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CHAPTER 2

ASSET ACCOUNTS

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1. SCOPE AND COVERAGE

This chapter describes how to compile asset accounts. It covers physical accounts of all environmental assets (economic and non-economic), including accounts for ecosystems and qualitative aspects of the assets. Monetary accounts are covered only for SNA type of assets. More controversial valuation of non-use benefits provided by the assets are discussed in Chapter 5. Sectoral accounts are also discussed in details.

Asset accounts include balance sheet accounts and accumulation accounts. In the 1993 SNA, balance sheets show the values of the stocks of assets and liabilities held by institutional units or sectors at the beginning and end of an accounting period. The values of the assets held at any moment in time vary automatically whenever any transactions, price changes or other changes affecting the volume of assets or liabilities held take place. These are all recorded in one or another of the accumulation accounts so that the difference between the values in the opening and closing balance sheets is entirely accounted for within the System, provided, of course, that the assets and liabilities recorded in the balance sheets are valued consistently with the transactions and other changes--that is, at current prices.

In the 1993 SNA, assets are defined as entities that must be owned by some unit, or units, and from which economic benefits are derived by their owner(s) by holding or using them over a period of time. The SEEA complements the 1993 SNA by:

(a) extending the asset boundary to include all environmental assets that are within the national territory of a country. Environmental assets are natural assets that function as 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 esthetic values. Therefore, uncultivated forests, wild animals, fish within the EEZ zone and all ecosystems are included in the SEEA asset boundaries;

(b) linking physical accounts with monetary environmental accounts and balance sheets: physical natural resource accounts cover the total stock or reserves of natural resources and changes therein, even if these resources are not (yet) affected by the economic system;

(c) rearranging the information already included in the 1993 SNA with respect to:

(i) assessing costs of non-sustainable use (depletion) of natural resources in production and final consumption; and

(ii) treating discoveries as developed natural assets, that is as a result of a production process;

(iii) assessing the costs of degradation of natural assets as a result of production and final consumption.

Why compile asset accounts?

Asset accounts provide the basis for the assessment of national wealth, which in the SEEA is expanded to include, produced capital as well as natural capital. National wealth indicators allow the assessment of the degree to which produced capital is used as a substitute of natural capital. They also can be used to estimate the extent in which we are maintaining the value of natural wealth, thereby ensuring a steady flow of income from the exploitation of the resources. Accounting for wealth and its distribution provides measures of the availability of productive and financial capacities, and of the concentration of economic power within and among nations.

Asset accounts may be compiled by sector, e.g. industries, government and households. The link of the asset accounts with the supply and use table, as indicated in Figure 1, allows to design sectoral policies, which address questions like:

Is the resource being managed sustainably?
How is the asset currently used?
What is the economic contribution of the asset use in each sector?
To what extent is the exploitation/use of the resource subsidized?
Is the resource rent being recovered through taxes or user fees?

Physical asset accounts are the basis for the calculation of monetary accounts. Monetary figures for depletion, in fact, depend on two variables: the physical quantity of resource use, and the resource's market price. Market prices for resources can change markedly from year to year for reasons unrelated to their physical scarcity. Therefore it is quite possible, when the physical use of a resource has gone up but its price has gone down, for the costs of depletion to be shown as decreasing despite the fact that more of the resource has been extracted. In order to ensure that perceptions of depletion are not misled by such seemingly perverse results, physical depletion figures should always be quoted as well as their monetary value. Measurements in constant prices and "revaluation" (capturing holding gains and losses from price changes) aim at presenting "volume" rather than value changes.

Physical asset accounts provide useful information also for resource management decision. They are used to estimate the sustainable yields for forest, fish, and water. A major limitation of physical data is the aggregation of physical quantities, which are usually measured in different units and, if they are measured in the same units, produce meaningless results. Monetary and physical accounts thus produce complementary information for policy making.

2. CLASSIFICATION OF ENVIRONMENTAL ASSETS IN THE SEEA

In a general sense, an asset can be defined as an entity that functions as a store of value to the individual (or individuals) who is (are) in a position to benefit from it by holding or using it. If this simple notion is applied to the environment, it is possible to define an **environmental asset** as an element of the environment that function as a store of benefits to an individual or group of individuals.

This definition is too vague to be of use in an accounting framework. For that, a more rigorous definition is required that allows a clear distinction to be made between elements of the environment that are, and are not, environmental assets. In the case of both the 1993 SNA and the SEEA, more rigorous definitions are arrived at by constraining the scope of environmental assets to those that deliver certain types of benefits to humans.

2.1 Environmental assets in the 1993

In general, the 1993 SNA describes methods of accounting for stocks and flows of goods and services related to marketplace activity. Thus, its recommendations for asset accounting, whether for environmental assets or produced assets, are restricted to the proper means of accounting for assets that contribute to marketplace activity. Such assets are termed economic assets in the 1993 SNA. In order then to understand how environmental assets are treated in the 1993 SNA, it is necessary first to understand how economic assets are treated therein.

An **economic asset** is defined in the 1993 SNA (paras. 10.2 and 10.3) as an entity 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 them, or using them, over a period of time. Different kinds of benefits may be derived from different kinds of assets, as follows:

- Some benefits are derived by using assets such as buildings or machinery in production;
- Some benefits consist of property incomes: for example, interest, dividends, rents, etc., received by the owners of financial assets and land;
- Finally, assets act as stores of value that may be realized by disposing of them or terminating them. While some assets may be held until the benefits derivable from them are exhausted, others may be disposed of before that point in order to realize the capitalized values of the benefits still remaining. Some assets may be held purely as stores of values (precious metals or stones, etc.) without any other benefits being derived from them.

The 1993 SNA recognises two broad classes of economic assets: financial and non-financial assets. Financial assets include such entities as money on deposit in banks, shares in corporations, accounts receivable, etc. Since environmental assets never have the character of financial assets, the latter are not further discussed here.

