C (-)			C (-)				C (+)			
11	Shift in environmental costs (3.1.5)	C (+)	C (+)	C (+)		C (+)	C (+)			C (-)	C (-)	C (-)				
12	Treatment of residuals (3.2)	B (+,-)	B (+,-)	B (-)		B (-)	B (-)			B (+,-)	B (-)	B (-)		B (+)		B (+)
13	Use of produced fixed assets (3.3)	A (+)	A (+)	A (+)		D (+)	D (+)			A (-)	A (-)	D (-)				
14	Eco value added/EDP (4) (version V.2)	C (+,-)	C (+,-)	C (+,-)	A	C (+,-)	C (-)						C (+,-)	C (+,-)		C (+,-
15	Adjustments due to market valuation (4.1)	C (+,-)	C (+,-)	C (+,-)		C (+,-)	C (+,-)		C (+)		C (+,-)					
16	Eco value added/EDP at market values (4.2)	C (+,-)	C (+,-)	C (+,-)	A	C (+,-)	C (-)									
17	Eco-margin (4.2.1)	C (-)	C (-)	C (-)		C (-)	C (-)									
18	Net value added/NDP (4.2.2)	A	A	A	A	D										
19	Production taxes, net (4.2.2.1)	A	A	A												
20	Compensation of employees (4.2.2.2)	B* A	B* A		B* A											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			B* A		B* D	B*									
22	Compensation of employers, others (4.2.2.3.2)	B* A	B* A	A			B*									
23	Gross output (5)	B A	B A	B A	A	B D	D									
24	Other accumulations: volume changes, revaluation (6/7)									B A (+,-)	B A (+,-)	B D (+,-)	B** A (+,-)			
25	Closing stocks (8)									B A	B A	B D	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.4 SEEA matrix with household production: maintenance cost valuation of environmental costs (version V.2) - numerical example

(Monetary units)

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									991.3	83.1	367.7	1756.4			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	141.8	28.3	12.2		73.7	24.4		42.5	55.5	1.2	20.6	6.1	68.9	409.6	65.6
3	Marketed household products	31.2	8.8	1.7		15.7	5.4			9.3	0.2	4.9	1.2	4.8	74.3	8.9
4	Own-account household products					17.5	10.3			3.2		2.5			33.5	
	Use of other household output (2.2)															
5	Use of other household products (2.2.1)					35.7	236.9								272.6	
6	Value of household consumption activities (2.2.2)							281.3							281.3	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	11.9	1.7	3.9		0.7	0.0				-0.9		-17.3	0.0		0.0
8	Use of land, landscape etc. (3.1.2)	6.9	1.3	0.8		0.5	0.3						-9.8			
9	Discharge of residuals (3.1.3)	24.6	8.3	0.4		4.4	8.9			5.1	0.0	2.3	-50.9	-4.7		-1.6
10	Restoration of natural assets (3.1.4)	0.0	0.0	0.0		0.0			-5.0				5.0			
11	Shift in environmental costs (3.1.5)	3.6	1.2	0.3		1.5	0.8			-5.1	0.0	-2.3				
12	Treatment of residuals (3.2)															
13	Use of produced fixed assets (3.3)	18.7	5.2	2.4		18.0	4.3			-23.0	-3.3	-22.3				
14	**Eco value added/EDP (version V.2) (4)**	170.9	19.5	8.8	3.0	104.9	-10.0									
15	Adjustments due to market valuation (4.1)	-31.7	-10.2	-2.5		-6.8	-10.0		5.0		0.9		52.2	4.7		1.6
16	Eco value added/EDP at market values (4.2)	202.6	29.7	11.3	3.0	111.7	0.0									
17	Eco-margin (4.2.1)	-15.3	-2.3	-2.9		-0.3	0.0									
18	Net value added/NDP (4.2.2)	217.9	32.0	14.2	3.0	112.0										
19	Production taxes, net (4.2.2.1)	31.2	4.6	0.6												
20	Compensation of employees (4.2.2.2)	77.9	12.8		3.0											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			13.6		112.0										
22	Compensation of employers, others (4.2.2.3.2)	108.8	14.6													
23	**Gross output (5)**	409.6	74.3	30.5	3.0	272.6	281.3									
24	**Other accumulations: volume changes, revaluation (6/7)**									112.8	12.6	22.6	434.2			
25	**Closing stocks (8)**									1149.1	93.8	396.0	2177.1			

Table 5.5 SEEA matrix with household production: market valuation of environmental costs and imputed repercussion costs (version V.3) - general concepts

		1 Domestic production						2 Final consumption		3. Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)									B A	B A	B D	B** A			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	B A	B A	B A		B A	B A		B A	B A	B A	B A	A	B A	B A	B A
3	Marketed household products	B A	B A	B A		B A	B A			B A	B A	B A	A	B A	B A	B A
4	Own-account household products					B A	B A			B A		B A			B A	
	Use of other household output (2.2)															
5	Use of other household products (2.2.1)					B D	B D								B D	
6	Value of household consumption activities (2.2.2)							D							D	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)		B C (+) (+)	B C (+) (+)						B C (-) (-)	B C (+) (+)		B C (+) (+)
8	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (+)				C (-)					B** C (-)			
9	Discharge of residuals (3.1.3)	B C (-) (+)	B C (-) (+)	B C (-) (+)		B C (-) (+)	B C (-) (+)	C (-)		B (-)	B (-)	B C (-) (-)	B C (+) (-)	B (+)		B (+)
10	Restoration of natural assets (3.1.4)	C (-)	C (-)	C (-)									C (+)			
11	Shift in environmental costs (3.1.5)															
12	Treatment of residuals (3.2)	B (+,-)	B (-)	B (-)		B (-)	B (-)			B (+,-)	B (-)	B (-)		B (+)		B (+)
13	Use of produced fixed assets (3.3)	A (+)	A (+)	A (+)		D (+)	D (+)			A (-)	A (-)	D (-)				
14	Eco value added/EDP (version V.2) (4)	C (+,-)	C (+,-)	C (+,-)	A	C (+,-)	C (-)									
15	Adjustments due to market valuation (4.1)	C (-)	C (-)	C (-)		C (-)	C (-)	C (+)								
16	Eco value added/EDP at market values (4.2)	C (+,-)	C (+,-)	C (+,-)	A	C (+,-)	C (-)									
17	Eco-margin (4.2.1)	C (-)	C (-)	C (-)		C (-)	C (-)									
18	Net value added/NDP (4.2.2)	A	A	A	A	D										
19	Production taxes, net (4.2.2.1)	A	A	A												
20	Compensation of employees (4.2.2.2)	B* A	B* A		B* A											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			B* A		B* D										
22	Compensation of employers, others (4.2.2.3.2)	B* A	B* A	A			B*									
23	Gross output (5)	B A	B A	B A	A	B D	D									
24	Other accumulations: volume changes, revaluation (6/7)									B A (+,-)	B A (+,-)	B D (+,-)	B** A (+,-)			
25	Closing stocks (8)									B A	B A	B D	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.6 SEEA matrix with household production: market valuation of environmental costs and imputed repercussion costs (version V.3) - numerical example
(Monetary units)

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries				1.2 Other household activities		2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
		Industries outside the SNA household sector	Industries of the SNA household sector			1.2.1 Other household production	1.2.2 Consumption activities			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
			Marketed production	Own-account production: Goods, housing services	Own-account production: Domestic services											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Opening stocks (1)									991.3	83.1	367.7	1756.4			
	Use of products (2)															
	Use of products of industries (2.1)															
2	Products except household products	141.8	28.3	12.2		73.7	24.4		42.5	55.5	1.2	20.6	6.1	68.9	409.6	65.6
3	Marketed household products	31.2	8.8	1.7		15.7	5.4			9.3	0.2	4.9	1.2	4.8	74.3	8.9
4	Own-account household products					17.5	10.3			3.2		2.5			33.5	
	Use of other household output (2.2)															
6	Use of other household products (2.2.1)					35.7	236.9								272.6	
8	*Value of household consumption activities (2.2.2)*							281.3							281.3	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
7	Depletion of natural assets (3.1.1)	8.0	1.2	2.1		0.3	0.0						-11.6	0.0		0.0
		0.8	0.2	0.1												
8	Use of land, landscape etc. (3.1.2)	0.7	0.0	0.0		7.9	3.7	-12.3					-1.1			
		8.5	0.9	0.7		0.0	0.0									
9	Discharge of residuals (3.1.3)	5.3	0.5	0.2		41.8	15.2	-63.0				0.0	-10.1			
10	Restoration of natural assets (3.1.4)	-2.0	0.0	0.0									2.0			
11	Shift in environmental costs (3.1.5)															
12	Treatment of residuals (3.2)															
13	Use of produced fixed assets (3.3)	18.7	5.2	2.4		18.0	4.3			-23.0	-3.3	-22.3				
14	Eco value added/EDP (version V.2) (4)	196.6	29.2	11.1	3.0	62.0	-18.9									
15	Adjustments due to market valuation (4.1)	-6.0	-0.5	-0.2		-49.7	-18.9	75.3								
16	Eco value added/EDP at market values (4.2)	202.6	29.7	11.3	3.0	111.7	0.0									
17	Eco-margin (4.2.1)	-15.3	-2.3	-2.9		-0.3	0.0									
18	Net value added/NDP (4.2.2)	217.9	32.0	14.2	3.0	112.0										
19	Production taxes, net (4.2.2.1)	31.2	4.6	0.6												
20	*Compensation of employees (4.2.2.2)*	77.9	12.8		3.0											
	Net operating surplus (4.2.2.3)															
21	Compensation of own-account workers (4.2.2.3.1)			13.6		112.0										
22	Compensation of employers, others (4.2.2.3.2)	108.8	14.6													
23	*Gross output (5)*	409.6	74.3	30.5	3.0	272.6	281.3									
24	Other accumulations: volume changes, revaluation (6/7)									112.8	12.6	22.6	434.2			
25	Closing stocks (8)									1149.1	93.8	396.0	2177.1			

repercussion costs are counterbalanced in the individual consumption column (table 5.6, rows 8 and 9, column 7: − 75.3; row 15, column 7: + 75.3).

