NATURAL RESOURCE ACCOUNTS FOR NEW ZEALAND

- OVERVIEW DOCUMENT -

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1. Introduction

[Please refer to the glossary for an explanation of technical terms]

New Zealanders are becoming increasingly aware of the complex relationships between society, the economy and the environment. Historically, New Zealand has often utilised its abundant natural resources for economic development. In recent years, however, the apparent depletion of some natural resources has shifted New Zealand's focus towards sustainable development.

Sustainable development is defined as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*.[1] To move down the sustainable development path requires readily available information about the linkages between the economy, environment, and society.

Information about the level of natural resource use and existing stocks of natural resources can be obtained from natural resource accounts. 'Natural resources' refer to renewable and non-renewable naturally occurring biological assets that have the potential to be used for economic production or consumption. Consumption includes the consumption of environmental services, which refers to the qualitative functions of natural non-produced assets such as land, water and air (including the related ecosystem) and their biota.[2]

Standard measures of economic performance such as Gross Domestic Product (GDP) do not fully account for unsustainable use of natural resources. Natural resource accounts complement measures, such as GDP, to provide a more complete picture of a country's economic and environmental performance.

The decision to produce 'national environmental accounts' was announced in the Budget 2000. New Zealand is the only Organisation for Economic Co-operation and Development (OECD) nation that has not compiled a set of environmental accounts. Producing these accounts will, amongst other things, help New Zealand meet its commitments under various ratified international conventions. Statistics New Zealand is therefore producing a set of developmental natural resource accounts in association with the Ministry for the Environment.

This paper provides a background for natural resource accounts, and the New Zealand natural resource accounts in particular. It is designed to complement any report or tables released for specific New Zealand natural resource accounts. There are a wide variety of natural resource accounts that can be produced including forestry, fisheries, sub-soil/energy assets, water, land, and (eventually) ecosystems. Accounts for forestry, energy and fish are expected to be made available in 2002. The presentation of natural resource accounts will vary for different resources, but they all share a common conceptual basis.

[1] Rio Declaration on Environment and Development, 1992.
[2] From the United Nations glossary of environmental statistics, http://esa.un.org/unsd/envmnt/default.asp.

1.1 Introduction to Natural Resource Accounts

1.1.1 Introduction to the concept of natural resource accounting

Gross domestic product (GDP) is the most well known measure of economic growth, and is prepared using the System of National Accounts (SNA). GDP is a measure of the value added[3] for the goods and services produced by an economy.

Despite the fact that GDP provides a robust, internationally comparable measure of economic performance, it has some limitations, such as giving an incomplete view of the environment. For example, the extraction of oil from the environment increases GDP, as this creates additional economic production. However, no account is taken for the fact that oil is a non-renewable resource, and stock levels are being depleted. Similarly, the cost of cleaning up the environment after an oil spill also increases GDP, as economic activity has taken place. Also, effluent and other discharges into the environment from social or economic activity are *not* deducted from GDP.

The above issues are addressed by expanding the SNA framework to cover the environment. This expanded framework is known as the System of Environmental and Economic Accounting (SEEA). It is consistent with the SNA and, amongst other things, allows for the measurement of natural resource accounts.

Natural resource accounts are the first stage of environmental accounts. Apart from addressing conceptual concerns with GDP, environmental accounting has a number of other functions. It seeks to measure depletion of natural resources that can threaten living standards, the food chain, ecological stability, and economic productivity; assess the extent of environmental protection expenditure; and measure health and welfare costs associated with the degradation of the environment.

1.1.2 The function and purpose of natural resource accounting

Economic growth and human well-being is dependent on the services provided by the environment; such as the provision of raw material and energy, absorption of waste, and other amenities. A common framework enables analysis between the environment, economy and society. SEEA is a framework that theoretically accommodates this type of analysis.

Natural resource accounts consist of stock and flow accounts in physical and monetary units. The accounts will help provide a measure of New Zealand's total natural wealth. Natural resource accounts provide information that can improve resource management, and will help determine whether natural resources are being utilised efficiently on a national basis, and across sectors. Natural resource accounts can be used to assess the physical and monetary extent of environmental depletion and degradation. The accounts will help researchers analyse the effects of environmental policy on the economy, and economic policy on the environment.

Statistics New Zealand does not plan to compile emissions accounts at this stage, but may do so in the future. Note that under SEEA, the flow accounts for each natural resource contain residual flows that make up aspects of an emissions account.

Economic accounts as they stand at present, focus on New Zealand's wealth without taking natural resource stocks into account. As a result, economic accounts are quite unsuitable as a tool for measuring environmental

[3] Value added refers to the value of output less the value of intermediate consumption. It is a measure of the contribution of GDP made by an individual producer, industry or sector.

sustainability. Environmental accounts seek to overcome this weakness by incorporating information about stocks and flows of natural capital into the framework provided by national accounts.

1.1.3 The application of natural resource accounts to New Zealand

Natural resource accounts serve the basic functions of an accounting system. They provide the information needed by policy makers, businesses, and individuals to track important trends and to determine the economic importance of changes to environmental resources.

Table 1. Potential Analytical Uses of Natural Resource Accounts [4]

Natural resource accounts (tracing the quantity and quality of resources), in combination with economic models, can be used to analyse various environmental/economic issues, including:

- Measuring physical scarcity of natural resources
- Improving resource management – generating empirical evidence of over-exploitation
- Establishing a balance sheet for resource sectors: analysis of sectoral economic performance (eg productivity), taking into account resource depletion
- Measuring total wealth by examining policies for sustainable development
- Valuing environmental degradation and depletion of natural resources
- Measuring the incidence of environmental regulations and taxes
- Estimating optimal emission tax rates
- Measuring the efficiency of natural resource use by economic sector
- Dealing with aspects of international trade and the environment
- Analysing structural changes in the economy
- Linking pollution components to standard macro-economic models
- Tracing the dispersion and impact of pollution
- Measuring the economic effect of pollution abatement and environmental protection
- Measuring the sectoral costs associated with government regulation and policy
- Measuring unit abatement cost

New Zealand has a heavy reliance on natural resources for economic benefit. Therefore, it is important to measure natural asset stocks and flows, as it provides important information on the following topics:

- Resource management: this can be improved through the ability to assess the physical extent of environmental depletion and degradation.

- Policy analysis: natural resource accounts help analyse the effectiveness of current economic and environmental policies, and provide the necessary information to change current policy to improve resource use efficiency through the analysis of sectoral economic performance and measurement of total natural wealth.

[4] Hamilton K (1994). "Environmental Accounting for Decision Making", background paper to the OECD seminar.