Non-financial assets are sub-divided into produced and non-produced assets. Produced assets are those that come into existence as output from production process. They are sub-divided, on the basis of their role in production, into fixed assets, inventories and valuables. Fixed assets are defined as those assets that are used repeatedly or continuosly into production. Inventories are used up in production as intermediate consumption, sold or otherwise disposed of. Valuables are acquired and held primarily as stores of value. They are not relevant in environmental-economic accounting and thus are not discussed further here.

Cultivated assets

Produced assets include cultivated assets, such as trees, livestocks and fish. They have characteristics of environmental assets. They may be fixed assets or inventories. For example, breeding stock, dairy cattle, trees cultivated for production of fruits, rubber, etc.,that continue to be used year after year are fixed assets. On the other hand, animals raised for slaughter, trees grown for timber productions that yield a final product once only when they are ultimately felled are not fixed assets but are recorded as work-in-progress.

The 1993 SNA defines cultivated assets that are fixed assets, used year after year into production, as:

Cultivated assets (AN.1114) – Livestock for breeding, dairy, draught, etc. and vineyards, orchards and other plantations of trees yielding repeat products that are under the direct control, responsibility and management of institutional units, as defined below.
Immature cultivated assets are excluded unless produced for own use.
Cultivated assets are further sub-divided as follows:

- **Livestock for breeding, dairy, draught, etc. (AN.11141)** - Livestock that are cultivated for the products they provide year after year. They include breeding stocks (including fish and poultry), dairy cattle, draft animals, sheep or other animals used for wool production and animals used for transportation, racing or entertainment.

- **Vineyards, orchards and other plantations of trees yielding repeat products (AN.11142)** - Trees (including vines and shrubs) cultivated for products they yield year after year, including those cultivated for fruits and nuts, for sap and resin and for bark and leaf products.

The 1993 SNA defines work-in-progress on cultivated assets,

Work-in-progress on cultivated assets (AN.1221) - Livestock raised for products yielded only on slaughter, such as fowl and fish raised commercially, trees and other vegetation yielding once-only products on destruction and immature cultivated assets yielding repeat products.
Fixed assets are further sub-divided into tangible and intangible assets. Cultivated assets described above are tangible assets. Intangible assets that are relevant to environmental assets

are mineral explorations. They are defined in the 1993 SNA as follows:

Intangible fixed assets (AN.112) - Fixed assets that consist of mineral exploration, computer software, entertainment, literary or artistic originals and other intangible fixed assets, as defined below, intended to be used for more than one year.

- **Mineral exploration (AN.1121) -** The value of expenditures on exploration for petroleum and natural gas and for non-petroleum deposits. These expenditures include prelicence costs, licence and acquisition costs, appraisal costs and the costs of actual test drilling and boring, as well as the costs of aerial and other surveys, transportation costs, etc., incurred to make it possible to carry out the tests.

Non-produced assets

The category of non-produced assets is the most important from the perspective of integrated environment-economy accounting, as it is principally here that the 1993 SNA treats environmental assets. Non-produced assets are defined as those that result from processes other than economic production and are further sub-divided into tangible and intangible non-produced assets. Intangible non-produced assets include patents, leases and a few other similar items; they are not relevant to the environment and are not discussed further here. Tangible non-produced assets is the term used in the 1993 SNA to describe those environmental assets that meet the criteria for definition as economic assets. According to the 1993 SNA, the conditions under which environmental assets are rightly considered economic assets are as follows:

> Naturally occurring assets over which ownership rights have been established and are effectively enforced...qualify as economic assets and [are to] be recorded in balance sheets. [Such assets] do not necessarily have to be owned by individual units, and may be owned collectively by groups of units or by governments on behalf of entire communities...In order to comply with the general definition of an economic asset, environmental assets must not only be owned but be capable of bringing economic benefits to their owners, given the technology, scientific knowledge, economic infrastructure, available resources and set of relative prices prevailing on the dates to which the balance sheet relates or expected in the near future (1993 SNA, para. 10.10 and 10.11).

The 1993 SNA recognizes four broad categories of tangible non-produced assets: land, subsoil resources, “non-cultivated biological resources” (timber and wildlife) and water resources. The definition of each is given below.

Land (AN.211) - The ground, including the soil covering and any associated surface waters, over which ownership rights are enforced. Also included are major improvements that cannot be physically separated from the land itself. Excluded are any buildings or other structures situated on it or running through it; cultivated crops, trees and animals; subsoil assets; non-cultivated biological resources and water resources below the ground.
Land is further sub-divided as follows:

- **Land underlying buildings and structures (AN.2111) -** Land on which dwellings, non-residential buildings and structures are constructed or into which their foundations are dug, including yards and gardens deemed an integral part of farm and non-farm dwellings and access roads to farms.

- **Land under cultivation (AN.2112) -** Land on which agricultural or horticultural production is carried on for commercial or subsistence purposes, including, in principle, land under plantations, orchards and vineyards.

- **Recreational land and associated surface water (AN.2113) -** Land that is used as privately owned amenity land, park lands and pleasure grounds and publicly owned parks and recreational areas, together with associated surface water.

- **Other land and associated surface water (AN.2119) -** Land not elsewhere classified, including private gardens and plots not cultivated for subsistence or commercial purposes, communal grazing land, land surrounding dwellings in excess of those yards and gardens deemed an integral part of farm and non-farm dwellings and associated surface water.

Subsoil assets (AN.212) - Proven reserves of mineral deposits located on or below the earth's surface that are economically exploitable, given current technology and relative prices. Ownership rights to the subsoil assets are usually separable from those to the land itself. Subsoil assets consist of coal, oil and natural gas reserves, metallic mineral reserves and non-metallic mineral reserves.