355. The introduction of imputed repercussion costs affects especially EVA of other household activities. In the numerical example, it is assumed that imputed repercussion costs are associated mainly with other household production activities (49.7) and consumption activities (18.9). These additional costs are reflected in diminished or negative figures of EVA (111.7 − 49.7 = 62.0: 0.0 − 18.9 = 0 −18.9: see rows 14-16 and columns 5 and 6 of table 5.6).

B. Environmental services

1. General description of concepts

356. The production boundary of the economy can also be extended by introducing the concept of environmental services produced by nature (for example, Peskin, 1989; Vanoli, forthcoming). Those services describe qualitative (including spatial) functions of natural non-produced assets of land (including ecosystems), water and air. As environmental services often compete with other economic functions and with each other, a value could be imputed to them (Hueting, 1980, chap. 4; OECD, 1989, chap. 3; Pearce, Markandya and Barbier, 1989, chap. 3; Peskin, 1989). Services provided by the different natural assets could be treated as production activities of the natural environment.

357. Three types of environmental services are distinguished:

(a) Disposal services. Disposal services reflect the function of the natural domestic environment (land, air, water) as an absorptive sink for residuals of domestic and foreign economic activities;

(b) Productive services of land. Services of land reflect the spatial and economic functions of land (including water areas) for production purposes including the use of soil for agricultural purposes;

(c) Consumer services. Consumer services of the natural environment encompass the elementary functions of the environment in providing for physiological as well as recreational and related needs of human beings.

358. The three types of environmental services dealt with in this approach represent only the qualitative and spatial economic use of natural assets. Not considered as production are the "quantitative" results of the functions of natural assets, through which natural resources are provided as inputs for production and final consumption. This approach may be appropriate in the case of non-renewable natural assets because the assets were "produced" a long time before, but it is less convincing in the case of biological ones. In the latter case, such a production concept could be considered within the context of a further extension of the economic production

boundary. At any rate, major conceptual questions, valuation issues and practical problems of data availability make the identification and treatment of environmental services still a rather controversial approach still (see also version IV.3 (above) dealing with the contingent valuation approach).

359. As already discussed in chapters II and IV, costs caused and costs borne are not directly comparable because the former are connected with stress on the natural environment in a specific country and for a specific time-period, while costs borne reflect repercussions from (response of) the deteriorated natural environment that may affect the population in other countries and in later periods. As a consequence, environmental services cannot be dealt with in one version that combines the costs-caused and the costs-borne approach. In valuing the disposal services and productive services of land (including landscape and ecosystems), a cost-caused concept, described in section C of chapter IV above, would need to be applied. However, in valuing consumer services, contingent valuation concepts that are related to the cost-borne concept as described in section D of chapter IV may be used.

360. The following sections illustrate how these alternative concepts could be addressed within the extended framework of the SEEA. Further research and practical experience are required to make a meaningful transition from illustration to recommendation with respect to practical application of these versions.

2. Disposal and productive services of land (SEEA, version V.4)

361. Version V.4 of the SEEA as set forth in tables 5.7 and 5.8 extends version V.2 (subsection A (3), table 5.3) by introducing disposal services and productive services of land. The basic concept for valuing the use of natural assets remains the maintenance cost approach. The treatment of depletion of natural assets remains unchanged in comparison with versions IV.2 and V.2 of the SEEA.

362. The treatment of the environmental costs of degrading natural assets through use of land, landscape etc. and discharging residuals is presented in two steps. The costs of use of land, landscape etc. (row 10) are recorded, in a first step, as inputs not of industries or other household activities, but rather of the productive services of land (column 5: 9.8). Similarly, the environmental costs of discharging residuals into the natural environment (row 11) are in a first step recorded as inputs of production activity involving "disposal services" (column 4: 50.9) and not as costs of industries or other household activities. The value of the output of disposal services and productive services of land is equal to environmental costs (row 21, columns 4 and 5). This "input method" is similar to the method used for valuing the gross output of non-market production in the SNA.

363. The use of the two types of environmental services mentioned is shown in rows 5-7. To associate those services with the activities through which residuals have been discharged and the land has been degraded, environmental services are distributed partly between intermediate

Table 5.7 SEEA matrix with environmental services: disposal services and productive services of land (version V.4) - general concepts

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
			1.2 Other household activities		1.3 Environmental services			2.1	2.2	3.1 Produced assets			3.2			
										3.1.1 Industries		3.1.2				
		Industries	1.2.1 Other household production	1.2.2 Consumption activities	1.3.1 Disposal services	1.3.2 Productive services of land	1.3.3 Consumer services	Individual consumption	Collective consumption	3.1.1.1 Man-made	3.1.1.2 Natural	Consumer durables	Non-produced natural assets		Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									B A	B A	B D	B** A			
	Use of products (2)															
2	Use of products of industries (2.1)	B A	B A	B A					A	B A	B A	B A	A	B A	B A	B A
	Use of other household output (2.2)															
3	Use of other household products (2.2.1)		B D	B D											B D	
4	Value of household consumption activities (2.2.2)							D							D	
	Use of environmental services (2.3)															
	Disposal services (2.3.1)															
5	Domestic origin (2.3.1.1)	C (+)	C (+)	C (+)						C (+)	C (+)	C (+)		C (+)	C (+)	
6	Foreign origin (2.3.1.2)	C (+)	C (+)							C (+)						C (+)
7	Productive services of land (2.3.2)	C (+)	C (+)	C (+)											C (+)	
8	Consumer services (2.3.3)															
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
9	Depletion of natural assets (3.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)							C (+,-)		B C (-) (-)	B C (+) (+)		B C (+) (+)
10	Use of land, landscape etc. (3.1.2)					C (+)							B** C (+,-) (-)			
11	Discharge of residuals (3.1.3)	B (-)	B (-)	B (-)	C (+)					B (+,-)	B (-)	B (-)	B C (+) (-)	B (+)		B (+)
12	Restoration of natural assets (3.1.4)	C (-)	C (-)						C (-)				C (+)			
13	Shift in environmental costs (3.1.5)	C (+)	C (+)	C (+)						C (-)	C (-)	C (-)				
14	Treatment of residuals (3.2)	B (+,-)	B (-)	B (-)						B (+,-)	B (-)	B (-)		B (+)		B (+)
15	Use of produced fixed assets (3.3)	A (+)	D (+)	D (+)						A (-)	A (-)	D (-)				
16	**Eco value added/EDP (version V.4) (4)**	C (+,-)	C (+,-)	C (-)												
17	Adjustments due to market valuation (4.1)	C (+,-)	C (+,-)	C (+,-)					C (+)		C (+,-)		C (+,-)	C (+,-)		C (-)
18	Eco value added/EDP at market values (4.2)															
19	Eco-margin (4.2.1)	C (-)	C (-)	C (-)												
20	Net value added/NDP (4.2.2)	B* A	B* D	B*												
23	**Gross output (5)**	B A	B D	D	C (+)	C (+)										
24	**Other accumulations: volume changes, revaluation (6/7)**									B A (+,-)	B A (+,-)	B D (+,-)	B** A (+,-)			
25	**Closing stocks (8)**									B A	B A	B D	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.8 SEEA matrix with environmental services: disposal services and productive services of land (version V.4) - numerical example
(Monetary units)

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries	1.2 Other household activities		1.3 Environmental services			2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
			1.2.1 Other household production	1.2.2 Consumption activities	1.3.1 Disposal services	1.3.2 Productive services of land	1.3.3 Consumer services			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									991.3	93.1	367.7	1756.4			
	Use of products (2)															
2	Use of products of industries (2.1)	224.0	106.9	40.1												
	Use of other household output (2.2)								42.5	68.0	1.4	28.0	7.3	73.7	517.4	74.5
3	Use of other household products (2.2.1)		35.7	236.9											272.6	
4	Value of household consumption activities (2.2.2)							281.3							281.3	
	Use of environmental services (2.3)															
	Disposal services (2.3.1)															
5	Domestic origin (2.3.1.1)	28.6	4.4	8.9						5.1	0.0	2.3		1.6	50.9	
6	Foreign origin (2.3.1.2)	4.7														4.7
7	Productive services of land (2.3.2)	9.0	0.5	0.3						0.0						
8	Consumer services (2.3.3)														9.8	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
9	Depletion of natural assets (3.1.1)	17.5	0.7	0.0							-0.9		-17.3		0.0	0.0
10	Use of land, landscape etc. (3.1.2)					9.8							-9.8			
11	Discharge of residuals (3.1.3)				50.9								-50.9			
12	Restoration of natural assets (3.1.4)	0.0	0.0						-5.0				5.0			
13	Shift in environmental costs (3.1.5)	5.1	1.5	0.8						-5.1	0.0	-2.3				
14	Treatment of residuals (3.2)															
15	Use of produced fixed assets (3.3)	26.3	18.0	4.3						-23.0	-3.3	-22.3				
16	**Eco value added/EDP (version V.4) (4)**	202.2	104.9	-10.0												
17	Adjustments due to market valuation (4.1)	-44.4	-6.8	-10.0					5.0		0.9		52.2	-1.6		-4.7
18	Eco value added/EDP at market values (4.2)	246.6	111.7	0.0												
19	Eco-margin (4.2.1)	-20.5	-0.3	0.0												
20	Net value added/NDP (4.2.2)	267.1	112.0													
23	**Gross output (5)**	517.4	272.6	281.3	50.9	9.8										
24	**Other accumulations: volume changes, revaluation (6/7)**									112.8	12.6	22.6	434.2			
25	**Closing stocks (8)**									1149.1	93.8	396.0	2177.1			

consumption of industries and household consumption activities (rows 5 and 7, columns 1-3), and partly under additional environmental costs in the non-financial assets accounts (columns 9-11). In comparison with version V.2 of the SEEA, this treatment associates environmental costs with the economic activities responsible, not in a first step, but rather in a second one, after treating those costs as inputs of environmental services.