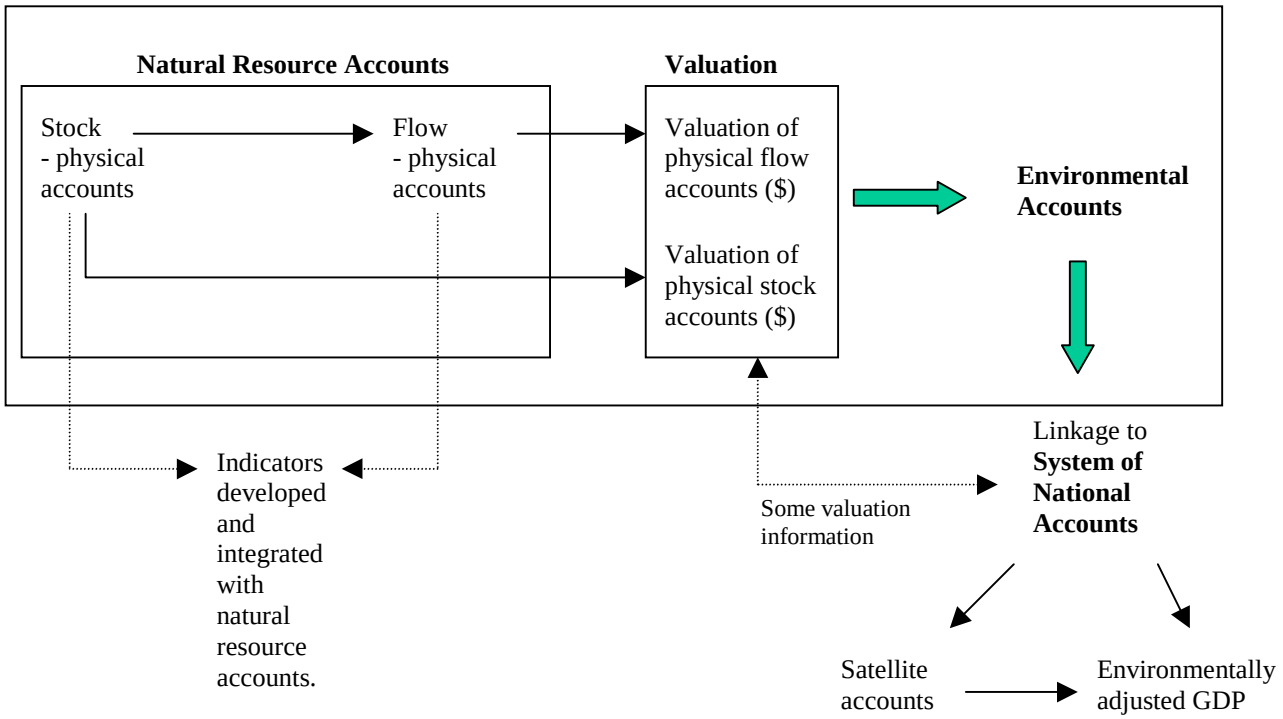
- Indicator development: output from the natural resource accounts may provide information that can be applied to a particular environmental issue. For example, the percentage of forests that are indigenous compared to the percentage that are exotic.

- Sustainable development strategies and policies: information about environmental and economic interactions, assisting the advancement of sustainable development strategies and policies.

One important point to note is that the potential uses of the environmental accounts are greatly enhanced once a consistent and coherent time series has been established.

1.1.4 Development path using natural resource accounts

Table 2. System of Environmental and Economic Accounts (SEEA)



Natural resource accounts are the first step in the process of compiling environmental accounts and integrating environmental resource information into the System of National Accounts (SNA).

From this information indicators can be developed and integrated into State of the Environment Reporting (SER) and sustainable development reporting. For example, the opening stock of cultivated fish stock, if measured over time, will highlight trends in species biomass and depletion rates.

Once a natural resource account is compiled for a specific resource, the physical account information will be valued in monetary terms. Valuation will be done for both stock and flow accounts. Some of the valuation information from the SNA can be used at this point, although there will still be valuation issues that need to be assessed and documented.

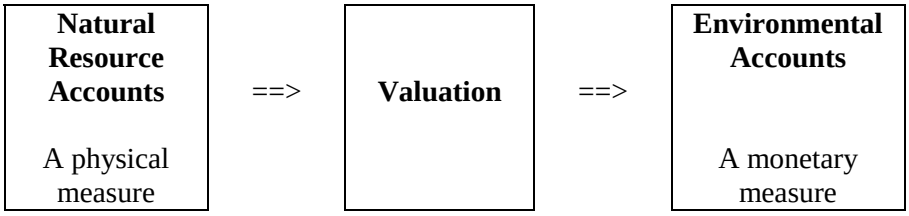
After the natural resource accounts have been valued and monetary accounts compiled, the combination of the two are referred to as environmental accounts. The environmental accounts can then be integrated directly into the SNA or linked to the SNA as a satellite account. Using a satellite account is the most popular option, as it provides room to experiment with methodology, without impacting the GDP series.

2. Natural resource accounting

2.1 The difference between natural resource and environmental accounting

2.1.1 Use of physical versus monetary accounts

The physical accounts are also referred to as natural resource accounts. They measure the physical stocks and flows in units such as tonnes and cubic metres. These quantities are then valued (using a variety of methods and assumptions), resulting in monetary figures which form the environmental accounts.



The physical and monetary accounts complement each other. It is preferable to value natural resources using market values, but where these are not available, other techniques may be used. There are also a number of assets that may only be measured in physical terms including soil resources, part of the water resources, agricultural land and associated surface water and ecosystems. Often the *changes*, for example degradation and depletion of soil resources, can be measured, but the opening and closing stock cannot. This may be due to the sheer vastness of the natural resource.

The physical accounts are a good way of viewing what is actually happening in the environment. For example, the accounts can show exactly how expansive the forests of New Zealand are, or exactly how much coal is left in our mines.

Monetary/environmental accounts have the advantage that they have a common denominator (dollars). This allows different resources to be compared using the same units. Valuation is calculated in a way that is consistent with the System of National Accounts (SNA). The monetary estimates can be linked to the current national accounts.

As mentioned previously, the coverage of the monetary accounts is limited. Not all natural resources are able to have monetary values applied, and for those that can be valued, there may be issues regarding the appropriate valuation method. Monetary accounts should generally be used in conjunction with the physical accounts.

2.2 System of Environmental and Economic Accounts (SEEA)

2.2.1 Function of SEEA

SEEA was developed by the United Nations Statistical Division (UNSTAT). It was designed as a satellite system to use in conjunction with conventional national accounts, and aims to "*reflect the use that is made of natural resources and the damage that is caused to the environment*"[5] by economic and social development**.**

[5] Netherlands Court of Audit (1997),"*Natural Resource Accounting*", 8,

The SEEA is intended to be suitable for all countries and all aspects of environmental accounting. Which aspects of the SEEA a country chooses to implement depends on their respective needs and priorities.

2.2.2 International developments and ratification

The SEEA manual has been in existence since 1993. At the time the revised SNA was approved by the Statistical Commission in 1993, there was no clear consensus on the way to approach environmental accounting in the SNA. The SNA 1993 was published with a clear message that environmental accounting remained on the research agenda for urgent work in the near future. The changes in the SNA 1993, however, do go some way to assessing the relationship between the economy and the environment (see also 2.3.1).

Soon after the publication of the revised SNA manual, the United Nations Statistical Division (UNSTAT) published an interim handbook on Integrated Environmental and Economic Accounting (the SEEA). The intent is to update the handbook from 2002 onwards,[6] after it is exposed to wider comment and subject to experimentation in practice.

2.3 SEEA and the System of National Accounts (SNA)

2.3.1 Function of the System of National Accounts

The System of National Accounts (SNA) is an internationally agreed set of guidelines, which give a comprehensive and consistent description of economic activity in each country. This helps monitor the behaviour of the economy, and assists with macroeconomic analysis, economic policy and decision making. Because the standards are internationally accepted and implemented, comparisons of economic performance can be made between countries. The SNA consists of a variety of accounts including; current accounts, capital accounts, production accounts, accumulation accounts, balance sheets, and satellite accounts.

Generally the national accounts are intended to record economic transactions that have been observed and can be expressed in monetary terms. This approach has the disadvantage of failing to identify either the scale of environmental damage or the extent of the resource depletion caused by these transactions.

Satellite accounts were introduced to address these perceived limitations within the SNA.[7] In the satellite accounts, the national accounts aggregates are amended to treat natural resources as capital in the production of goods and services. They also record the cost of use (depletion or degradation). Many of the cost and capital items needed to account for natural resources are already identified separately. Others will need to be disaggregated further and reclassified, while others will need to be added. In the SNA only produced assets are included explicitly within net value added.

2.3.2 Principle differences

There are two principle differences between the SEEA and the SNA. The first difference involves the coverage of assets, and the second involves the treatment of assets.

Available: http://www.rekenkamer.nl/ea/docs/activities/natural.htm

[6] Some quotes used in this report are from older versions of the SEEA and are still valid, but are not found in more recent versions of the SEEA. All footnote references to SEEA indicate which version of SEEA was used.

[7] For more information on satellite accounts, see the SNA 1993 manual, 21.122 - 21.186.