Non-cultivated biological assets (AN.213) - Animals and plants that yield both once-only and repeat products over which ownership rights are enforced but for which natural growth and/or regeneration is not under the direct control, responsibility and management of institutional units. Examples are virgin forests and fisheries within the territory of the country. Only those resources that are currently, or are likely soon to be exploitable for economic purposes are included.

Water resources (AN.214) - Aquifers and other ground water resources to the extent that their scarcity leads to the enforcement of ownership and/or use rights, market valuation and some measure of economic control.

As can be seen from the foregoing, the scope of the environmental assets covered by the 1993 SNA is quite large despite the restriction in coverage to assets that qualify as economic assets.[1] Nonetheless, a substantial and very important group of environmental assets fall outside the scope of the 1993 SNA asset boundary. In particular, environmental assets over which ownership rights cannot be established are excluded. These include resources such as air, major water bodies and ecosystems that are so vast or uncontrollable that effective

[1] It bears mentioning that very few countries have taken steps to implement the recommendations of the 1993 SNA regarding environmental assets. Thus, despite the fact that the 1993 SNA already provides a good deal of scope for accounting for environmental assets, these assets continue to be under-represented in the national accounts of most nations. This is no doubt due in part to the fact that only a handful of countries currently produce national balance sheet accounts and it is this set of accounts where environmental assets would be recorded if they were measured.

ownership rights cannot be enforced. Likewise, resources whose existence has not been proven by exploration and development (undiscovered subsoil resources for example) or that are currently inaccessible (remote forests for example) are not covered by the 1993 SNA. The same is true for resource reserves that do not yet provide economic benefit because the capital needed to exploit them is not in place. (These resources may become economic assets at some future point as the result of advances in technology or changes in prices.)
As discussed later, a major distinction between the treatment of environmental assets in the 1993 SNA and the SEEA is that the asset boundary of the SEEA is extended to include many of the elements of the environment that are excluded in the 1993 SNA.

Intangible non-produced assets entitle their owners to engage in certain specific activities or to produce certain specific goods or services and to exclude other institutional units to do so except with the permission of the owner. They include patented entities, leases and other transferable contracts, purchased goodwill and othe intangible non-produced assets. The sub-category of intangible non-produced fixed assets that is relevant to environmental assets is leases and other transferable contracts, defined in the 1993 SNA as follows:

Leases and other transferable contracts (AN.222) - Leases or contracts where the lessee has the right to convey the lease to a third party independently of the lessor. Examples include leases of land and buildings and other structures, concessions or exclusive rights to exploit mineral deposits or fishing grounds, transferable contracts with athletes and authors and options to buy tangible assets not yet produced. Leases on the rental of machinery are excluded from non-financial intangible assets.

2.2 Environmental Assets in the SEEA

As noted above, the treatment of environmental assets in the SEEA is largely distinguished from that in the 1993 SNA by differences in the asset boundary. While the asset boundary of the 1993 SNA is restricted to those elements of the environment that meet the criteria for definition as economic assets, the SEEA extends this boundary considerably. This is necessary because the restricted asset boundary of the 1993 SNA falls short of what is required for a full assessment of the human-environment relationship. For this, information is required on all elements of the environment that contribute to human well-being, not just those that contribute to narrowly-defined economic well-being. Likewise, a complete evaluation requires information on all elements of the environment that may be affected, either qualitatively or quantitatively, by human activity, not just those that are subject to quantitative depletion through economic use.

It is clear from this that a full assessment of the human-environment relationship requires, in principle, information on *all* elements of the environment. On these grounds, the asset boundary of the SEEA is extended to include, in principle, all elements of the environment. The way in which individual elements of the environment are treated within this boundary cannot be explained, however, without first discussing the types of environmental benefits recognised in the SEEA.

Environmental benefits in the SEEA

The 1993 SNA recognises benefits from the environment only when they have the nature of economic benefits. In practice, this includes only those benefits that are realised from ownership (private or collective) of elements of the environment that have a value in the market. As already noted, this market-based definition of environmental benefits is too narrow for use in the SEEA, as it excludes the numerous elements of the environment that provide non-economic benefits to humans. The SEEA therefore adopts a definition of environmental benefits that is much more inclusive than that in the 1993 SNA.

The SEEA recognises two broad categories of environmental benefits: use benefits and non-use benefits.

Use benefits are, as the name implies, those that are associated with the active use of the environment by humans. For a use benefit to be realised, an individual or group of individuals has to be actively engaged in some activity that depends upon a specific element of the environment. Use benefits can be divided into two sub-categories: direct-use benefits and indirect-use benefits.

- **Direct-use benefits** include those benefits derived from the use of the environment as a source of materials, energy or space for input into human activities. Also included are the benefits associated with non-consumptive uses of the environment, such as recreation.

  Some direct-use benefits are captured in the value of measured market activity (the value of resource extraction and recreation for example). Others provide non-market benefits; that is, they provide benefits for which the value is not captured in the value of market-place activity. The benefits derived by humans from the aesthetic appreciation of the environment are an example of non-market direct-use benefits.

- **Indirect-use benefits** are those associated with human use of the services (or functions) provided by the environment. They do not derive from the direct use of the environment, but rather from the passive use of a service that the environment renders free of charge. They include the benefits humans derive from making use of the environment's capacity for, *inter alia*, fixation of carbon from the atmosphere, provision of oxygen and absorption of the sun's damaging ultra-violet radiation. By their nature, indirect-use benefits are always non-market, as there is never any market transaction associated with the indirect use of the environment.

The second broad category of environmental benefits recognised in the SEEA is that of non-use benefits. These too can be sub-divided, in this case into existence, bequest and option benefits.