364. The introduction of the category of environmental services permits a distinction between those of domestic and those of foreign origin. This leads to a modification of the concepts of cross-boundary flows of residuals. Instead of showing exports and imports of environmental costs in row 11, the matrix shows disposal services as exported (row 5, column 13) or imported (row 6, column 1). Export of environmental costs thus corresponds to import of disposal services and vice versa.

365. In comparison with version V.2 of the SEEA, the introduction of disposal services and of productive services of land does not influence macroeconomic aggregates. The totals of environmental costs and of the inputs of production activities remain unchanged. Environmental costs are presented only under use of productive services instead of being treated as costs of using natural assets.

3. Consumer services (SEEA, version V.5)

366. In version V.5 (tables 5.9 and 5.10), the consumer services of the natural environment are considered to be the result of a "productive" activity of that environment (column 6). The (negative) value of the gross output of such services is estimated by adding up the actual repercussion costs borne by households and the imputed repercussion costs that those households are willing to bear (12.7 + 75.3, chap. IV). Both cost elements acquire a negative sign because the description of consumer services is limited to recording the decrease of these services (table 5.10, row 21: − 88.0). The (negative) value of consumer services corresponds to its (negative) EVA, with modification of EDP of version V.5 (row 16). EDP at market values (row 18) remains unchanged as a result of the presence of an adjustment item (row 17) of the same value.

367. In tables 5.9 and 5.10, use of consumer services of the natural environment is shown in three steps. In a first step, the (negative) value of consumer services is distributed among the different productive and consumption activities of households as intermediate consumption. Such treatment allows consumer services to be associated with different household activities. In a second step, those consumer services are recorded as by-products of the corresponding activities without modifying their EVA and NVA values. In a third step, consumer services of the natural environment are distributed as by-products of those activities so as to become part of individual consumption. As an alternative, but one involving some loss of information on the relationships between household activities and consumer services, the direct deduction of the loss of those services from the final consumption of households has been proposed (Vanoli, 1991).

Table 5.9 SEEA matrix with environmental services: consumptive services (version V.5) - general concepts

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries	1.2 Other household activities		1.3 Environmental services			2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		3.1.2 Consumer durables				
			1.2.1 Other household production	1.2.2 Consumption activities	1.3.1 Disposal services	1.3.2 Productive services of land	1.3.3 Consumer services			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									B A	B A	B D	B** A			
	Use of products (2)															
2	Use of products of industries (2.1)	B A	B A	B A				C (-)	A	B A	B A	B A	A	B A	B A/C (-)	B A
	Use of other household output (2.2)															
3	Use of other household products (2.2.1)		B D	B D				C (-)							B D/C (-)	
4	Value of household consumption activities (2.2.2)							D/C (-)							D/C (-)	
	Use of environmental services (2.3)															
	Disposal services (2.3.1)															
5	Domestic origin (2.3.1.1)															
6	Foreign origin (2.3.1.2)															
7	Productive services of land (2.3.2)															
8	Consumer services (2.3.3)	C (-)	C (-)	C (-)											C (-)	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
9	Depletion of natural assets ((3.1.1)	B (+) C (+)	B (+) C (+)	B (+) C (+)									B (-) C (-)	B (+) C (+)		B (+) C (+)
10	Use of land, landscape etc. (3.1.2)	C (+)											B** (+,-) C (-)			
11	Discharge of residuals (3.1.3)	B (-) C (+)	B (-) C (+)	B (-) C (+)						B (-)	B (-)	B (-) C (-)	B (+) C (-)	B (+)		B (+)
12	Restoration of natural assets (3.1.4)	C (-)	C (-)	C (-)									C (+)			
13	Shift in environmental costs (3.1.5)									B (+,-)	B (-)	B (-)		B (+)		B (+)
14	Treatment of residuals (3.2)	B (+,-)	B (-)	B (-)						B (+,-)	B (-)	B (-)		B (+)		B (+)
15	Use of produced fixed assets (3.3)	A (+)	D (+)	D (+)						A (-)	A (-)	D (-)				
16	**Eco value added/EDP (version V.4) (4)**	C (+,-)	C (+,-)	C (-)			C (-)									
17	Adjustments due to market valuation (4.1)						C (-)	C (+)								
18	Eco value added/EDP at market values (4.2)	C (+,-)	C (+,-)	C (-)												
19	Eco-margin (4.2.1)	C (-)	C (-)	C (-)												
20	Net value added/NDP (4.2.2)	B* A	B* D	B*												
23	**Gross Output (5)**	B A/C (-)	B D/C (-)	D/C (-)			C (-)									
24	**Other accumulations: volume changes, revaluation (6/7)**									B A (+,-)	B A (+,-)	B D (+,-)	B** A (+,-)			
25	**Closing stocks (8)**									B A	B A	B D	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.10 SEEA matrix with environmental services: consumptive services (version V.5) - numerical example
(Monetary units)

		1 Domestic production						2 Final consumption		3 Non-financial assets (uses and stocks of assets)				4 Exports	5 Total uses	
		1.1 Industries	1.2 Other household activities		1.3 Environmental services			2.1 Individual consumption	2.2 Collective consumption	3.1 Produced assets			3.2 Non-produced natural assets			
										3.1.1 Industries		Consumer durables				
			1.2.1 Other household production	1.2.2 Consumption activities	1.3.1 Disposal services	1.3.2 Productive services of land	1.3.3 Consumer services			3.1.1.1 Man-made	3.1.1.2 Natural				Domestic origin	Foreign origin
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Opening stocks (1)**									991,3	83,1	367,7	1756,4			
	Use of products (2)															
2	Use of products of industries (2.1)	224,0	106,9	40,1				-6,7	42,5	68,0	1,4	28,0	7,3	73,7	510,7	74,5
3	Use of other household output (2.2)		35,7	236,9				-58,3							214,3	
	Use of other household products (2.2.1)															
4	Value of household consumption activities (2.2.2)							258,3							258,3	
	Use of environmental services (2.3)															
	Disposal services (2.3.1)															
5	Domestic origin (2.3.1.1)															
6	Foreign origin (2.3.1.2)															
7	Productive services of land (2.3.2)															
8	Consumer services (2.3.3)	-6,7	-58,3	-23,0											-88,0	
	Use of non-financial assets (3)															
	Use of non-produced natural assets (3.1)															
9	Depletion of natural assets (3.1.1)	11,3	0,3	0,0									-11,6	0,0		0,0
10	Use of land, landscape etc. (3.1.2)	1,1											-1,1			
11	Discharge of residuals (3.1.3)	10,1	0,0	0,0						0,0	0,0	0,0	-10,1			
12	Restoration of natural assets (3.1.4)	-2,0											2,0			
13	Shift in environmental costs (3.1.5)															
14	Treatment of residuals (3.2)															
15	Use of produced fixed assets (3.3)	26,3	18,0	4,3						-23,0	-3,3	-22,3				
16	**Eco value added/EDP (version V.5) (4)**	246,6	111,7	0,0			-88,0									
17	Adjustments due to market valuation (4.1)															
18	Eco value added/EDP at market values (4.2)	246,6	111,7	0,0			-88,0	88,0								
19	Eco-margin (4.2.1)	-20,5	-0,3	0,0												
20	Net value added/NDP (4.2.2)	267,1	112,0													
21	**Gross output (5)**	517,4 -6,7	272,6 -58,3	281,3 -23,0			-88,0									
22	**Other accumulations: volume changes, revaluation (6/7)**									112,8	12,6	22,6	434,2			
23	**Closing stocks (8)**									1149,1	93,8	396,0	2177,1			

368. Except for its introduction of consumer services of the natural environment, version V.5 is identical to version V.1 (presented in subsection A (2)). EDP of version V.5 is lower because of the negative value of consumer services (table 5.10, row 16: 246.6 + 111.7 − 88.0 = 270.3).

C. Externalization of internal environmental protection activities (SEEA, version V.6)

369. For a comprehensive analysis of environmental activities in an economy, there is a need to present together both external and internal environmental protection activities. The difficulty is that in the conventional SNA they are not treated in the same manner. Internal ("ancillary") environmental protection services are covered only by their inputs in the conventional SNA, whereas external environmental protection services are covered under outputs of specific industries. When analysing environmental protection activities, input-output models would have, therefore, to work with two categories of environmental protection services, each category requiring different modelling assumptions (section D, below).