The coverage of the assets under the two systems differs significantly. Under the SNA, the asset boundary is used to define the types of goods that can be classified as 'economic assets'. To be defined as an economic asset, it must be of *"economic value and be under the ownership or control of an economic agent"*.[8] As such, natural assets are only included if they provide economic benefits to the owner and have effective ownership or property rights associated with them. This is usually as a result of being controlled by an institutional unit, often via explicit ownership, and having a market price available.

Included within the SNA boundary are environmental assets such as proven subsoil assets, land and water over which ownership rights are enforced, farmed fish stocks and managed forests. Natural fish stocks over which ownership rights are enforced are also included. Most of New Zealand's natural fish stocks will be included in the SNA as ownership rights can be enforced via the quota system.

Outside the SNA asset boundary are assets such as probable or possible subsoil assets, and land, water, naturally occurring forests, and natural fish stocks over which ownership rights are not enforced. Probable and possible subsoil assets are excluded as they are not of 'definite' economic value. There is no guarantee that they will provide economic benefit to the owner. As with natural fish stocks, naturally occurring forests are excluded only if ownership rights are not enforced. Examples of natural fish stocks that will be excluded from SNA are those in protected areas such as marine parks, and proven subsoil reserves in national parks.

Environmental assets such as air are also excluded from SNA, despite the fact that economic activities could not exist without them. They are excluded because no ownership rights are associated with them, and they do not produce economic benefits 'directly'. Similarly, the SNA excludes environmental assets that produce non-economic benefits. Services provided by ecosystems such as the cleansing of fouled air and water are excluded from the SNA for this reason (but are included in the scope of the SEEA).

Not only does the SNA exclude assets that are not producing direct economic benefit, or non-economic benefits, the SNA also excludes items that are not of economic benefit to current individuals, such as unproven sub-soil assets.

The SEEA therefore has a wider coverage than SNA and in principle includes all natural assets. It also allows for the measurement of non-use benefits of assets – those that may eventually be of benefit to those currently living, or currently not born. *"The inclusion of option, bequest and existence benefits effectively broadens the scope of the SEEA asset boundary to include all land and natural resources. In addition, ecosystems are included in the SEEA asset boundary on the grounds that they provide a variety of services that bring indirect use benefits to humans."*[9]

The SEEA includes those assets that contribute to production activities directly, and those that are simply affected by the environmental impacts of economic activities. The SEEA includes economic assets and non-economic assets (also referred to as environmental assets) as the focus is on environmental impacts. The details of ownership and control are irrelevant. See 3.1 for a more detailed discussion of economic and environmental assets.

[8] SEEA (2000). Draft as at July, 1, 11. See also SEEA (2002). Draft as at January, 7, 6.
[9] SEEA (2002). Draft as at January, 7, 8.49.

Below is a table setting out the SEEA asset classifications. For practical purposes it may often be difficult to separate out components into the suggested groupings.

Table 3. SEEA Asset Classification[10]

EA.1 Natural Resources
- EA.11 Mineral and energy resources
- EA.12 Soil resources (cubic metres, tonnes)
- EA.13 Water resources (cubic metres)
- EA.14 Biological resources
  - *EA.141 Timber resources*
  - *EA.142 Crop and plant resources, other than timber*
  - *EA.143 Aquatic resources*
  - *EA.144 Animal resources, other than aquatic*

EA.2 Land and surface water (hectares)
- EA.21 Land underlying buildings and structures
- EA.22 Agricultural land and associated surface water
- EA.23 Wooded land and associated surface water
- EA.24 Major water bodies
- EA.25 Other land

EA.3 Ecosytems
- EA.31 Terrestrial ecosystems
- EA.32 Aquatic ecosystems
- EA.33 Atmospheric systems

EA.M Memorandum item – Intangible environmental assets
- AN.1121 Mineral exploration
- AN.2221 Transferable licenses and concessions for the exploitation of natural resources
- AN.2222 Tradable permits allowing the emission of residuals
- AN.2223 Other intangible non-produced environmental assets

[10] SEEA (2002). Draft as at January, table 7.2, 7, 10.

The table below describes the difference in the classifications of assets, between the SEEA and the SNA.

Table 4. Classification of Natural Assets in the SNA and the SEEA[11]

SNA		SEEA
AN.1	**Produced Assets**	
AN.11	*Fixed assets*	
AN.1114	Cultivated assets	
AN.12	*Inventories*	
AN.1221	Work-in-progress on cultivated assets	
AN.2	**Non-Produced Assets**	
AN.21	*Tangible non-produced assets*	*Tangible non-produced assets*
AN.211	Land, including associated water surfaces	Land, including ecosystems
AN.212	Subsoil assets	Subsoil assets
AN.213	Non-cultivated biological resources	Wild biota
AN.214	Water resources	Water
		Air

The classification of produced assets is the same in both SEEA and the SNA. Subsoil assets appear in both the SNA and SEEA, although it should be noted that, as discussed in section 2.3.2, the scope of subsoil assets is much broader in SEEA than the SNA.

Air is excluded from the SNA because it does not satisfy the SNA criteria of economic assets, that is, being of economic value and being under the ownership or control of an economic agent.

Land in the SNA includes associated water surfaces, such as lakes and rivers, which are generally associated with recreational land. The SEEA categorises these surfaces as water. The water category in the SEEA is, therefore, much broader than 'water resources' in the SNA. The SEEA category includes sub-categories for groundwater, lakes, rivers, coastal and ocean water. Land in the SEEA includes ecosystems, which are not explicitly included as economic assets in SNA analysis, but are important as they deal with effects such as soil erosion and the effects of acid rain on the quality of forests and land in general.

Non-cultivated biological resources in the SNA are only included where ownership rights are enforced and the assets are under human control. Generally, this will only include uncultivated forests and wild herds that are constrained to a specific area and/or are managed by one economic unit. Wild biota is the nearest asset category in the SEEA, and in principle includes all forests (including virgin forests), all fish stocks and all animals that are not classified as 'cultivated assets' in the SNA. For example, commercial forests in the SEEA will be categorised as cultivated assets, the same as in the SNA, and the remaining forests will be categorised as non-produced wild biota.

While there are many more examples of differences between SNA and SEEA, the essential point of difference is that the SEEA is broader than the SNA and includes all natural assets that are included in the SNA.

[11] SNA (1993), table 21.7, 514.

Table 5. Environmental Assets within the SNA 1993[12]

AN.1 Produced assets

- AN.11 Fixed assets
  - AN.111 Tangible fixed assets
    - AN.1114 Cultivated assets
      - AN.11141 Livestock for breeding, dairy, draught, etc
      - AN.11142 Vineyards, orchards and other plantations
  - AN.112 Intangible fixed assets
    - AN.1121 Mineral exploration
- AN.12 Inventories
  - AN.122 Work in progress
    - AN.1221 Work in progress on cultivated assets

AN.2 Non-produced assets

- AN.21 Tangible non-produced assets
  - AN.211 Land
    - AN.2111 Land underlying buildings and structures
    - AN.2112 Land under cultivation
    - AN.2113 Recreational land and associated surface water
    - AN.2119 Other land and associated surface water
  - AN.212 Subsoil assets
    - AN.2121 Coal, oil and natural gas reserves
    - AN.2122 Metallic mineral reserves
    - AN.2123 Non-metallic mineral reserves
  - AN.213 Non-cultivated biological resources
  - AN.214 Water resources
- AN.22 Intangible non-produced assets
  - AN.222 Leases and other transferable contracts.

Environmental assets that do not fit into the definition of natural assets under the SNA 1993 fall outside the asset boundary. As such, assets over which ownership rights cannot be established, for example air, major water bodies, and ecosystems that are so vast or uncontrollable that effective ownership rights cannot be enforced, have been excluded.

[12] SEEA (2002). Draft as at January, 7, 8, table 7.1.

3. Asset or stock accounts

3.1 An introduction to stock accounts

Integrated economic and environmental accounting requires the measurement of stocks of assets, which are presented in a stock account. The two main objectives of a stock account are: to measure the absolute level of natural resources at a point in time as an indication of New Zealand's wealth, and to show any change in stock levels of the asset over a certain period of time.[13] The change in stock level is determined by calculating an opening and a closing balance. The harvesting/extraction component of stock change is further examined in the flow (or supply and use) accounts, which are discussed in chapter 4 of this document.