- **Existence benefits** are those derived from the mere existence of the environment independent of its use. Existence benefits may be derived by some individuals, for example, from simple knowledge of the continued survival of a certain species on which they place a high intrinsic value. Donations to environmental funds that preserve remote environments to which most donors are likely never to travel are offered as evidence that humans do derive benefits from knowledge of the mere existence of certain elements of the environment.

- **Bequest and option benefits** are those derived from the continued existence of elements of the environment that may one day provide use benefits for those currently living (option benefits) or for those yet to be born (bequest benefits). An example is the benefit derived from maintaining a rain forest to protect future sources of genetic material for drugs or hybrid agricultural crops.

Environmental assets redefined

Environmental assets were defined at the beginning of this section as elements of the environment that yield a flow of benefits to an individual or group of individuals. Having now defined the environmental benefits recognised in the SEEA clearly, it is possible to restate this definition as follows:

> **Environmental assets** are elements of the environment that contribute to human well-being by yielding either use or non-use environmental benefits to an individual or group of individuals.

The asset boundary of the SEEA is defined to include all elements of the environment that meet the above definition.

A notable characteristic of the above definition of environmental assets is its temporal aspect. In contrast to the 1993 SNA, the SEEA explicitly recognises that the needs of the future count when identifying environmental assets. This is in keeping with the widely accepted notion that sustainable development requires that the needs of the future not be compromised as a result of decisions made today. The recognition of option and bequest benefits in the SEEA means that an element of the environment that provides no direct benefit today is still recognised as an asset if it may provide direct benefits one day. Since it is impossible to say with certainty that a particular element of the environment will never benefit humans, it is the recognition of option and bequest benefits that effectively broadens the scope of the SEEA asset boundary to include all elements of the environment. The implications of this are wide ranging. For example, while the 1993 SNA recognises only proven reserves of sub-soil resources as assets, the SEEA goes well beyond this to recognise both known deposits plus speculative deposits that are believed to exist but have not yet been proven geologically. Likewise, the recognition of bequest benefits means that ecosystems from which no known benefit is derived today (such as deep-ocean ecosystems) are recognised as assets because of their potential to one day yield direct benefits.

Practical challenges in measuring assets

On theoretical grounds, any element of the environment is within the asset boundary of the SEEA, for practical reasons, however, much will be excluded from the environmental asset accounts of any one nation. Actually accounting for each and every environmental asset would require an enormous amount of information, much, if not most, of which will not exist in most countries. Even for those assets for which useful information exists, building asset accounts may not be straightforward. The benefits derived from the environment become less and less quantifiable as one moves from direct-use to indirect-use to non-use benefits. The SEEA, as opposed to the SNA, includes compilation of physical accounts. Some indirect-used benefits, such as carbon sequestration, may be better quantified in physical terms, others may be only measured in monetary terms. However, at some point, suitable methods cease to exist at all, practically eliminating the possibility of building physical or monetary accounts for certain assets. The possibilities for including environmental assets that provide indirect-use and non-use benefits in asset accounts are therefore limited.

Environmental assets as inventories and fixed assets

Environmental assets can exhibit the characteristics of both inventories and fixed assets depending upon the manner in which they are used in human activities. Environmental assets that provide the physical inputs[2] used in human activities often resemble inventories. They exist as more or less homogenous stocks from which matter is gradually withdrawn and they are subject to quantitative depletion through human use. On the other hand, assets whose main human benefit is the provision of environmental services have more the nature of fixed assets, in that they themselves are not quantitatively consumed but are subject to qualitative degradation.

The simplest cases are the two extremes: pure inventory assets and pure fixed assets. The most clear cut case of the former is sub-soil deposits of natural resources. These assets serve no other human purpose than the provision of materials (minerals, fossil fuels, etc.), are of finite (if uncertain) size and are irreversibly depleted as a result of human use.[3] At the other end of the spectrum are pure fixed assets, of which there are very few (if any) true examples. The atmosphere comes perhaps closest to having the nature of a pure fixed asset, in that it benefit humans (almost) exclusively through the services it provides, is not subject to quantitative depletion but is subject to significant qualitative degradation through excessive use.

In between these two extremes is a wide variety of environmental assets that exhibits the nature of both inventories and fixed assets. The best example is ecosystems. Ecosystems clearly have the nature of fixed assets in that that they provide services and can be degraded through excessive use. However, ecosystems also have the character of inventories to the extent that they are storehouses of material–timber for example–that are drawn upon for human purposes.

Yet the way in which ecosystems supply materials is not like that of a pure environmental inventory such as an oil deposit. The oceans could, in principle, provide a never-ending

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[2]In this context, physical inputs include matter, energy and space.

[3]This is only true if one adopts a wide perspective on the concept of an environmental inventories. For example, it is true that the absolute quantity of crude oil below the earth's surface is finite. If one interprets this total amount as the earth's inventory of crude oil, then it is true that human activity can do nothing to increase the inventory. On the other hand, if one interprets the inventory of crude oil as being only that oil which has been discovered to date, then there is certainly scope for increasing the inventory through exploration. In the SEEA, it is the wide interpretation of environmental inventories that is adopted.

supply of fish so long as human consumption did not surpass their capacity to produce fish. Pure inventory assets can never do this, as their use inevitably leads to irreversible depletion. Thus, under conditions of sustainable use, it is reasonable to consider the ocean as a fixed asset, one of whose services is the provision of a perpetual supply of fish. Under conditions of unsustainable use, where human consumption exceeds the fish supply, the oceans lose their character as a fixed asset (at least with respect to the provision of fish) and the existing fish population takes on the character of a depletable inventory. If sustainable use conditions return, the oceans can revert back to their status as a fixed asset.

It is clear from the foregoing that the comparison of environmental assets with fixed assets should not be taken too far. Produced fixed assets do not flip into inventory status and out again the way that ecosystems can. Nor are produced fixed assets self-renewing. Rather, their use inevitably leads to a degradation in service quality that can only be countered through human investment in their maintenance. Environmental fixed assets, on the other hand, do not require input from humans to continue functioning. So long as human use of these assets is within their capacity to render services, these assets can, in principle, deliver their services in perpetuity.