370. Such separate treatments can be avoided by segregating the inputs (intermediate consumption, use of produced fixed assets, net taxes on production, compensation of employees) of internal environmental protection services from the industries where they are performed to serve the purposes of those industries and by transferring them to a new industrial services sector. This externalization implies that an additional gross output of those services, equal to the total of the inputs, would have to be shown, since market prices for internal services do not exist. The externalized services would then be recorded as intermediate inputs of those industries that had produced the environmental protection services for internal purposes.

371. The externalization of internal environmental protection services entails an increase in the gross output of the whole economy, while total value added remains unchanged: The increase in value added in the environmental protection industries is counterbalanced by a decline in value added in the industries that previously performed the internal services. This treatment is also proposed in chapter XXI of the SNA (United Nations, 1992), which deals with satellite analysis and accounts.

372. Tables 5.11 and 5.12 show the SEEA matrix with externalized internal environmental protection services assigned to column 2 and row 3. This version (V.6) of the SEEA is based on version IV.2 presented in section C of chapter IV above. This implies that environmental costs are taken into account according to the maintenance cost concept. Of course, externalized internal environmental protection services could also be integrated with other SEEA concepts, for example, that of version V.2. (This would imply an extension of the production boundary with regard to household activities.) The present version has been chosen because it seems to be a suitable starting-point for calculating symmetric input-output tables (subsection D (1)).

Table 5.11 SEEA matrix with externalized internal environmental protection services (version V.6): general concepts

		1.1 Domestic production of industries			2 Final consumption		3 Non-financial assets (uses and stocks of assets)						4 Exports	5 Total uses	
		Environmental protection services (including recycling)		Other industries	2.1 Individual consumption	2.2 Collective consumption	3.1.1 Produced assets of industries					3.2 Non-produced natural assets			
							3.1.1.1 Man-made				3.1.1.2 Natural				
							Fixed assets								
		External (including recycling)	Internal				Environmental protection services		Other industries	Change in stocks				Domestic origin	Foreign origin
							External	Externalized							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Opening stocks (1)**						B A	B A	B A	B A	B A	B** A			
	Use of products of industries (2.1)														
2	External environmental protection services (including recycling)	B A	B A	B A	B A	A							A	B A	B A
3	Externalized internal environmental protection services	B D	B D	B D										B D	
4	Other products	B A	B A	B A	B A	A	B A	B A	B A	B A	B A	A	B A	B A	B A
	Use of non-financial assets (3)														
	Use of non-produced natural assets (3.1)														
5	Depletion of natural assets (3.1.1)	B C (+) (+)	B C (+) (+)	B C (+) (+)	B C (+) (+)						C (+,-)	B C (-) (-)			B C (+) (+)
6	Use of land, landscape etc. (3.1.2)	C (+)	C (+)	C (+)	C (+)							B** C (+,-) (-)			
7	Discharge of residuals (3.1.3)	B C (-) (+)	B C (-) (+)	B C (-) (+)	B C (-) (+)		B C (-) (+)	B C (-) (+)	B C (-) (+)	B C (-) (+)	B C (-) (+)	B C (+) (-)	B C (+) (-)		B C (+) (-)
8	Restoration of natural assets (3.1.4)	C (-)	C (-)	C (-)	C (-)	C (-)						C (+)			
9	Transfer of environmental costs (3.1.5)	C (+)	C (+)	C (-)	C (-)		C (-)	C (-)	C (-)	C (-)	C (-)				
10	Treatment of residuals (3.2)	B (+,-)	B (+,-)	B (-)	B (-)		B (+,-)	B (+,-)	B (-)	B (-)	B (-)		B (+)		B (+)
11	Use of produced fixed assets (3.3.1)	A (+)	A (+)	A (+)			A (-)	A (-)	A (-)		A (-)				
12	**Contributions to unadjusted EDP (4)**	C (+,-)	C (+,-)	C (+,-)											
13	Adjustments due to market valuation (4.1)	C (+,-)	C (+,-)	C (+,-)	C (+)	C (+)					C (+,-)	C (+,-)	C (+,-)	C (+,-)	C (+,-)
	Contributions to adjusted EDP (4.2)	C	C	C											
14	Eco-margin (4.2.1)	(-)	(-)	(-)											
15	Net taxes on production (4.2.2.1)	A	A	A											
16	Compensation of employees (4.2.2.2)	A	A	A											
17	Operating surplus (4.2.2.3)	A		A											
18	**Gross output of industries (5.1)**	A	D	A											
19	**Other accumulations: volume changes, revaluation (6/7)**						B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B A (+,-)	B** A (+,-)			
20	**Total closing stocks (8)**						B A	B A	B A	B A	B A	B** A			

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.12 SEEA matrix with externalized internal environmental protection services (version V.6): numerical example
(Monetary units)

		1.1 Domestic production of industries			2 Final consumption		3 Non-financial assets (uses and stocks of assets)						4 Exports	5 Total uses	
		Environmental protection services (including recycling)		Other industries	2.1 Individual consumption	2.2 Collective consumption	3.1.1 Produced assets of industries					3.2 Non-produced natural assets		Domestic origin	Foreign origin
							3.1.1.1 Man-made				3.1.1.2 Natural				
							Fixed assets								
		External (including recycling)	Externalized internal				Environmental protection services		Other industries	Change in stocks					
							External	Externalized							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Opening stocks (1)**						20,8	75,3	686,5	208,7	83,1	1756,4			
	Use of products (2)														
2	Use of products of industries (2.1)	0,0	0,0	22,4	8,8	5,0							0,0	36,2	0,0
	External environmental protection services (including recycling)														
3	Externalized internal environmental protection services	0,0	0,0	31,7										31,7	
4	Other products	15,9	17,9	167,8	166,2	37,5	0,7	2,4	58,3	6,6	1,4	7,3	73,7	481,2	74,5
	Use of non-financial assets (3)														
	Use of non-produced natural assets (3.1)														
5	Depletion of natural assets (3.1.1)	0,3	0,4	16,8	0,7						-0,9	-17,3			0,0
6	Use of land, landscape etc. (3.1.2)	0,2	0,0	8,8	0,8							-9,8			
7	Discharge of residuals (3.1.3)	5,8	4,2	23,3	15,6		1,8	2,1	1,2	0,0	0,0	-50,9	-4,7		-1,6
8	Restoration of natural assets (3.1.4)	0,0	0,0	0,0	0,0	-5,0						5,0			
9	Transfer of environmental costs (3.1.5)	1,8	2,1	18,3	-17,1		-1,8	-2,1			0,0				
10	Treatment of residuals (3.2)								-1,2	0,0					
11	Use of produced fixed assets (3.3.1)	1,3	4,8	20,2			-1,3	-4,8	-16,9		-3,3				
12	**Eco value added/EDP (version V.4) (4)**	10,9	2,3	171,9											
13	Adjustments due to market valuation (4.1)	-7,6	-6,5	-47,1	0,0	5,0					0,9	52,2	4,7		1,6
	Eco value added/EDP at market values (4.2)														
14	Eco-margin (4.2.1)	-0,5	-0,2	-20,1											
15	Net taxes on production (4.2.2.1)	2,0	0,3	34,1											
16	Compensation of employees (4.2.2.2)	13,0	8,7	72,0											
17	Operating surplus (4.2.2.3)	4,0		133,0											
18	**Gross output of industries (5.1)**	36,2	31,7	481,2											
19	**Other accumulations: volume changes, revaluation (6/7)**						2,2	5,3	84,4	20,9	12,6	434,2			
20	**Closing stocks (8)**						22,4	78,2	812,3	236,2	93,8	2177,1			

373. The output of externalized environmental protection services is valued on the basis of cost of inputs for producing those services. The inputs consist only of actual costs (tables 5.11 and 5.12, column 2): intermediate consumption (tables 5.11 and 5.12: rows 2-4), use of produced fixed assets (row 11), net taxes on production (row 15) and compensation of employees (row 16). Imputed environmental costs of externalized environmental protection services (table 5.11, rows 5-9) are counterbalanced by adjustments due to market valuation (row 13) and the eco-margin (row 14). They have, therefore, no influence on the "market" value of externalized services. Operating surplus is zero because output value equals actual costs (row 17).

374. The classification of externalized internal environmental protection services should be as disaggregated as far as possible to reveal information in the following two areas:

(a) Industries that originally performed those services for their own purposes;

(b) Types of environmental protection measures.

The way in which this could be done is described in chapter II (subsection B (2)) where it is suggested that cross-classification be applied to the internal environmental protection units, identifying on the one hand the ISIC category of the main (or secondary) production activity under which the ancillary environmental protection activity is carried out, and on the other the ISIC category of the environmental protection unit in question. Externalized environmental protection services are used in the different industries that have performed them for their own purposes (table 5.11, row 3). Those industries could produce external environmental protection services (column 1) or products other than environmental protection services (column 3). The intermediate inputs of these industries are reduced by intermediate consumption for the purpose of producing externalized environmental protection services (rows 2 and 4, column 2) and increased by the value of externalized services (row 3). Cost components of value added (use of fixed produced assets, production taxes, compensation of employees) of the industries that originally performed externalized services as internal activities are diminished by the value added of the production of externalized internal services (table 5.11, rows 11 and 16, column 2). The operating surplus of those industries (except production of externalized environmental protection services) remains unchanged.

375. The numerical example presented in table 5.12 shows the changes caused by externalization. The gross output of industries increases by the value of the output of externalized services (31.7). It is assumed that those services are delivered only to industries not producing environmental protection services (table 5.12, column 3). Intermediate consumption of other industries (column 3) is increased by the value of externalized services (31.7) and diminished by the intermediate inputs of externalized services (17.9). The net value added of other industries (column 3), originally amounting to 248.1, is diminished by that of externalized services (9.0 = 31.7 - 17.9 - 4.8).