A stock account can be compiled for any quantifiable asset. Initially, a physical stock account is produced as per the SEEA natural resource account framework. Once the physical stock account is compiled, the individual components can be valued in monetary terms.

The SEEA methodology distinguishes between two types of assets included in stock accounts: economic assets and environmental assets.

Economic assets:
For a natural resource to be considered an 'economic asset', and therefore included in the SNA, ownership rights must exist over the natural resource and it must bring economic benefit to the owners.

Under the SNA, natural assets can either be fixed assets or work-in-progress. They are classified as a fixed asset if the same asset repeatedly or continually produces products, such as apple trees, or are classified as work-in-progress if they produce only once, such as forests for wood harvesting. Fisheries can be an example of both a fixed asset and work-in-progress. Fish used for breeding are considered a fixed asset, while fish cultivated for sale are considered work-in-progress.

Environmental assets:
In the SEEA environmental assets are *"natural assets that function as a source of materials and energy as well as of environmental services of waste absorption, ecological functions, such as habitat or flood and climate control and other non-economic amenities such as health or aesthetic values. Therefore, uncultivated forests, wild animals, fish within the exclusive economic zone (EEZ), and all ecosystems are included in the SEEA asset boundary".*[14]

Under the SEEA not all elements are considered to be environmental assets. There are some elements which in themselves do not directly provide benefits, but the larger element within which they belong, such as an ecosystem, does provide direct benefit. It is the ecosystem that is considered an environmental asset. The parts that make this up are not considered environmental assets in their own right. For example,
"the countless species involved in decomposing organic matter in forests do not themselves provide either use or non-use environmental benefits to humans [with the exception of those used for medicinal purposes or as a food source] and are not, therefore, considered environmental assets in the SEEA. The forest ecosystems of which they are an element clearly do benefit humans…and therefore, qualify as environmental assets in the SEEA".[15]

Some environmental assets appear more than once within the classification, once in their own right and again as an integral part of another asset. Timber, for example, is an asset in its own right, but it also plays an important

[13] The initial resource account estimates will be produced as a time series and backdated as far as possible, depending on data availability.
[14] SEEA (2000). Draft as at 31 July, 2A.22, 8.
[15] SEEA (2000). Draft as at 31 July, 2A, 14, 5.

role as part of an ecosystem. This highlights the fact that some natural resources provide multiple benefits. It does not normally cause problems in double-counting, in monetary terms, because usually it is only the 'integrated' asset for which a monetary value can be established.

3.1.1 Structure of the stock account

For each asset, the structure of the account works like a balance sheet (see below). Changes between the opening and closing stock levels are a result of both economic activity and environmental processes.

The basic accounting form of a stock account is seen in the table below.

Table 6. Generic accounting entries for physical stock accounts [16]

Opening stock levels	Type of change
Increases in stocks	
Due to economic activity	Economic
Due to regular natural processes	Natural
Decreases in stocks	
Due to economic activity	Economic
Due to regular natural processes	Natural
Due to natural disasters (net decrease)	Natural
Changes due to economic reclassification[17]	Economic
Change in environmental quality	Natural/Economic
Closing stock levels	

[16] SEEA, (2002). Draft as at January, 7, 16, table 7.3.

[17] Economic reclassification refers to changes in classification due to economic or political decisions. An example of this is a mineral deposit which becomes exploitable due to new technology. See SEEA (2002), 7, 8.95, 18 for further discussion and examples.

The table[18] below shows the accounting entries for different types of environmental assets.

Table 7: Accounting Entries for Different Types of Environmental Assets

	Mineral and Energy Resources	Soil Resources	Water Resources	Biological Resources		Land and Surface Water	Ecosystems
				Cultivated	Non-Cultivated		
END OF YEAR STOCKS	Yes			Yes	Yes	Yes	
Increases							
Economic causes	Discoveries		Discovery of aquifers	New plantings, breeding programs		Land improvement	
Natural causes			Additions	Growth	Growth, natural extension		Yes
Decreases							
Economic causes	Extractions		Abstractions	Harvesting, thinning	Harvesting		Yes
Natural causes			Deductions	Natural death	Natural death		Yes
Catastrophic losses		Yes	Yes	Yes	Yes		Yes
Reclass-ifications	Possible reserves to proven		Non-economic to economic	To/from non-cultivated	To/from cultivated	From one land category to another	
Quality change		Yes	Yes	Yes	Yes	Yes	

3.1.2 Units of measurement

Stock accounts describe the state of assets at a given point in time. In the SEEA, the accounts are compiled both in physical, and whenever possible, in monetary terms. According to the nature of the assets, and the purpose of the accounts, the unit of measurement may simply be a count of individual items, or an additive measure that allows for additions and subtractions from the stocks, such as area, volume or mass.

Another way of measuring natural assets in physical terms is through the aggregation of different assets. By using conversion factors, different physical units of measurements are expressed as 'equivalents'. Expressing tables in equivalents will usually make the tables more useful analytically.

Measuring quality changes in an asset could be utilised in a stock account for those resources where the total stock is too vast to measure, or measurement is otherwise impractical or of no real benefit. Assets can be classified according to their inclusion in a given quality class. Stock accounts describe not only changes in quantity but also changes in quality that can be measured by changes in classification. An asset in a given quality class may change to another class, for example, land may change from 'agricultural land' to 'land underlying buildings'. In general, complex environmental assets, such as ecosystems and air, cannot be fully described by their monetary value or by any other additive measure. The quality of the asset may be used as an alternative description, an example being, how the quality of the air changes over time.

[18] SEEA, (2000). Draft as at 31 July, 2A, 19, table 2A.5. The SEEA (2002), draft as at January, 7, has a larger and more detailed version of this table (24-25, table 7.6).

Whatever the physical measurement unit used for a particular asset there are several important points that should be noted:

- The units should be consistent and comparable over time.
- Different assets can have different physical units of measurement.
- A stock account can be compiled by quality classes, species, or ownership etc.
- Not all assets can have total stock volumes because they are not available or particularly useful, for example, soil and water (refer to Table 7).

Because of consistency and comparability in the units of measurement, changes between the opening and closing levels of stock can be accurately measured.

3.2 Use of stock accounts

3.2.1 Internationally

Stock accounts provide information about natural assets. There is a wide range of potential uses of environmental accounts, from measuring physical scarcity of natural resources, to tracing the dispersion and impact of pollution.

For example, the construction of a fish account for Namibia revealed the extent of the depletion of that resource. Since the 1960s Namibia's fish stocks have become so depleted that Horse Mackerel is less than 20 percent of the original stock size[19]. This example shows the depletion that can result from uncontrolled open access fishing.

Accounts for forestry have been constructed for Brazil, Malaysia and Indonesia among others. Many of these accounts have also revealed depletion in national resources. Physical accounts for water, concerning depletion and availability, have provided important information for the management of water resources in France, Spain, Moldova, Chile[20] and South Africa.[21] Natural resource accounts are still at an early stage of development internationally and more such examples should occur over time.

The potential uses of natural resource accounts are enhanced once a consistent and coherent time series has been established. To maximise their use, the accounts would ideally be part of the national accounts and be produced on a routine basis.

Natural resource accounts perform two major functions: measuring natural wealth, and assisting with decision making for resource management. These uses are explored more fully in sections 3.2.1 and 3.2.2. Other applications include the development of indicators and the assessment of the performance and effectiveness of government policies.

3.2.2 Assessment of natural wealth

Natural resource accounts were developed as a response to the lack of environmental information in the economic accounts. Economic accounts focus on national wealth, without taking environmental assets into account, and are, therefore, a weak measure of economic sustainability.

[19] SEEA (2001). Draft as at May, 9, 24. See also SEEA (2002), draft as at January, 11, 11.79.
[20] SEEA (2001). Draft as at May, 9.
[21] SEEA, (2002). Draft as at January, 11, 6.