The comparison with inventories does not fare much better. While it is true that many environmental assets have some of the character of inventories, in that they are storehouses of material from which withdrawals are made to meet the needs of human activities, there are considerable differences between environmental inventories and produced inventories. For one, environmental inventories are subject primarily to depletion through human use.[4] In contrast, inventories of produced assets can be both increased and decreased by human activities. Another distinction is that inventories of produced assets do not usually represent more than one year's worth of demand, whereas environmental inventories may represent anything from a few years to centuries' worth of demand. Finally, whereas the size of environmental inventories is difficult to measure and, therefore, always uncertain, inventories of produced assets are reasonably easily measured to a considerable degree of accuracy.

Thus, it seems inappropriate to use either the term fixed assets or the term inventories when discussing environmental assets. These terms have specific meanings with respect to produced assets that do not translate well into the environmental domain. Nevertheless, as it is useful to be able to describe environmental assets collectively, replacements for these terms are desirable.

To describe the group of environmental assets whose principal human benefit is the provision of services (that is, those similar to fixed assets), it is tempting to adopt the term "ecosystem assets." This is too limiting however. While ecosystems comprise by definition both living (biotic) and non-living (abiotic) components, some environmental systems that provide human benefits are entirely abiotic. The atmosphere, for example, is composed entirely of abiotic elements (birds notwithstanding) yet provides many human benefits. Thus, the more general term "environmental system assets" is used in the SEEA to describe environmental

[4] The exception is biological resources, which are not subject to depletion so long as human use is within the capacity of the environment to supply them. In some limited sense, human activities can even increase the size of these assets through, for example, silvicultural programs.

assets that have the capacity for self-renewal, that render services to humans and that are subject mainly to qualitative degradation (as opposed to quantitative depletion) through use.

As for environmental assets whose principal human benefit is the provision of the materials, energy and space used in human activities (that is, those similar to inventories), these are referred to in the SEEA as "natural resource stock assets." This term conveys the notion that these assets are valued by humans mainly for their utilitarian uses and not for any intrinsic benefits that they might provide.

2.3 SEEA Classification of Environmental Assets

The detailed classification of environmental assets used in the SEEA is presented below. As can be seen, assets are grouped according to the three broad classes of environmental assets defined in the previous section: cultivated assets, natural resource stock assets and environmental system assets. Cultivated assets are discussed in details in Section 2.2.
The classification reported below reflects, to a large extent, the SNA classification of non-financial assets.

Natural resource stock assets are defined as those that provide materials, energy and space used in human activities and that are subject primarily to quantitative depletion through human use. They are sub-divided into three categories: sub-soil resources, biological resources and land resources.

Sub-soil resources are further sub-divided into proven and speculative reserves. The proven reserves category corresponds with the sub-soil resources that are included within the asset boundary of the 1993 SNA. The speculative reserves category, which includes sub-soil resources thought to exist but not proven by exploration, is included in the SEEA in recognition that these resources provide option and/or bequest benefits. Ground water is included under sub-soil resources because it, unlike surface water, provides primarily material input to human activity (no services) and is often irreversibly depletable as a result of human activity. Other water resources (lakes, rivers, etc.) is categorised under aquatic ecosystems (3.2).

The biological assets classified as natural resource stock assets in the SEEA are those that are directly used as sources of material inputs in human activities. These are primarily timber and fishery resources, although certain other flora and fauna also serve as important sources of material inputs. Although distinct from sub-soil resources in being conditionally renewable (that is, renewable provided that appropriate conditions exist for the continued functioning of the ecosystems that produce them), timber and fishery resources do meet the essential criteria for classification as natural resource stock assets. That is, their primary benefit to humans is as a source of materials and they are subject to quantitative depletion under conditions of excessive use.

It is worth emphasising that the classification of timber and fishery resources as natural resource stock assets does not preclude recognition that these assets are components of broader ecosystems that provide benefits beyond the provision of materials. Thus, these assets implicitly appear twice in the SEEA asset classification, once as resource stock assets reflecting the utilitarian benefits they provide and again as components of ecosystems reflecting the indirect-use and non-use benefits they provide.

The land resources category under natural resource stock assets includes only that land which provides a direct input of space into human activities. This includes land given over to urban areas, transportation and other networks, agriculture, intensive forestry and recreation. Again it is realised that land provides many other benefits other than space. These benefits are implicitly included as part of “terrestrial environmental system assets” in category 3.1 of the SEEA asset classification.

It may seem that land does not qualify as a natural resource stock asset since it is not quantitatively depletable. Some might argue that it has more of the nature of a fixed asset. While it is true that land cannot be depleted at the aggregate level (the surface area of the earth being fixed for all intents and purposes), individual land types are subject to depletion through conversion into other types. Thus, agricultural land can be lost through conversion to urban land. For this reason, and because its use as a source of space is essentially utilitarian in nature, directly-used land is classified as a natural resource stock asset in the SEEA.

Soil is included as a category or resource stock assets as it can be though as a source of material input into economic activities. Soil erosion can be considered as a quantitative change in the availability of soil (loss of topsoil) and hence it is depleatable, as well as a qualitative change. Moreover, soil can be thought of in terms of the stocks of nutrients that it contains. The nutrients may be depleted as a consequence of poor agricultural practices. For these reasons it is included as a separate category in the classification of natural resource stock assets.

The third broad category of environmental assets recognised in the SEEA asset classification is environmental system assets. These are environmental assets that have the capacity for self-renewal, that render services to humans (which may include the provision of materials), and that are subject mainly to qualitative degradation (as opposed to quantitative depletion) through excessive use.