D. Input-output table and analysis

1. Symmetric input-output table with environment-related extensions

376. The SEEA matrix in section C can be transformed into a symmetric input-output table related to products (product-by-product table: United Nations, 1992, chap. XV). This type of input-output table facilitates the use of SEEA data in further environmental analysis (modelling).

377. Tables 5.13 and 5.14 show the structure of the symmetric input-output table related to products. The table differs from the SEEA matrix described in section C from three perspectives:

(a) Information on capital accumulation (limited). The table contains less information on the accumulation of non-financial assets. The items of the asset accounts that are not integrated with the flow account of the SEEA CR 1. Opening stocks, CR 6. Other accumulation and volume changes, CR 7. Revaluation due to market price changes and CR 8. Closing stocks—are excluded. More comprehensive models could take into account stock data as well as other accumulations of non-produced natural assets (for example, Thoss, 1974; Alfsen, 1991);

(b) Product-based branch classification. Production activities (tables 5.13 and 5.14, columns 1 and 2) are not classified under establishment-based industries but rather under product-based "branches". The gross output of each branch is homogeneous and consists of the total production of a specific product group, excluding any other (secondary) production. The transition from an establishment-based use table to a product-by-product table will be described in detail in the forthcoming *SNA Handbook on Input-Output Tables*. The transition from an industry to a branch classification of production activities also requires a reclassification of produced fixed assets to the branches that are using these assets (tables 5.13 and 14, columns 5 and 6);

(c) Environmental costs of household consumption. Environmental costs of household consumption are not transferred to production activities (row 11). This transfer would introduce an unrealistic input structure into domestic production.

378. Internal environmental protection services are externalized to simplify the structure of the input-output table (see also section C). This is not a prerequisite for input-output applications. Examples of input-output models with internal environmental protection activities are given in Schäfer and Stahmer (1989). The input-output table presented here applies the maintenance cost concept (with adjustments due to market valuation). Of course, other concepts of environmental costs, requiring some modification of the present tabulation, could be applied, as well.

379. Table 5.14 presents a numerical example of the input-output table that is consistent with the illustrative figures used throughout the handbook. Gross output of environmental protection services comprises external (36.2) and externalized internal (31.7) environmental protection

Table 5.13 Input-output table with environment - related extensions: general concepts

		1 Domestic production of branches		2 Final consumption		3 Accumulation of non-financial assets					4 Exports	5 Total uses
						3.1.1 Produced assets of branches				3.2		
						3.1.1.1 Man-made			3.1.1.2 Natural			
						Fixed assets		Change in stocks				
		Recycling, environmental protection services	Other branches	2.1 Individual consumption	2.2 Collective consumption	Recycling, environmental protection services	Other branches			Non-produced natural assets		
		1	2	3	4	5	6	7	8	9	10	11
	Use of products of branches (2.1)											
	Domestic production (2.1.1)											
1	Recycling, environmental protection services	B 1.1, P 1.1	B 1.2, P 1.2	B 1.3, P 1.3	P 1.4						D 1.10	b 1.11, d 1.11
2	Other products	B 2.1, A 2.1	B 2.2, A 2.2	B 2.3, A 2.3	A 2.4	B 2.5, A 2.5	B 2.6, A 2.6	B 2.7, A 2.7	B 2.8, A 2.8	A 2.9	B 2.10, A 2.10	b 2.11, a 2.11
	Imports (2.1.2)											
3	Recycling, environmental protection services	B 3.1, A 3.1	B 3.2, A 3.2	B 3.3, A 3.3								b 3.11, a 3.11
4	Other products	B 4.1, A 4.1	B 4.2, A 4.2	B 4.3, A 4.3		B 4.5, A 4.5	B 4.6, A 4.6	B 4.7, A 4.7	B 4.8, A 4.8		B 4.10, A 4.10	b 4.11, a 4.11
	Use of non-financial assets (3)											
	Use of non-produced natural assets (3.1)											
	Depletion of natural assets (3.1.1)											
5	Domestic origin (3.1.1.1)	B 5.1 (+), C 5.1 (+)	B 5.2 (+), C 5.2 (+)	B 5.3 (+), C 5.3 (+)					C 5.8 (+,-)	B 5.9 (-), C 5.9 (-)		
6	Foreign origin (3.1.1.2)	B 6.1 (+), C 6.1 (+)	B 6.2 (+), C 6.2 (+)	B 6.3, C 6.3								b 6.11, c 6.11
7	Use of land etc. (3.1.2)	C 7.1 (+)	C 7.2 (+)	C 7.3 (+)						C 7.9 (-)		
	Discharge of residuals (3.1.3)											
8	Domestic origin (3.1.3.1)	B 8.1 (-), C 8.1 (+)	B 8.2 (-), C 8.2 (+)	B 8.3 (-), C 8.3 (+)		B 8.5 (-), C 8.5 (+)	B 8.6 (-), C 8.6 (+)	B 8.7 (-), C 8.7 (+)	B 8.8 (-), C 8.8 (+)	B 8.9 (+), C 8.9 (-)	B 8.10 (+), C 8.10 (-)	
9	Foreign origin (3.1.3.2)									B 9.9 (+), C 9.9 (-)		b 9.11 (+), c 9.11 (-)
10	Restoration of natural assets (3.1.4)				C 10.4 (-)					C 10.9 (+)		
11	Transfer of environmental costs (3.1.5)	C 11.1 (+)	C 11.2 (+)			C 11.5 (-)	C 11.6 (-)	C 11.7 (-)	C 11.8 (-)			
	Treatment etc. of residuals (3.2)											
12	Domestic origin (3.2.1)	B 12.1 (+,-)	B 12.2 (-)	B 12.3 (-)		B 12.5 (-)	B 12.6 (-)	B 12.7 (-)	B 12.8 (-)		B 12.10 (+)	
13	Foreign origin (3.2.2)	B 13.1 (+)										b 13.11 (+)
14	Use of produced fixed assets (3.3.1)	A 14.1 (+)	A 14.2 (+)			A 14.5 (-)	A 14.6 (-)		A 14.8 (-)			
15	**Contributions to unadjusted EDP (4) (columns1-3); adjustments of final uses (columns 4-10)**	C 15.1 (+,-)	C 15.2 (+,-)	C 15.3 (+,-)	C 15.4 (+,-)				C 15.8 (+,-)	C 15.9 (+,-)	C 15.10	e 15.11
16	Adjustments due to market valuation (4.1)	C 16.1 (+,-)	C 16.2 (+,-)	C 16.3 (-)	C 16.4 (+)				C 16.8 (+,-)	C 16.9 (+,-)	C 16.10 (+)	c 16.11 (+,-)
	Contributions to adjusted EDP (4.2)											
17	Eco-margin (4.2.1)	C 17.1 (-)	C 17.2 (-)	C 17.3 (-)								c 17.11 (-)
18	Contributions to NDP (4.2.2)	A 18.1 (-)	A 18.2									e 18.11
19	**Gross output of branches (5.1), final uses**	d' 19.1	e' 19.2	e' 19.3	e' 19.4	e' 19.5	e' 19.6	e' 19.7	c' 19.8	c' 19.9	e' 19.10	(X)

Note: A-matrices denote monetary data (market values); B-matrices physical data; C-matrices imputed environmental costs; and D-matrices externalized internal environmental protection services.

Table 5.14 Input-output table with environment - related extensions: numerical example
(Monetary units)

		1 Domestic production of branches		2 Final consumption		3 Accumulation of non-financial assets					4 Exports	5 Total uses
						3.1.1 Produced assets of branches				3.2 Non-produced natural assets		
						3.1.1.1 Man-made			3.1.1.2 Natural			
						Fixed assets		Change in stocks				
		Recycling, environmental protection services	Other branches	2.1 Individual consumption	2.2 Collective consumption	Recycling, environmental protection services	Other branches					
		1	2	3	4	5	6	7	8	9	10	11
	Use of products of branches (2.1)											
	Domestic production (2.1.1)											
1	Recycling, environmental protection services	0	54,1	8,8	5						0	67,9
2	Other products	31,5	130,2	139,9	37,5	2,8	52,4	6,6	1,4	7,3	71,6	481,2
	Imports (2.1.2)											
3	Recycling, environmental protection services	0	0	0								0
4	Other products	2,3	37,6	26,3		0,3	5,9	0	0		2,1	74,5
	Use of non-financial assets (3)											
	Use of non-produced natural assets (3.1)											
	Depletion of natural assets (3.1.1)											
5	Domestic origin (3.1.1.1)	0,7	16,8	0,7					-0,9	-17,3		
6	Foreign origin (3.1.1.2)	0	0									0
7	Use of land etc. (3.1.2)	0,2	8,8	0,8						-9,8		
	Discharge of residuals (3.1.3)											
8	Domestic origin (3.1.3.1)	10	23,3	15,6		3,9	1,2	0	0	-49,3	-4,7	
9	Foreign origin (3.1.3.2)									-1,6		-1,6
10	Restoration of natural assets (3.1.4)				-5					5		
11	Transfer of environmental costs (3.1.5)	3,9	1,2			-3,9	-1,2	0	0			
	Treatment etc. of residuals (3.2)											
12	Domestic origin (3.2.1)											
13	Foreign origin (3.2.2)											
14	Use of produced fixed assets (3.3.1)	6,1	20,2			-6,1	-16,9		-3,3			
15	**Contributions to unadjusted EDP (4) (columns1-3); adjustments of final uses (columns 4-10)**	13,2	189	-17,1	5				0,9	52,2	4,7	247,9
	Adjustments due to market											
16	valuation (4.1)	-14,1	-30,3	-16,8	5				0,9	52,2	4,7	1,6
	Contributions to adjusted EDP (4.2)											
17	Eco-margin (4.2.1)	-0,7	-19,8	-0,3								-20,8
18	Contributions to NDP (4.2.2)	28	239,1									267,1
19	**Gross output of branches (5.1), final uses**	67,9	481,2	175	42,5	-3	41,4	6,6	-1,9	-13,5	73,7	(X)

activities (table 5.12). EDP of the extended input-output framework (row 15) can be derived as the total of EVA of branches (columns 1 and 2) and of the correction items with regard to environmental costs of household consumption activities (column 3). Conventional NDP is shown in row 18 to facilitate input-output analysis of traditional monetary data.