Asset accounts provide the basis for the assessment of natural wealth. In the SEEA, asset accounts include produced capital as well as natural capital. The accounts can be used to estimate the extent to which New Zealand is maintaining the value of its natural wealth, thereby helping to ensure a steady flow of future income from the sustainable use of environmental resources.

Accounting for natural wealth and its distribution provides measures of the availability of natural resources for productive and financial activities, and of the concentration of economic power within and among nations. The composition of a country's natural wealth is important. A developing nation's economy may show large increases in the share of cultivated assets to total assets, while for developed nations this ratio generally changes little over time.

3.2.3 Information for resource management decisions

Natural resource accounts provide information that is useful for the formulation and measurement of sustainable development policies. By examining the degree and manner in which natural resources are used, judgements can be made about the prospects for sustainable growth.

Resource rich countries like New Zealand consume natural resources over time. Many of these regenerate very slowly, or the resource regenerates, but may be harvested unsustainably. For many resources, management systems have been set up to address the issue of sustainable management. Two examples are the fishing quota system that helps to maintain the fisheries resource, and forestry where a legislative regime supports sustainable management of the resource. Natural resource accounts can assist with this management and monitoring process. Eventually they can provide estimates of depletion of natural assets that can be absorbed into the System of National Accounts (SNA). Linking environmental and economic information enables the analysis of economic performance by sector and the utilisation of natural resources by those sectors.

Physical stock accounts, a component of the natural resource accounts, also provide useful information for resource management decisions. They are used to estimate the sustainable yields for forests, fish and water. A major limitation of physical data is that resources are measured in a variety of units. For example, a forestry account may be expressed in hectares and cubic metres, but a fish account cannot use these measures, and is more likely to be expressed in tonnes. This means that different resources cannot be aggregated, and meaningful comparisons between resources may be difficult. Monetary accounts provide a single common measure, and can be incorporated into the current System of National Accounts (SNA). Monetary and physical accounts thus provide complementary information for policy making.

It should be noted that physical stock accounts are often the basis for the calculation of monetary accounts. Monetary figures for depletion, for example, depend on the physical quantity of resource use, and the resource's market price. Market prices for resources can change significantly from year to year for reasons unrelated to their physical quantity. Therefore, it is possible, depending on the valuation method used, that when the physical use of a resource has gone up but its price has gone down, the costs of depletion is shown as decreasing, despite the fact that more of the resource has been extracted. In order to ensure that perceptions of depletion are not misled by such results, physical depletion figures can be used to present 'volume' rather than value changes.

Therefore, both monetary and physical accounts are necessary to provide a complete picture of natural asset use by the economy.

3.4 Linkage with flow accounts

Natural resource accounts consist of stock accounts and flow accounts. Stock accounts show the opening and closing stock level of the specific asset, and the changes that have occurred during the time period. The flow

accounts are linked to the stock accounts. Given the stock changes specified in the stock account, the flow accounts describe these changes further, particularly the economic harvesting or extraction of the resource. They will show how the natural resource has been supplied and used within the economy, and by whom.

4. Flow or supply and use accounts

4.1 An introduction to flow accounts

Understanding the physical flows between the environment and the economy helps to identify the consequences of economic activities on national or global natural resources and ecological systems. Similar information could be produced on a regional level if desired. It is the purpose of flow (or supply and use) accounts to record these flows. Flow accounts show the supply and use of resources, and the flow of resulting products and residuals. Natural resources are used as inputs to the production and consumption processes, while the outputs include disposal of solid waste and other residuals from the economy back into the environment.

The purpose of flow accounts includes:

- revealing the economic flows generated by harvesting from the stock account
- identifying potential threats to the environment as a result of residual flows (or waste)
- providing information needed to construct environmental performance indicators that help analyse further the environmental impacts of particular economic and social activities.

Flows can occur domestically or internationally. The economic activities of one country can affect its own environment, but they can also affect the environment of another country. This is not as important for New Zealand, due to its distance from other countries. However, it can be a major issue for countries that are in close proximity to each other, as in Europe. International flows can include: emissions of global contaminants, for example greenhouse gases; trans-boundary flows of emissions, such as acid rain gases or river-borne pollutants; or resource use and emissions arising from the production of traded goods.

A distinction can also be made between flows that have an immediate and lagged impact. The impact of many economic activities is often felt immediately. However, there can sometimes be a long time lag between the economic activity and its impact. Metal mines, for example, can cause contamination of fresh water long after the mine is closed. This is also true for landfill sites and nuclear waste.

As with assets in the stock accounts, assets in the flow accounts can be separated into both economic assets and environmental assets. Changes in economic assets can be easily measured in monetary terms. Changes in environmental assets refer to changes in their capacity to provide services, which are not easily measured in monetary terms. The changes in both of these assets are the result of different transactions (see the diagram below for a summary of the process).

Table 8. Stocks and Flows of Assets

	Economic Assets	**Environmental Assets**
Opening balances	Opening balance sheets	Opening stocks
Are altered by	Transactions and other flows	Economic activities, natural processes
Resulting in	Changes in balance sheets	Changes in state
Leading to new closing balances	Closing balance sheets	Closing stocks

Changes in economic assets are the result of transactions and other flows. The transactions are gross fixed capital formation and consumption of fixed capital. The ‘other flows’ are accounted for in the asset accounts

outside the production boundary. They include natural growth and withdrawals from stocks for non-produced assets (such as the now illegal native timber logging on the West Coast), changes in quality (degradation), as well as changes due to natural disasters, and changes in prices.

Changes in environmental assets are more difficult to measure, as they refer to changes in the capacity of environmental assets to provide services to production and welfare. For example, it is very difficult to measure the change in the quality and size of wetlands. The causes of these changes need to be identified. These may be direct or indirect impacts of economic activities, or 'pure' natural processes. In general, it will be very difficult to identify all the processes, economic or natural, which influence the state of assets, and to fully explain the changes that occur.

Physical flows are characterised according to the type of material and energy and according to their nature with respect to origin and destination. Three types of physical flows can be distinguished. They are:

- natural resources, which are the physical flows from the environment to the economy (eg timber from forests to sawmills)
- products, the physical flows within the economy (eg wood products from sawmills to furniture manufacturers, and furniture to consumers)
- residuals, which are flows from the economy back to the environment (eg timber treatment chemicals).

Natural Resources

These can be renewable or non-renewable physical inputs that can be withdrawn from the natural environment. The moment natural resources are harvested or extracted for sale or economic use, they have entered the economic sphere, and the resources will be classified further as products. The economic sphere will be discussed later in this section, but briefly, it consists of all the physical flows and stocks that involve economic transactions and ownership as defined in the SNA. The alternative is the environmental sphere, which covers all other physical items not included in the economic sphere.

Products

These consist of material flows within the economic sphere. They are products resulting from production, and include both goods and services. Physical flows of goods are the most important, but there may also be services related to the delivery of goods.

Residuals

This includes all physical outputs discharged from the economic sphere back into the natural environment. Residuals can be reabsorbed into the economic sphere by recycling or waste (water) collection and incineration activities. As a result, these residual inputs are converted into products, or outputted as less harmful residual flows. Pesticides, fertiliser, and compost are examples of products whose use and function is brought into the environment on purpose, and so are related to flows from the economy into the environment.

Further distinctions about flows can be made, including: flows between the economic and environmental spheres, flows of products within the economy, and the flows between the national economy and rest of the world.

Flows between the economic and environmental spheres

The economic sphere consists of all the physical flows and stocks that involve economic transactions and ownership as defined in the SNA. The environmental sphere consists of all the other items that do not belong to the economic sphere. For example, produced assets such as cultivated fish stocks are part of the economic sphere, while tangible non-produced assets such as fossil fuels are considered outside the economic sphere. Examples of flows between the economic and environmental sphere include fossil fuels, that are extracted and used in economic production and pollution or waste resulting from economic activity.