For the most part, the individual components of environmental systems are not classified as unique assets in the SEEA asset classification. This reflects the fact that it is not generally the components of environmental systems that render the services that benefit humans, but the systems as a whole. Exceptions to this rule can be made in the cases of individual elements of environmental systems upon which humans place high intrinsic value. For example, many humans place high values on so-called “charismatic” animal species such as baboons or whales. Thus, it can be argued that these species provide benefits to humans above and beyond the benefits of the environmental systems to which they belong. Since the actual examples of such species vary from one country to the next, the SEEA asset classification does not explicitly include them. It is left to countries to decide for themselves which examples to include in their environmental asset accounts.

As noted above, biological assets that provide direct material inputs into human activity are classified as natural resource stock assets in the SEEA. To the extent that these assets provide other benefits to humans, they are also included implicitly in as components of their respective environmental system assets. Thus, forests that are used as source of timber are classified as natural resource stock assets. Since these same forests provide other benefits as well (carbon absorption for example), they are implicitly included as environmental system assets. Remote or virgin forests that are not exploited for timber are classified only as environmental system assets.

Three types of environmental system assets are recognised in the SEEA: terrestrial systems, aquatic systems and atmospheric systems. Each of these is further sub-divided according to the major types of sub-systems found on the planet. Still further sub-division is possible to meet the needs of individual countries. For example, forest systems could be further sub-divided into coniferous, deciduous and mixed wood sub-categories, each of which could be again sub-divided into virgin and disturbed categories.

Some of those assets provide direct-use benefits. For example, in some countries, rights to use the atmosphere for economic activities, such as flights, telecommunications, etc. or for emitting atmospheric pollution are marketed. Since the principal human benefit of the atmosphere is the provision of services it is classified as environmental system asset.

A few services are general to all three broad systems. They all offer habitat for flora and fauna, absorption of human wastes, recreational opportunities and environmental amenities. Other services may be offered by some systems and not by others. If it is desired, countries may identify in their asset classifications each of the services provided by a specific environmental system and attempt to provide separate statistics for each service. For example, physical and monetary estimates could be provided for each of the services offered by forests. This would entail calculating, for example, the amount of carbon dioxide absorbed by a country's forests in a given period and estimating the value of this service to the population. The same would have to be done for all other services offered by the forest. Of course, it may not be possible to derive physical and/or monetary estimates for each service. For example, the amenity service of the environment does not lend itself to meaningful measurement in physical terms but it may be reasonably measured in monetary terms. Likewise, the monetary value of habitat might be very difficult to estimate, while the physical extent of habitat (at least for a particular species) might be rather easily measured.

If it is not possible or not desirable to provide individual estimates for each service of an environmental system, it is also acceptable to simply present a single set of statistics that incorporates all the services offered by a system. In the forest example, this might consist of a physical estimate of the extent of the forest and a corresponding monetary estimate of the value of forests to the population (aside from the value of the timber they contain, which is classified as a natural resource stock asset).

1. Cultivated assets

1.1 Cultivated fixed assets

1.1.1 Livestock for breeding, dairy, draught, etc.
1.1.1.1 Livestock (except aquatic animals)
1.1.1.2 Fish stock and stock of other aquatic animals in fish ponds and farms
1.1.2 Vineyards, orchards and other plantations of trees yielding repeat products
1.2 Work-in-progress on natural growth products
1.2.1 Livestocks raised for slaugther
1.2.1.1 Livestock (except aquatic animals)
1.2.1.2 Fish stock and stock of other aquatic animals in fish ponds and farms
1.2.2 Crops and plants of cultivated forests
1.2.2.1 Crops and other produced plants, not yet harvested (work-in-progress)
1.2.2.2 Trees of timber tracts
1.2.2.3 Other plants of cultivated forests

2. Natural resource stock assets

2.1 Sub-soil resources
2.1.1 Fossil fuels
2.1.1.1 Proven
2.1.1.2 Speculative
2.1.2 Metallic minerals
2.1.2.1 Proven
2.1.2.2 Speculative
2.1.3 Non-metallic minerals
2.1.3.1 Proven
2.1.3.2 Speculative
2.1.4 Ground water
2.1.4.1 Proven
2.1.4.2 Speculative
2.1.5 Other

2.2 Biological resources
2.2.2 Timber resources
2.2.2.1 Hardwood
2.2.2.2 Softwood
2.2.2.3 Mixed wood
2.2.3 Fisheries resources
2.2.3.1 Pelagic fish
2.2.3.2 Groundfish
2.2.3.3 Shellfish
2.2.3.4 Other
2.2.4 Other biological resources

2.3 Land resources
2.3.2 Urban and built-upon land
2.3.3 Transportation and other networks
2.3.4 Agricultural land

2.3.5 Land for intensive forestry
2.3.6 Recreational land

2.4 Soil

3. Environmental system assets

3.1 Terrestrial systems
3.1.1 Forests
3.1.2 Wetlands
3.1.3 Montane regions
3.1.4 Prairies
3.1.5 Tundra
3.1.6 Other terrestrial systems
3.2 Aquatic systems
3.2.1 Marine
3.2.2 Coastal
3.2.3 Riverine
3.2.4 Lacustrine
3.2.5 Other natural aquatic ecosystems
3.3 Atmospheric systems

2.4 Comparison of the SEEA and 1993 SNA and 1993 SEEA asset classifications

THIS SECTION WILL BE COMPLETED ONCE WE HAVE AGREED UPON THE SEEA ASSET CLASSIFICATION

3. STRUCTURE OF ASSET ACCOUNTS

3.1 General structure of assets accounts

Asset accounts are a way of describing assets within a given system defined by a boundary. Only those assets that are within the boundary, during the whole period or a part of it, are described. This section focuses on the description of the non-financial tangible assets that fall within the boundary described in Section 2. Intangible assets although relevant for economic-environmental accounting are not further described here.