2. Environment-related input-output analysis

380. Depending on the nature of environmental-economic interactions and the focus on key policy parameters and variables, a wide variety of different environment-related input-output analyses can be conceived. Based on the different SEEA versions, the following types of analysis could be usefully explored:

(a) Analysis of monetary flows of environmental protection activities. Input-output models could be used for analysing data according to the concepts of the SEEA, versions II and V.6, that is, the externalization of internal environmental protection activities. Such analysis could determine the economic importance of environmental protection activities and identify the burden of the environmental protection costs directly and indirectly associated with the production of particular branches or product groups;

(b) Analysis of physical flows of raw materials, produced goods and residuals. Physical flows could be linked to monetary data without introducing imputed environmental costs, based on version III of the SEEA. The analysis would aim at studying international implications with regard to the depletion of natural assets, the production of goods and the destination of residuals. Furthermore, data on the use of raw materials and outputs of residuals could be linked with the flows of produced goods in an application of the concepts of materials/energy balances;

(c) Analysis of imputed environmental costs at maintenance values. Based on version IV.2 of the SEEA, input-output models could, for example, determine the indirect imputed environmental costs connected with international trade;

(d) Analysis of maintenance of natural assets. Based on version IV.2 of the SEEA, models could study the impacts of changes in the structure of inputs and in the structure of final uses connected with the maintenance of natural assets. In a first step, the immediate impacts of maintenance activities on economic structures could be introduced as exogenous changes. In a second step, indirect effects of these structural changes on the use of raw materials and on the output of residuals could be analysed. Such models would of course be based on the simplifying assumptions of input-output analysis and would provide only preliminary insight into the economic and environmental implications of strategies for maintaining natural assets.

381. Further improvements and extensions of the SEEA should facilitate the incorporation of environmental concerns into input-output analysis. However, as practical experience has shown

(section C of chapter VI), such analysis could only be realized if data availability is improved in tandem with methodological development.

VI. Implementing the SEEA

A. Integration of economic and environmental accounting

382. There are various reasons for integrating environmental and economic accounting. The first reason has to do with analysis. Calculations of environmental costs in environmental accounting are often done in a detailed breakdown, for instance, to distinguish different types of lumber or different species of fish when calculating environmental adjustments to value added in forestry and fishing. Similar calculations are carried out in the context of national accounting. Obviously, the two types of calculations need to be compatible, as otherwise it would be difficult to assess how environmental adjustments will affect economic variables such as capital and output. It would be a mistake to make only overall adjustments to GDP which, apart from giving a political message, would not present much information that was useful for purposes of analysis and policy-making.

383. The other reason for integrating work on environmental and national (economic) accounting is institution- and organization-related. Detailed environmental analyses preceding environmental accounting are often carried out by specialists who are very different from those dealing with national accounts. Moreover, they carry out their work in institutions that are different from those dealing with national accounts. Integration would require new organizational structures that permitted inter-institutional and interdisciplinary cooperation. Only in this manner could continuity of the work, beyond one-time research efforts, be ensured.

384. Spatial aspects of the integration of economic and environmental accounting could be addressed by regional accounts. Environmental accounting deals with concerns that are typically related to regional or local-level effects. This is a particular problem in large countries where regional and (subnational) policies might be most efficient in dealing with environmental-economic interactions. Certain regions may be particularly affected by air pollution, others by overfishing and others by deforestation. Also, certain regions may be affected by environmental impacts of activities in neighbouring countries, for example, those involving shared natural resources such as freshwater bodies. Integration of environmental and economic accounting may therefore require regional integrated accounting. In cases of significant environmental effects across national borders, there may also be a need for regional accounting across those borders. Further practical experience with regional accounting needs to be acquired, especially in large developing countries, where the measurement of cross-boundary flows of goods and services might be easier to obtain.

B. Flexibility and consistency: a building-blocks approach

385. In order to adapt to different environmental and socio-economic conditions in countries, the SEEA has been designed to be as comprehensive, flexible and consistent as possible. The objective of comprehensiveness refers not only to a variety of different economic activities or categories of environmental deterioration, but also to alternative theoretical approaches that can

be applied in analysing the economic and environmental situation. Physical accounting (as discussed) and accounting based on different types of monetary valuation are equally important for this purpose.

386. Comprehensiveness does not imply the use of the whole range of concerns and methods to describe environmental-economic interrelations. The specific environmental and economic problems of a particular country should determine the choice of the main areas of environmental concerns to be taken into account. Furthermore, data availability and limited possibilities of further improvement of the database restrict the application of SEEA concepts. These constraints require a flexible system of building blocks that could be used independently of each other (van Bochove and van Tuinen, 1986).

387. Flexibility of the SEEA should not affect the consistency of the system. Consistency is maintained if national versions of the SEEA, while applying compatible accounting rules for extended systems, remain an extension of national (economic) accounts. These rules involve the balance of supply and destination of products, of natural resources and residuals, and of stocks and flows of tangible assets. Flexibility permits the selection of high-priority flow and asset accounts, but should not encourage the development of incomplete accounts. In summary, the concepts of the SEEA should be comprehensive enough to enable each country to choose suitable building blocks for its specific system of environmental accounting, while at the same time maintaining close links to the conventional national (economic) accounts.

388. The implementation of the SEEA should thus focus on high-priority environmental concerns and related economic activities. Implementation will be further limited by data availability. Therefore, it seems useful to start with implementing those parts of the SEEA that have high priority and a sufficient data basis. After improving the database, more complete versions of the SEEA should be implemented. In figure VI an overview is given of possible building blocks of the SEEA. Of course, each building block comprises a variety of specific items that are compiled separately (for example, accounts for different types of products, raw materials and residuals).

389. The building blocks are grouped according to the main data categories presented in versions I, II, III and IV of the SEEA, into:

(a) Reformatting and disaggregation of the SNA. These parts of the SEEA comprise building blocks including production accounts and accounts of non-financial assets that are reformatted on the basis of a further disaggregation (version I). Disaggregation refers to the identification of monetary data connected with environment-related activities (for example, separate identification of environmental protection activities that are responses to the repercussions of a deteriorated natural environment) (A-matrices of version II);

(b) Physical accounting. This part of the SEEA comprises accounts for products, raw materials and residuals, as well as land-use accounts, and could also be linked to systems

of environmental statistics and indicators and other (more aggregated) indices of environmental quality (B-matrices of version III);

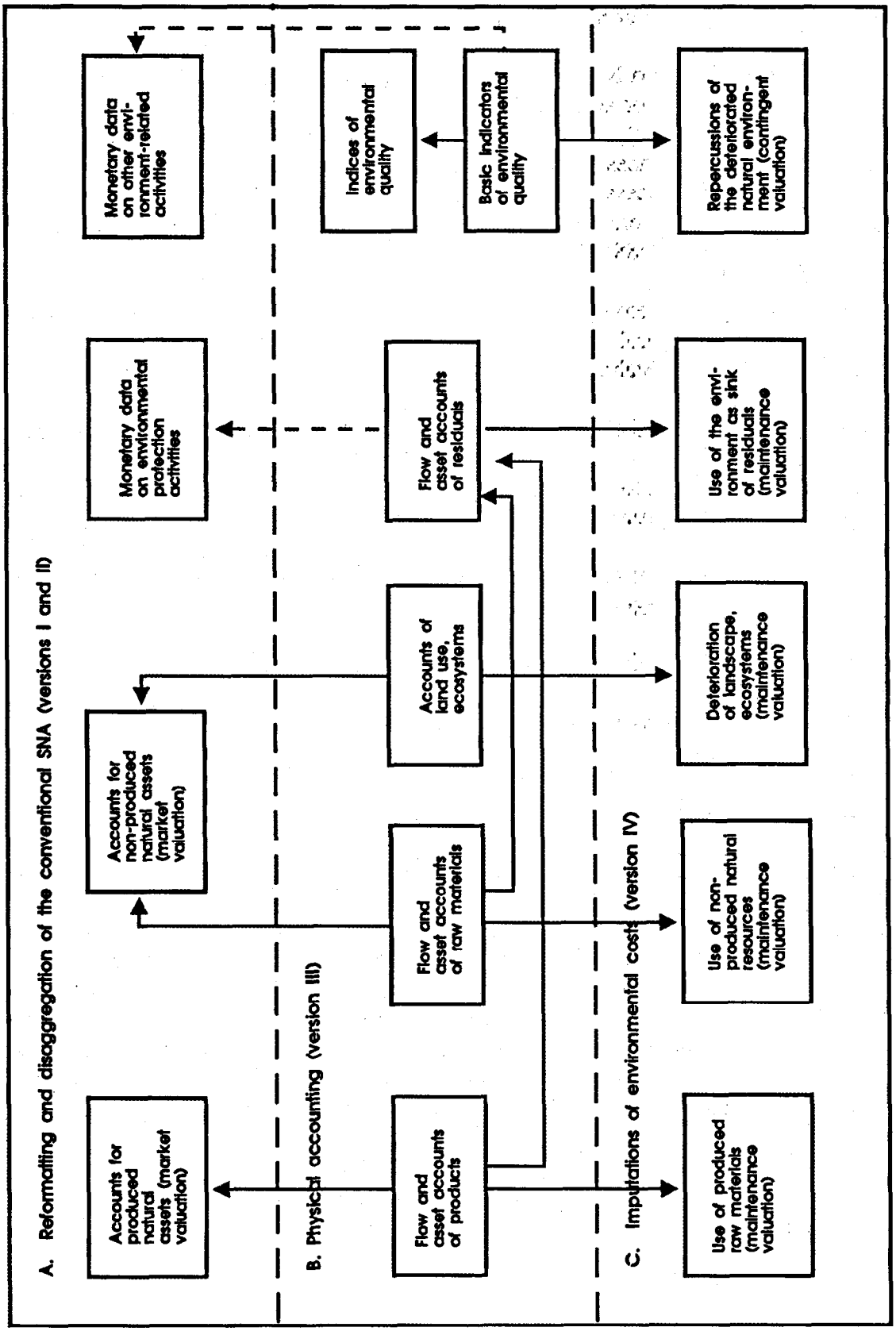
(c) Imputation of environmental costs. This part of the SEEA comprises estimates of the impacts of economic activities on the natural environment in monetary terms (C-matrices of versions IV). Those estimates include the (hypothetical) costs of maintaining the qualitative and quantitative level of natural assets and the cost of responding to the repercussions of the deteriorated natural environment.