Flows of products within the New Zealand economy
Included here are flows between different industries, and between industries and final demand. Production and consumption are the only processes that belong to the economic sphere. All other processes, not regarded either as consumption or production, are assumed to take place entirely in the environmental sphere.

Flows between New Zealand and the rest of the world
These occur via imports and exports, and cross-border pollution. The New Zealand economy is defined in terms of the activities of New Zealand residents. A person is a New Zealand resident if their centre of economic interest is within the New Zealand economy. The rest of the world consists of all the non-resident institutional units that enter into transactions, or have other economic links with New Zealand residents.

There are two types of cross border flows: international trade, which is fully within the economic sphere, and cross border transfers of residuals, also referred to as cross border pollution. Cross border pollution may include:

- flows from foreign economies to the New Zealand economy such as the transport of waste
- flows transferred from the foreign economic sphere to the New Zealand environment, for example, pollution from international transport as a result of oil spills
- flows appearing entirely within the environmental sphere, such as cross border residual flows resulting from global greenhouse gases.

Cross border pollution transfers are important for determining the total net accumulation of residuals in New Zealand's environment. Due to New Zealand's relative isolation from the rest of the world, we are affected primarily by global issues such as climate change and ozone depletion, as opposed to more localised problems such as acid rain and air pollution faced by many European countries.

While most flows are easily identifiable, hidden flows and indirect flows are not so easily recognised. Hidden flows are part of the material requirements of production that will never enter the economic system, such as ancillary flows. This refers to the material that is removed from the natural environment, along with the desired resource, in the process of obtaining the natural resource. Examples of hidden flows include, the by-catch gathered when fishing, or soil removed when coal mining. Indirect flows are input requirements of the production process that are not embodied in the output of products, for example, energy inputs and capital.

Knowledge of the boundaries of physical flow accounts is required to establish which supplementary estimates are required for the coverage of hidden flows. Hidden flows connected to imported products, such as energy inputs and capital that will never be physically included in the final imported product, also need to be considered.

4.2 Function of flow accounts

4.2.1 Measurement of physical flows to and from the economy

In their most complete form, the physical flow accounts give a description of how material and energy are used as inputs in the economy, how commodities are produced and used, and how residuals and wastes are the result of economic activities by industries and households. Individual flow accounts can help highlight the origin or destination of some specific natural resources, materials or residual flows within the economy, or between the economy and the environment.

For any particular production or consumption process and for a regional or national economy, there should be a balance between all inputs (ie national resources, products, and imports) and all outputs (exports and residuals), plus total material accumulation.

Flow accounts are measured in physical and monetary terms. A detailed physical flow analysis may lead to hundreds of different products or substances being created. To communicate the results more effectively, the flow accounts require aggregation. It is possible to present physical flow accounts at different levels of aggregation. The most condensed form is called 'economy-wide material flow accounts' (see the table below). The major aim of economy-wide material flow accounts is to estimate the total material requirement of the New Zealand economy.

Table 9. Economy Wide Material Flow Account[22]

	INPUT		**OUTPUT**	
	1000 tonnes		*1000 tonnes*	
1. Economic sphere				
Products	149,530	*import*	102,060	*export*
2. Environmental sphere				
2.1 Natural resources				
Subsoil assets	237,893	*resource input*		
Non cultivated biotic assets	9,530			
Water	7,470			
Air (O2, N2)	148,800			
2.2 Residuals				
To air	-	*recycling, waste*	206,932	*gross residual*
To water	147	*treatment and*	1,226	*output*
Solid waste	32,510	*storage*	179,863	
Total material accumulation in the economic sphere			95,799	
Total	**585,880**	**Input**	**585,880**	**output**

(This table is an illustrative example only)

The World Resources Institute (WRI) used this model of material flow analysis. They compared material flows across five industrialised countries (Austria, Germany, Japan, the Netherlands and the United States of America) and even though these economies are shifting away from heavy industry towards knowledge-based and service industries, the use of materials and generation of waste continues to increase. The increase is attributed to *"economic growth and consumer choices that favour energy and material intensive lifestyles"*. [23]

Physical flows can be calculated using any relevant unit of physical quantity. Usually weight (tonnes), volume (m^3), or area (m^2) are the most useful. These measures can include or exclude packaging. Packaging is usually included to ensure its impact is taken into account.

Data sources need to be compatible or in a common unit, although it is possible to use alternative units or classifications to represent some of the quality aspects of certain flows. This may require the conversion of some data into other units. Individual pollutants can be weighted and aggregated in order to convert data sources

[22] SEEA (1999). Draft as at November, 3, 25, table 3. The data in this table is illustrative only.
[23] SEEA, (2001). Draft as at May, 9, 10.

into compatible units or equivalents. Examples of physical weighting procedures, that are used internationally, include the conversion of greenhouse gas pollutants into CO_2 equivalents, and the conversion of sulphur and nitrogen oxides and ammonia into acidification equivalents.

When calculating the flow accounts, the supply side must equal the use side, and inputs must equal outputs. So, for any commodity, total supply must equal total use, and for any industry, the sum of its uses of each of the energy commodities must equal some level, which might be given as a predetermined target total. Both dimensions must balance in physical and monetary terms before they become internally consistent**.**

4.2.2 A basis for constructing performance indicators

One of the purposes of flow accounts is to provide information to enable the construction of environmental performance indicators. These help assist the analysis of the environmental impacts resulting from certain economic activities, such as domestic consumption and production, and international trade. Flow accounts are often used to show how 'resource efficient' the economy is, and how efficiency has changed for particular material and industrial sectors.

4.3 Coverage of flow accounts

4.3.1 Supply tables

A physical supply table, also referred to as a 'table of origin', focuses on the detailed description of the origin of physical flows. For products, it gives an overview of the domestic production by industry and imports from the rest of the world. For residuals, it shows how much residual has been emitted by different industries and households within New Zealand, as well as pollution that is received from the rest of the world. There is actually no supply table for natural resources, as the environment itself is regarded as the origin of natural resources, and no further analysis is given. Statistics New Zealand will be compiling a supply table for products only.

The information on the supply of residuals allows a basis on which to calculate appropriate taxes for emissions within New Zealand. For example, the government may decide that industries that have high emission levels should pay a higher tax, as an incentive for them to lower their emissions.

Table 10. Simplified Version of a Physical Supply Table for Forestry Products

	Industries (ANZSIC)			**Sub-total**	**Imports**	**Total**
Products Examples include:	Examples include: Forestry	Logging	Recycling			
Standing timber (m^3)						
Sawn logs (m^3)						
Fuel wood (m^3)						
Paper pulp (tonnes)						
Etc…						

Once figures are included in the supply table above, it would be possible to see how many cubic metres of standing timber, sawn logs, fuel wood etc the respective industries supplied. The supply table above is a very simplified version, and only covers products. Supply tables for natural resources would normally include residuals, showing respective residuals emitted by different industries and households.

4.3.2 Use tables

A physical use table, also referred to as a 'table of destination', focuses on a detailed description of the destination of physical flows. For products, it shows how many of the various products are used by industries and households as inputs into production or as final consumption, how much is used as capital formation, and how much is exported to the rest of the world. For residuals, it shows the amount of residuals that are re-absorbed (ie recycled or treated by industries, or accumulated in the New Zealand economy). For natural resources, it shows the extraction of natural resources from the environment by industries and households.

Table 11. Simplified Version of a Physical Use Table for Forestry Products

	Intermediate consumption of Industries (ANZSIC)		**Sub-Total**	**Final consumption**	**Capital formation**	**Exports**	**Total**
Products Examples include:	Examples include: Forestry	Logging					
Standing timber (m^3)							
Sawn logs (m^3)							
Fuel wood (m^3)							
Paper pulp (t)							
Etc…							

As with the supply table, the use table above is a very simplified version, and only covers products. A use table for natural assets would also normally include residuals and natural resources. Statistics New Zealand will initially be compiling a use table for products only.