As described in Section 2, the system includes economic assets, which cover cultivated assets and natural resource stock assets, and environmental system assets. In the SEEA economic assets mostly coincide with the 1993 SNA definition, although some reclassifications and extensions have been introduced for economic-environmental accounting purposes.

Assets are the components of the balance sheets of the total economy and institutional sectors. In contrast to the accounts that show economic flows, a balance sheet shows the stocks of assets held at one point in time by each unit or sector or the economy as a whole. However, stocks are connected with flows: they result from the accumulation of prior transactions and other flows, and they are modified by future transactions and other flows. Generally recorded at the point in time when an inventory is drawn up, they result in fact from a continuum of entries and withdrawals, plus some changes, either in substance or in value, occurring during the period a given asset is held. Thus stocks and flows are closely related.

During the period covered by the accounts, i.e. the interval of time between the two time periods the opening and closing stocks refer to, assets may:

come to existence within the system, through an economic or natural process;
enter the system (e.g. through imports or natural flows that cross the boundary of the system);
suffer modifications in their state or characteristics while they stay within the system;
disappear or leave the system (e.g. the asset may be used up in production or final consumption, or may change classification).

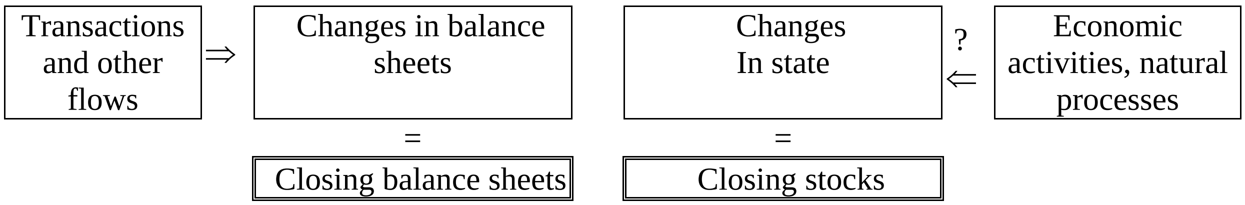
These events, called “changes in balance sheets”, are the result of processes within the system or exchanges between the system and the exterior.

For economic assets, changes in balance sheets are the result of transactions and other flows. The transactions, which appear both in the supply and use accounts and in the asset accounts, are capital formation and consumption of fixed capital. Other flows accounted for in the asset accounts outside the production boundary include natural growth and withdrawals from stocks (for non-produced assets), changes in quality (degradation), as well as changes due to natural disasters and changes in prices.

Changes in environmental system assets are more difficult to measure as they refer to changes in the capacity of environmental assets to provide services to production and welfare. The causes of these changes (e.g. direct or indirect impacts of economic activities, "pure" natural processes, etc.) should be identified. In general, it will be very difficult to identify all the processes, economic or natural, that influence the state of assets and to fully explain the changes according to the process. Figure 1 shows in a simplified manner the changes between opening and closing stocks for economic and environmental system assets.

Figure 1. Asset accounts – Stocks and flows

Economic assets	Environmental system assets
Opening balance sheets	Opening stocks
+	+



The 1993 SNA describes economic assets in their capacity to provide economic benefits to their owners. These economic benefits are multiform but are restricted to income derived (directly or indirectly) from production or future sale. Assets may be used in production directly by their owner, may be put at the disposal of a producer, or they may act as pure store of value. The economic benefits therefore are always monetary and monetary valuation always offers an adequate description of the economic assets. Physical data may be underlying the monetary valuation, but is not presented in the accounts.

Environmental assets provide economic benefits in the SNA sense as well as “free production services" to production (i.e. services useful and necessary for productive activities but the provision of which is at no cost) and "free consumption services" to welfare. Whereas changes in economic assets can be relatively easily measured in monetary terms, changes in environmental assets are changes in their capacity to provide these services, which are not easily measured in monetary terms.

The SEEA attempts to measure the interface between the economy and the environment. This interface can be measured in physical and most of the times, in monetary terms. The linkage of physical resource accounts with monetary accounts and balance sheets is a very important component of the SEEA. Monetary accounts depend on two quantities: the physical quantity of resource, and the resource market price. Market prices for resources, like any price in a far-from-perfect competition situation, can change markedly from year to year for reasons unrelated to their physical scarcity. Therefore it is quite possible that monetary accounts may provide misleading results, as the value of the asset may increase because of change in classification and not because of changes in quantity or quality. For example, built-up land has higher value than forestland but the environmental services provided are lower.

Units of measurement

Balance sheets describe (the state of) the assets at a given point in time. In the SEEA, the accounts are compiled both in physical and, whenever feasible, in monetary terms. According to the nature of the assets, and the purpose of the accounts, the unit of measurement may be a simple counting of individuals, or an (additive) measure, that is a measure, which allows for additions and subtractions from the stocks, e.g. area, volume or mass, value, etc. Aggregation of different assets may be possible in physical terms by using conversion factors to express different physical units of measurement in "equivalents". For instance, the energy content of different (re)sources can be converted into coal or oil equivalents, or contributions to global warming can be attributed to greenhouse gases in terms of CO_2 equivalents. For economic assets, the common *numeraire* is the monetary value, which allows aggregating and comparing all assets.

A quantitative description of environmental system assets may not possible or may not be sufficient to describe all the characteristics of the asset. Assets could be classified according to non-additive characteristics, e.g. according to their inclusion into a given quality class. Assets accounts thus describe not only changes in quantity but also changes quality measured by changes in classification: an asset in a given (quality) class may change to another class, e.g. land may change from "agricultural land" to "land underlying buildings". In general, complex environmental assets (e.g. ecosystems) cannot be fully described by their monetary value or by any other additive measure.