390. The arrows in figure VI represent dependencies between the compilations of data for the different building blocks. Data collection for the implementation of some building blocks may require data compiled for other parts of the system. For example, monetary data (building blocks of parts A and C in figure VI) can, in many cases, be compiled only on the basis of sufficient physical data (building blocks of part B). The compilation dependencies are less strong among the different building blocks in monetary terms. Those data can usually be compiled independently of each other. Nevertheless, imputed environmental costs of part C are intended to be analysed with regard to the actual conventional data in part A. The compilation dependencies among the different parts of the SEEA indicate that physical data and accounts need to be established first. Monetary data could then be estimated in a second step. This procedure does not exclude the immediate implementation of monetary building blocks that are either already available or less dependent on physical data. This is the case, in particular, when expenditures connected with environmental protection activities are estimated or the more controversial contingent valuation is applied.

391. The building-block approach would permit the limiting of the implementation of the SEEA in a first stage to parts A and B. This limitation would leave the concepts of the traditional national accounts largely unchanged because parts A and B record only (disaggregated) conventional SNA data. For the establishment of physical accounts, additional environmental statistics should provide further information without affecting the conventional SNA concepts. On the other hand, the presentation of details of environmental-economic interrelationships in physical terms only is of limited value. If the results of the SEEA are to support integrated environmental and economic planning and policy, the relative importance of economic activities and environmental effects needs to be established in order to construct aggregate "indices" that are better suited for overall policy formulation and monitoring. The estimation of imputed environmental costs allows such aggregation. As an intermediate step, aggregated physical indicators, for instance on changes in quality of specific environmental media, could supplement the conventional monetary concepts of the SNA.

392. Work on reformatting and disaggregating the SNA (part A of the SEEA) should concentrate on completing the asset accounts of the revised SNA (version I) and identifying the monetary data connected with environmental protection activities (version II). In a first step, the identification of environmental protection activities could be restricted to expenditures connected with end-of-pipe technologies. At the same time, asset accounts should be completed with regard to produced biological assets (for example, cultivated forests) and non-produced

Figure VI. Building blocks for implementing the SEEA



natural assets such as subsoil assets and land, while applying market valuations to the stock of assets and changes therein in accordance with the SNA. This would result in the estimation of imputed environmental costs at market values.

393. Physical accounts (part B of the SEEA) are especially important when quantifying the use of raw materials and land. For additional product flow accounts in physical units (for example, for energy use and residuals), it would be necessary to establish materials/energy balances (Ayres, 1978). Those balances could link the use of natural resources with the residuals discharged by economic processes. Further research is needed to develop suitable methods for aggregating physical indicators in particular within integrated frameworks of environment statistics (United Nations, 1988, 1991a).

394. To estimate imputed environmental costs necessary for maintaining the quantitative and qualitative levels of the natural environment (part C of the SEEA), the following steps should be carried out (Hamer and Stahmer, forthcoming):

(a) Description of physical changes of the natural environment caused by economic activities;

(b) Analysis of the extent to which those changes imply a quantitative depletion or qualitative degradation of the natural environment;

(c) Decision on the quantitative or qualitative standards that should have been observed to avoid depletion or degradation;

(d) Choice of possible activities to meet the standards selected;

(e) Estimation of the costs of those activities.

C. Country projects and programmes

395. Practical experience on how to integrate existing national accounts with environmental accounts has been gained through pilot studies carried out by the Statistical Division of the United Nations Secretariat and the World Bank in Mexico, Papua New Guinea and Thailand. Environmental adjustments were made not only to overall aggregates such as GDP, capital formation, final consumption and capital stock, but also to sectoral indicators, (van Tongeren, Schweinfest and Lutz, 1991; Bartelmus, Lutz and Schweinfest, 1992). Those indicators included output, intermediate consumption and value added. All environmental adjustments were applied in a manner consistent with the internal logic of a national accounting framework so that analyses based alternatively on economic and environmentally adjusted aggregates could be compared.

396. The pilot studies tested the feasibility of extending traditional economic accounting so as to incorporate environmental concerns in the SEEA framework. They illustrated the need to

establish a joint environmental-economic accounting framework in a first step. In a second step, environmental adjustments were introduced on the basis of a relatively limited database. Both studies concluded that the database needed considerable improvements in order to replace ad hoc estimation by more valid information.

397. These conclusions confirm the findings of other studies that existing databases for implementing the SEEA in a comprehensive manner are insufficient (see, for instance, Peskin and Lutz, 1990). This is true for both developing and developed countries. Furthermore, while attempts to establish environmental statistics have led to substantial improvements, available data are, in most cases, not representative of the whole country but often give only some impressions of locally restricted situations. In the further development of environmental accounting as an extension of national accounting, the fact that there are still serious deficiencies in basic economic statistics for the implementation of the SNA in many countries, especially developing countries, should also be taken into consideration.

398. This situation should not, however, discourage statisticians from starting to establish at least parts of the SEEA. The flexible construction of the SEEA allows partial implementation as a first step in fields that have a sufficient data basis and to which high priority is attached. The above-mentioned country studies are evidence of the feasibility of SEEA implementation even in countries with limited resources and statistical capacities. Table 6.1 gives an illustration of possible priorities for a stepwise implementation of the SEEA in developed and developing countries.

399. More experience needs to be gained in further country applications of the SEEA in order to determine which concepts and methods can be recommended internationally. It is expected that constraints of data availability and national priorities regarding environmental and developmental concerns will ultimately determine which components of the SEEA will need to be further developed and which are more of academic interest. In the course of such development, the orientation of environmental accounts may differ between developing and developed countries.

400. In general, in developing countries the problems of depletion of natural assets and of land degradation have the highest priority (Bartelmus, 1986, Pearce, Barbier and Markandya, 1990; and others, 1991; Ward, 1982). Depletion problems comprise the clearing of tropical forests, overfishing, the excessive exploitation of subsoil assets and water resources, and the loss of biodiversity. Land loss and the quality deterioration of agricultural land by soil erosion are urgent problems. Increasing attention is also being paid to the negative impacts of tourism on the natural environment.

401. In many developed countries, degradation of the quality of air, land and water by residuals, and possible avoidance strategies, have special importance for environmental policies. When using the SEEA, those countries may, as a first step, describe the discharge of residuals in physical terms. In a second step, the degradation of the natural environment could be estimated according to the cost of avoiding that degradation or of restoring environmental

Table 6.1. Priorities for implementing the SEEA

Environmental issues	Physical accounting		Monetary accounting	
	Developed country	Developing country	Developed country	Developing country
1 Use of natural assets (except discharge of residuals)				
Depletion of				
1.1 Biological assets	+	+ +	+	+ +
1.2 Subsoil assets	+	+ +	+	+ +
1.3 Water	0	+ +	0	+ +
Degradation of land (landscape)				
1.5 Restructuring (urbanization, changes in land use)	+ +	+ +	+	0
1.6 Agricultural use (soil erosion)	0	+ +	0	+ +
1.7 Recreational use	+	+	+	+
2 Product flow analysis	+ +	0	0	0
3 Degradation of the natural environment by discharge of residuals				
3.1 Wastes and land contamination	+ +	0	+	+
3.2 Waste water	+ +	+	+	+
3.3 Air pollution	+ +	+	+	+
4 Actual environment costs				
4.1 Environment protection activities			+ +	+
4.2 Damage costs			+	0

Note: Two plus signs (+ +) indicate high priority, one plus sign (+) indicates medium priority and a zero (0) indicates low priority.

estimated according to the cost of avoiding that degradation or of restoring environmental quality. In this case, a comparison of necessary prevention costs with the benefits of improved environmental quality could provide useful information on the efficiency of environmental measures. The benefits could be estimated by valuing the changes in "consumer services" of the natural environment (chap. V).