5. The development path

Statistics New Zealand is compiling a set of natural resource accounts, using the methodology set out in the System of Environmental and Economic Accounts (SEEA). There are three reasons for this initiative. Firstly, there is a direct link between the SEEA and the System of National Accounts (SNA) that Statistics New Zealand currently uses to produce the national accounts. Secondly, the SEEA is an established methodology used internationally by the majority of countries engaged in environmental accounting. Finally, producing a set of natural resource accounts, as proposed, is a step towards being able to produce a full set of environmental accounts.

5.1 Development strategy

The approximate order for compiling the natural resource accounts and environmental accounts is as follows:

1. **Forestry** is very important to New Zealand, economically, environmentally and socially. There are significant levels of both economic and non-economic benefit gained from forests. There is also a considerable amount of good quality data available.

2. **Energy (and minerals)** assets, including gas, coal, iron sand, gold, and geothermal energy, are economically important to New Zealand. There is a significant level of good quality data available in both physical and monetary units.

3. **Fish** provide considerable economic benefits to New Zealand. There is a significant level of good quality data available in both physical and monetary units.

4. **Water** is a basic necessity of life and also provides direct and indirect benefits to the economy. While a water account is not so important in national accounting terms, it is very important to the Ministry for the Environment. Obtaining data may be difficult for aspects of the water account.

5. **Land** accounts will include land cover and land use. The Ministry for the Environment regards a land account as important, as it will provide planning and policy information about the changing use of land in New Zealand.

6. **Ecosystems** accounts are not in the current work programme. While ecosystems are very important to New Zealand, there are several practical reasons why these accounts have been given a lower priority. Firstly, an ecosystems account is likely to be very complex. Therefore, this account should only be attempted after Statistics New Zealand has accumulated knowledge and experience from producing the other resource accounts. Secondly, no other country has produced an ecosystems account, and SEEA guidelines for ecosystems accounts are rather general at this stage. Finally, the resource accounts with the highest priority (forestry, fish and subsoil assets) are those that are most likely to be used for an estimate of environmentally adjusted GDP.

Statistics New Zealand will estimate natural resource accounts for the first five resources listed above. For each of these resources, an attempt will be made to produce stock and flow accounts, in physical and monetary units. The flow tables will be estimated as Supply and Use tables. Tables and reports will be produced progressively for the five resources, from late 2001 to mid-2004. It is expected that the reports and tables will be released in some form, although how this will be done is still to be finalised. These initial tables will be based on existing data and there may be gaps in the tables, which may highlight areas for future development, if the accounts are produced on an ongoing basis.

Glossary

Terms defined below are not necessarily used in this report.

Accumulation accounts in the SNA: One of the economic accounts compiled under the SNA. Accumulation accounts are flow accounts that record the acquisition and disposal of financial and non-financial assets and liabilities, by institutional units, through transactions or as a result of other events.

Acidification: An increase in acidity.

Agenda 21: The term 'Agenda 21' refers to a framework that shows how to implement sustainable development methodologies and theories. World leaders adopted the plan of action to achieve sustainable development at the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, in June 1992 (United Nations, 1993b).

Ancillary flows: Material that is removed from the natural environment, along with the desired natural resource extracted. Also see hidden flows.

Aquifers: Underground geological formation, or group of formations, containing groundwater that can supply wells and springs.

Asset boundary: Defines the type of goods that can be classified as assets. Under the SNA, only economic assets are included in the asset boundary. As a result, some natural assets are currently not included (also see economic assets and environmental assets).

Balance sheets in the SNA: A statement drawn up, at a particular point in time, showing the value of assets owned, and of the financial claims (ie liabilities) for the economy. The balance sheet shows 'national wealth'.

Bequest benefit: This is derived from the continued existence of elements of the environment that are not currently in use, but one day may provide use benefits to those not yet born. One example is maintaining a rain forest to protect future sources of genetic material for drugs or hybrid agricultural crops (see option benefits).

Biomass: Total living weight (generally in dry weight) of all living organisms in a particular area or habitat. It is sometimes expressed as weight per unit area of land or per unit volume of water.

Brackish water: Slightly salty water.

Capital account in the SNA: One of the economic accounts compiled under the SNA. It records all transactions in non-financial assets.

Capital formation: See gross fixed capital formation.

Carbon sink: A pool that absorbs, or takes up, released carbon from another part of the carbon cycle. Forests are an example of an effective carbon sink.

Consumption of fixed capital: The reduction in the value of the fixed assets used in production during the accounting period resulting from physical deterioration, normal obsolescence, or normal accidental damage. Also see depreciation.

Cultivated natural assets: Includes livestock for breeding, dairy, draught etc, and vineyards, orchards and other plantation trees, yielding repeated products and whose growth is under the direct control, responsibility and management of institutional units (within the production boundary of the SNA). A further breakdown is

used for plants and animals that produce the same product repetitively over time (eg dairy cattle, and rubber trees), and those that produce only once (eg beef cattle, and timber). Also see non-produced natural assets.

Current account in the SNA: One of the economic accounts compiled under the SNA. The current account (or balance of payments) refers to the external account of goods and services, primary incomes, and current transfers.

Deforestation: The clearing of tree formations and their replacement by non-forest land uses.

Degradation: See environmental degradation.

Depletion: See environmental depletion.

Depreciation: A method used in business accounts for allocating the costs of past expenditures on fixed assets over subsequent accounting periods. Depreciation methods are generally derived from the concept of consumption of fixed capital. See consumption of fixed capital.

Direct-use benefits: These are derived from the use of the environmental assets as sources of materials, energy or space for input into human activities. Also included here is the non-consumptive use of the environment, such as recreation. Direct-use benefits include non-economic direct use, such as the benefit received from the aesthetic appreciation of the environment. Also see indirect-use benefits.

Economic assets: Assets over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived by their owners by holding or using them over a period of time. Economic natural assets can be produced assets such as agricultural products or non-produced assets such as land, mineral deposits or natural forests. In the SEEA, economic non-produced natural assets are defined more broadly, including natural resources that are currently exploitable for economic purposes, even if no explicit ownership or control is currently exerted over these resources (eg fish in the oceans, or commercially exploitable timber in tropical forests). Also see environmental assets.

Ecosystem: Living organisms, their physical environment, and their interrelationships within a particular part of the environment. Examples of ecosystems include coastal and forest ecosystems.

Environmental accounting: A combination of natural resource accounts under the SEEA framework, which consists of stock and flow accounts in physical terms, and the monetary valuation of these accounts.

Environmental assets: All natural assets that are not economic assets. Environmental assets are non-produced natural assets that do not function as providers of natural resource inputs into production but as providers of environmental services of waste absorption, ecological functions such as habitat or flood and climate control, and other non-economic amenities such as health and aesthetic values. Also see economic assets.

Environmental degradation: Deterioration in the *quality* of the environment or natural resource as a result of surrounding concentrations of pollutants and other activities and processes, such as improper land use and natural disasters.

Environmental depletion: Reduction in the *quantity* of a natural resource. For renewable resources, depletion refers to the part of the harvest (eg logging) or catch, that is above the sustainable level of the resource stock. For non-renewable resources, depletion refers to the quantity of resources extracted.

Environmental indicators: Indicators are designed to give an overview of the interactions between the environment, society and the economy. Officially, they are a parameter, or a value derived from parameters, that provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value.

Environmental protection: Any activity designed to maintain or restore the quality of the environment through preventing the emission of pollutants or reducing the presence of polluting substances.

Environmental protection expenditure: Capital and operating spending which has been incurred, and can be attributed directly, to the pursuit of an environmental objective. See environmental protection.

Environmentally adjusted GDP: This is also known as green GDP. The original GDP figure, which measures economic growth, is adjusted to take into account the cost of natural resource depletion and environmental degradation.

Eutrophication: The slow ageing process during which a lake or estuary evolves into a bog or marsh and eventually disappears. During eutrophication, the lake becomes so rich in nutritive compounds (especially nitrogen and phosphorus) that algae and other microscopic plant life become superabundant, thereby choking the lake and causing it to eventually dry up. Eutrophication is accelerated by discharges of nutrients in the form of sewage, detergents and fertilisers into the ecosystem.