402. The depletion of domestic natural resources is generally not a major problem for developed countries. As already mentioned, developed countries have been blamed for compounding natural resource scarcities in developing countries by importing natural resources from those countries at prices that do not reflect full scarcity costs. In this case, an analysis of the possible indirect effects of the natural resource imports for the exporting country could provide an insight into the sustainability of international trade patterns. The "exportation" or "importation" of environmental problems by importing or exporting products that were produced with environmentally damaging technologies should thus be further studied, for example, by means of input-output analyses (subsection D (2) of chap. V).

Annexes

A. Classification of transactions, other flows and stocks, used in the rows of alternative SEEA matrices

Classification of transactions, other flows and stocks, used in the rows of SEEA matrices		Application in alternative versions of the SEEA
1	**Opening stocks**	II (in monetary terms only), III, IV and V
2	**Use of products**	II (in monetary terms only), III, IV and V
2.1	Use of products of industries (branches)	
2.1.1	Domestic production	
2.1.2	Imports	
2.2	Use of other household output	V.1-V.5
2.2.1	Use of other household products	
2.2.2	Value of household consumption activities	
2.3	Use of environmental services	
2.3.1	Disposable services	V.4 (in monetary terms only)
2.3.1.1	Domestic origin	
2.3.1.2	Foreign origin	
2.3.2	Productive services of land	V.4 (in monetary terms only)
2.3.3	Consumer services	V.5 (in monetary terms only)
3	**Use of non-financial assets**	
3.1	Use of non-produced natural assets	III (in physical terms only), IV and V
3.1.1	Depletion of natural assets	
3.1.1.1	Domestic origin	
3.1.1.2	Foreign origin	
3.1.2	Use of land, landscape, ecosystems etc.	
3.1.3	Discharge of residuals	

3.1.3.1	Domestic origin	
3.1.3.2	Foreign origin	
3.1.4	Restoration of natural assets	
3.1.5	Shift in imputed environmental costs	
3.2	Treatment of residuals	III, IV and V (in physical terms only)
3.2.1	Domestic origin	
3.2.2	Foreign origin	
3.3	Use of produced fixed assets	
3.3.1	Use of produced fixed assets of industries (branches)	All versions (in monetary terms only)
3.3.2	Use of consumer durables	V.1-V.5 (in monetary terms only)
4	**Eco value added/eco domestic product (EDP)**	IV.2, IV.3 and V.2-V.6 (in monetary terms only)
4.1	Adjustments due to market valuation	IV.2, IV.3 and V.2-V.6 (in monetary terms only)
4.2	Eco value added/eco domestic product (EDP) at market values	IV and V (in monetary terms only)
4.2.1	Eco-margin	IV and V (in monetary terms only)
4.2.2	Net value added/net domestic product (NDP)	All versions (in monetary terms only)
4.2.2.1	Net taxes on production	
4.2.2.2	Compensation of employees	
4.2.2.3	Net operating surplus	
4.2.2.3.1	Compensation of own-account workers	
4.2.2.3.2	Compensation of employers, other operating surplus	
5	**Gross output**	

5.1	Products of industries	II (in monetary terms only), III, IV and V
5.2	Other household products	V.1-V.5
5.3	Environmental services	V.4-V.5 (in monetary terms only)
6	**Other volume changes**	
6.1	Other volume changes of non-produced natural assets due to economic decisions	
6.1.1	Other volume changes of non-produced natural assets due to economic uses	II/III (in monetary terms only)
6.1.2	Other volume changes of non-produced natural assets due to other economic decisions Other accumulation of non-produced natural assets due to economic decisions	II (in monetary terms only), all versions III, IV and V
6.2	Other volume changes due to natural and multiple causes, n.e.c.	II (in monetary terms only), III, IV and V
7	**Revaluation due to market price changes (nominal holding gains or losses)**	All versions (in monetary terms only)
8	**Closing stocks**	II (in monetary terms only), III, IV and V

B. Classification of columns (CC) used in alternative versions of the SEEA matrices

Column entries		Application in alternative versions of the SEEA
1	**Domestic production**	
1.1	Industries (branches)	All versions
1.2	Other household activities	V.1-V.5
1.2.1	Other household production	
1.2.2	Consumption activities	
1.3	Environmental services	
1.3.1	Disposal services	V.4
1.3.2	Productive services of land	V.4
1.3.3	Consumer services	V.5
2	**Final consumption**	All versions
2.1	Individual consumption	
2.2	Collective consumption	
3	**Non-financial assets** (uses and stocks of assets)	
3.1	Produced assets	
3.1.1	Industries (branches)	All versions
3.1.1.1	Man-made	
3.1.1.2	Natural	
3.1.2	Consumer durables	V.1-V.5
3.2	Non-produced natural assets	All versions
3.2.1	Wild biota	
3.2.2	Subsoil assets	
3.2.3	Water	
3.2.4	Air	
3.2.5	Land including ecosystems (ecozones)	
3.2.5.1	Soil	
3.2.5.2	Area	
4	**Exports**	All versions
5	**Total uses**	All versions

C. Draft classification of environmental protection activities (CEPA)

1	**Protection of ambient air and climate**
1.1	Prevention of air pollution through in-process modifications
1.2	Treatment of exhaust gases and ventilation air
1.3	Measurement, control, laboratories and the like
1.4	Other purposes
2	**Protection of ambient water (excluding groundwater)**
2.1	Prevention of water pollution through in-process modifications
2.2	Industrial pretreatment plants
2.3	Sewerage
2.4	Purification by mechanical treatment technology
2.5	Purification by biological treatment technology
2.6	Purification by advanced treatment technology
2.7	Treatment of cooling water
2.8	Measurement, control, laboratories and the like
2.9	Restoring polluted surface water
2.10	Other purposes
3	**Prevention, collection, transport, treatment and disposal of wastes**
3.1	Prevention of wastes through in-process modifications
3.2	Collection and transport of wastes
3.3	Treatment and disposal of hazardous wastes
3.4	Treatment and disposal of other than hazardous waste
3.5	Measurement, control, laboratories and the like
3.6	Other purposes
4	**Recycling of wastes and other residuals**
5	**Protection of soil and groundwater**
5.1	Decontamination of soils and cleaning of groundwater
5.2	Measurement, control, laboratories and the like
5.3	Other purposes

6	**Noise abatement**
6.1	Noise from road and rail traffic
6.2	Air traffic noise
6.3	Industrial process noise
6.4	Measurement, control, laboratories and the like
6.5	Other noise abatement
7	**Protection of nature and landscape**
7.1	Protection of species
7.2	Protection of habitats
7.3	Erosion protection
7.4	Coastal protection, dune stabilization
7.5	Protection against avalanches
7.6	Fire protection
7.7	Measurement, control, laboratories and the like
8	**Other environmental protection measures**
8.1	Education and training, information
8.2	General administration of the environmental protection
9	**Research and development**

D. Classification of non-financial assets (CNFA) in SNA and 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 etc.	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	
1.2.2.2 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 eco-systems)	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 without or with 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 etc.	
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 etc.)	AN.22

E. SEEA Classification of other volume changes (COVC) of non-financial assets

	COVC (SEEA)	SNA (rev.)
1	**Other volume changes of non-produced natural assets due to economic decisions (CR 6.1)**	
1.1	Other volume changes of non-produced natural assets due to economic use (6.1.1)	
1.1.1	Depletion of non-produced assets due to economic activity (−)	K.61
1.1.2	Changes in land quality due to changes in economic uses (due, for example, to restructuring) (+,−)	K.3-part K.62-part
1.1.3	Degradation of land (soil, landscape, ecosystems) due to economic use (except discharge of residuals) (−)	K62-part
1.1.3.1	Degradation of the material composition of soil	
1.1.3.2	Soil erosion	
1.1.3.3	Other degradation of land, landscape, ecosystems	
1.1.4	Degradation of non-produced assets due to discharge of residuals (−)	K.62-part
1.1.5	Restoration of the quality of non-produced natural assets (+,−)	K.3-part
1.2	Other volume changes of non-produced natural assets due to other economic decisions (6.1.2)	
1.2.1	Discovery and adjustments of non-produced natural assets	K.3 -part K.62-part
1.2.1.1	Discovery of new resources (+)	
1.2.1.2	Adjustments of volume	
1.2.1.2.1	Adjustments of volume due to technological changes (+,−)	
1.2.1.2.2	Adjustments of volume due to price and cost changes (+,−)	
1.2.1.2.3	Adjustments due to new estimation methods (+,−)	
1.2.2	Changes in classification and structure of non-produced natural assets due to economic activities (for example, change in economic use) (shifts: −,+)	K.12.22-part
2	**Other volume changes of non-financial assets due to natural and multiple causes, n.e.c. (6.2)**	
2.1	Net natural growth (increase) of non-produced natural assets	K.5
2.1.1	Gross natural increase (+)	K.5-part

2.1.2	Recurrent natural depletion (−)	K.5-part
2.2	Catastrophic losses (−)	K.7
2.2.1	Catastrophic losses due to natural causes	K.7-part
2.2.2	Catastrophic losses due to economic (technological) causes	K.7-part
2.2.3	Catastrophic losses due to political events (for example, wars)	K.7-part
2.3	Other volume changes n.e.c. of non-financial assets (+, −)	K.2, K4, K.8, K.9, K.12-part

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