Existence benefits: This is derived from an environmental entity without any prospect of being useful to humans now or in the future, where it is desirable to maintain the existence of that entity.

Extraction: In relation to natural resources, it refers to the removal of part or all of a natural resource from its source.

Fluvial flooding: The inundation of land from rivers in flood.

Genuine Progress Indicator: An alternative to gross domestic product (GDP) that purports to measure economic welfare. It is based on the Index of Sustainable Economic Welfare (ISEW). See Index of Sustainable Economic Welfare.

Gross Domestic Product (GDP): A measure of the total economic activity occurring within the national boundary of a country. The output based GDP measure is the sum of the gross values added, of all resident producers at basic prices, plus all taxes less subsidies on imports.

Gross fixed capital formation: The total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period, plus certain additions to the value of non-produced assets (such as subsoil assets or major improvements in the quantity, quality or productivity of land) realised by the productive activity of institutional units.

Habitat: Place where an organism or population (human, animal, plant, micro-organism) lives.

Hidden flows: Hidden flows are part of the material requirements of production that will never enter the economic system. Ancillary flows, for example, refer to material that is removed from the natural environment, along with the desired resource, to obtain the natural resource. Examples of hidden flows include the by-catch gathered when fishing, and the soil removed when coal mining. See ancillary flows.

Indicators: See environmental indicators.

Indirect flows: Input requirements of the production process that are not embodied in the output of products, for example energy inputs and capital.

Indirect-use benefit: These arise from a passive use of a service that the environment renders free of charge. For example, making use of the environment's provision of oxygen and absorption of ultra-violet radiation. Indirect-use benefits are always non-economic – there are no market transactions associated. Also see direct-use benefits.

Index of Sustainable Economic Welfare (ISEW): This index is a measure of broadly defined economic welfare. It applies a number of adjustments to personal consumption adding desirable services such as household production and subtracting 'regrettable' expenditures, such as commuting, automobile accidents, water, air, soil and noise pollution, and other welfare losses, including unemployment. Also see Genuine Progress Indicator.

Institutional unit: An economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities.

Intermediate consumption: This consists of the value of goods and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital. The goods or services may be either transformed or used up by the production process.

Inventory: The stocks of finished goods, work-in-progress, and raw materials held by businesses.

NAMEA: The National Accounting Matrix including Environmental Accounts is an alternative environmental accounting framework that seeks to link environmental accounts into the national accounts. This NAMEA framework was developed by the Netherlands in the early 1990s. One of the main differences between the NAMEA and the SEEA is that the NAMEA does not include monetary values for environmental assets. It is used predominately by European countries.

Natural assets: Assets of the natural environment. These consist of biological assets (produced or wild), land and water areas with their ecosystems, and subsoil assets and air.

Natural resource accounting: An accounting system that deals with stocks and flows of natural assets, comprising biota (produced or wild), subsoil assets (proved reserves), water and land with their aquatic and terrestrial ecosystems. The term is used frequently in the sense of physical accounting as distinguished from monetary (environmental) accounting.

Non-cultivated natural assets: Naturally occurring assets, such as land and certain uncultivated forests and deposits of minerals, that are used in production but have not themselves been produced. They can be economic or environmental. Also see economic assets, environmental assets and cultivated natural assets.

Non-economic benefits: Benefits that are not of economic value, generally provided by environmental assets, for example ecosystems that cleanse fouled air and water, and religious or social values provided by forests.

Non-renewable natural resources: Exhaustible natural resources, such as mineral resources, that cannot be regenerated after exploitation.

Non-use benefits: See option benefits and bequest benefits.

Option benefits: This relates to the continued existence of elements of the environment that are currently not in use, but may one day provide use benefits. Also see bequest benefit.

PACE: Pollution Abatement and Control Expenditure. An environmental framework developed by the OECD.

Possible (inferred) reserves: Resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit, and for which there are few, if any, samples of measurements.

Probable (indicated) reserves: The estimated quantity and grade of a mineralised body for which sufficient information on continuity, extent, grade, operating and capital costs, etc is available on the basis of a study, indicating an economically viable operation at long-term forecast average mining prices.

Production accounts in the SNA: One of the economic accounts compiled under the SNA. The production account records the activity of producing goods and services as defined within the SNA. The balancing item, gross value added, is a measure of the contribution to GDP made by an individual producer, industry or sector.

Production boundary: This defines the extent of economic activity under the SNA. Sales of goods and services within the production boundary contribute to GDP. Within it are goods and services sold on markets, and goods and services provided by government (public administration and defence). An estimate is also made of 'imputed rent' on owner occupied houses, ie the rent a homeowner would be paying if they rented rather than owned their home.

Proven reserves: Such quantities of mineral deposits, at a specific date, as analysis of geological engineering data demonstrates with reasonable certainty to be recoverable in the future under the same economic and operational conditions.

Renewable natural resources: Natural resources that, after exploitation, can return to their previous stock levels by natural processes of growth or replenishment. Conditionally renewable resources are those whose exploitation eventually reaches a level beyond which regeneration will become impossible. Such is the case with the clear-cutting of tropical forests.

Residuals: The amount of a pollutant that remains in the environment after a natural or technological process has taken place. Residuals flow from the economic sphere back into the environment.

Resource management: The integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of regulations by which the management authorities control the present and future behaviour of interested parties, in order to ensure the continued productivity of the resources.

Satellite accounts: Accounts that are linked to a set of central core accounts and that enable attention to be focussed on a certain field or aspect of economic, environmental and social life in the context of national accounts. Satellite accounts under the SNA framework are commonly compiled for the environment, tourism, and unpaid housework.

SERIEE: The European System for the Collection of Economic Information on the Environment is an alternative environmental accounting framework developed by Eurostat. It is a system consisting mainly of data on environmental protection expenditure and economic data on the use and management of natural resources. The links to physical data such as the amount of waste and other pollutants generated or avoided, and the use of water and other resources, are to be established in parallel as far as possible. The System is designed to form a series of satellite accounts to the national accounts.

State of the Environment Reporting: This is designed to provide information on the current state of the environment, that is, environmental health. The information may be used to help determine the positive and negative effects on the environment of social and economic processes. Information is gathered from appropriate sources such as environmental indicators, natural resource accounts, environmental accounts, and others.

Supply-use tables: Supply and use tables are in the form of matrices that record how supplies of different kinds of goods and services originate from domestic industries and imports, and how those supplies are allocated between various intermediate or final uses, including exports. The supply and use tables are also referred to as flow accounts under the natural resource accounting framework.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

System of Environmental and Economic Accounts (SEEA): The SEEA was developed by the United Nations Statistical Division as a satellite system of the SNA for the incorporation of environmental concerns

(environmental costs, benefits and assets) in national accounts. The SEEA is intended to be a system with global application and standards, suitable for all countries and all aspects of the environment.

System of National Accounts (SNA): An international accounting framework consisting of a coherent, consistent and integrated set of macro-economic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. It provides a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for purposes of economic analysis, and decision and policy making. (System of National Accounts 1993)

Tangible assets: Assets including human-made (produced) non-financial assets and non-produced natural assets, and excluding intangible (non-produced) assets such as patents or goodwill. See also natural assets.

Terrestrial ecosystems: This refers to land ecosystems. Under the SEEA classification of natural resources, ecosystems are classified into terrestrial, aquatic and atmospheric ecosystems.

Trans-boundary flows: Flows of materials across defined boundaries, such as national boundaries. Acid rain in Europe is an example of this.

Transfers: A transfer is a transaction where one unit provides a good, asset or service to another unit without receiving any payment in return.

Use benefits: These are associated with active use of an element by an individual or a group. For the benefit to be realised, one has to be engaged in an activity that uses either a material or service from the environment in the current period. See also direct-use benefits and indirect-use benefits.

Value added: This is the value of output less the value of intermediate consumption. It is a measure of the contribution of GDP made by an individual producer, industry or sector.

Wild biota: a non-produced (non-cultivated) living component of an ecosystem.

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