SEEA asset accounts deal with the inter-relationships between the economy and the environment at the national level. Therefore, interactions at local level as well as presentation of complex assets in an integrated way (e.g. hydrological systems, ecosystems, etc.) are not covered in the SEEA. Supplementary accounts, linked to the SEEA could be developed to overcome these limitations.

3.2 SNA assets accounts

Structure of balance sheets and changes

This section discussed the structure of the accounts for economic assets as defined in section 2.1. Table 1 presents the structure of balance sheets and changes in balance sheets in the 1993 SNA. Produced assets include man-made assets and living biota and non-produced assets include wild (living) biota, subsoil assets, land and water resources.

Table 1. Asset accounts – Economic assets

	Economic assets					
	Produced		non produced			
	Man made	Biota	Wild biota	Subsoil assets	Land	Water
Opening stocks						
Transactions						
Gross fixed capital formation						
of which: land improvement/decontamination						
Consumption of fixed capital						
Changes in inventories						
of which: work in progress on cultivated assets						
Changes in non-produced assets due to:						
Direct economic use						
Withdrawals from stocks (sustainable use/depletion)						
Soil erosion						
Changes in quality due to (changes in) economic use						
Economic decisions						
Reassessment						

Transfers to economic assets						
Changes in quality (environmental degradation)						
Changes in classification						
Natural growth						
Changes in status						
Natural causes						
Changes due to political and catastrophic events						
Changes in prices						
Revaluation						
Closing stocks						

As the presentation of balance sheets does not distinguish institutional sectors, the value of acquisition less disposals of land is zero for the whole economy (except if there are transactions that change the boundary of the economic territory). However, the costs of ownership transfers of land and other non-produced assets has to be included in gross fixed capital formation.

The first category of changes in balance sheets corresponds to the transactions, which are also included in the production accounts. It covers:

- Gross fixed capital formation, including natural growth of cultivated assets, costs of ownership transfers on non-produced assets, and improvement to land
- Consumption of fixed capital
- Changes in inventories

The second category of changes in balance sheets corresponds to the "other changes in assets" accounts. The flows entering this account are reclassified according to whether the changes are brought about by direct economic use in production or consumption, economic decisions, natural causes or changes in prices.

"other changes in volume of non-produced assets due to direct economic use

- Withdrawals (extraction) from stocks of non produced assets (sustainable use/depletion)[5]
- Soil erosion due to agricultural activity
- Changes in quality due to changes in land use or to changes in economic use.

"other changes in volume of non-produced assets due to economic decisions"

- Reassessment of stocks of non-produced assets due to improved knowledge and technology
- Transfers to economic assets
- Quality changes due to general environmental conditions
- Changes in classifications

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[5] Depletion is defined, for renewable resources, the part of the harvest, logging, catch etc. which exceeds the sustainable level of resource use; for non-renewable resources (mineral deposits), the quantity of the resource extracted.

- Natural growth of non cultivated biological assets
- Changes due to changes in status (e.g. protection)

"other changes in volume of produced and non-produced assets due to natural causes"

- Catastrophic losses,
- Political events,

“other changes due to changes in prices”

- Revaluation

The SEEA considers other changes in volume due to direct economic use as, i.e. depletion and degradation of natural assets, as costs to be accounted for in the production accounts. This constitutes a major deviation from the 1993 where the depletion and degradation of (economic, non-produced) natural assets are recorded as “other changes in volume” in the asset accounts.

3.3 Valuation of Natural Resource Stock Assets

This section discusses the recommended methods for estimating the value of natural resource stock assets. Methods for valuing environmental system assets are discussed in Chapter 5 along with other non-market valuation methods.

Valuation of Environmental Assets in the 1993 SNA

The previous version of the SNA guidelines, published in 1968, "did not include much guidance on...balance sheets...and consequently provided little information" on the assets that should be covered by balance sheet accounts. Although the 1968 SNA "included in principle natural assets in its asset boundary," it did not do so in a "systematic manner" (1993 SNA, Annex I, para. 65). This lack of systematic guidance explains, in part, why natural resource assets have not been included in national balance sheet accounts in the past.

The 1993 SNA has corrected this weakness by providing explicit guidance for the inclusion of natural resource assets in balance sheet accounts. The 1993 SNA recommends that financial assets and liabilities, and non-financial assets, including tangible non-produced assets, be compiled into balance sheet accounts at the end of each accounting period. Balance sheets can be compiled for an institution, a sector of the economy or for the nation as a whole. The balance sheet shows as of the date of its compilation the value of all the assets owned by the economic agents for whom the account is compiled.

In general, the asset values placed on the balance sheet should be based on observed market prices for the assets as of the date of its compilation. In the case of financial and produced non-financial assets, it is usually possible to obtain such prices without a great deal of difficulty, as these assets are regularly bought and sold in the market. In contrast, it is often not possible to obtain market prices for non-produced assets. With the exception of land, which is commonly traded in all countries, non-produced environmental assets do not change hands on a regular basis in most countries. Rather, they are often owned collectively by governments who distribute rights to exploit these assets to private interests in return for royalties or some other kind of payment. In the absence of market through which a value for environmental assets could be determined, indirect methods of approximating their market value must be used. The 1993 SNA recommends the following methods for environmental assets (other than land):

- Subsoil assets - The value of subsoil asset reserves is usually determined by the present value of the expected net returns resulting from the commercial exploitation of those assets, although such valuations are subject to uncertainty and revision. It may also be possible to use the valuations which the owners of the assets place on them in their own accounts.

- Non-cultivated biological assets - These assets are to be valued by determining the present value of the future returns expected from them.

- Water - These assets are to be valued by determining the present value of the future returns expected from them.

The sum of all non-financial assets (both produced and non-produced) owned by the economic agents of a country is known as national wealth. National wealth is an important measure, as it represents the economic capital at the disposal of the nation from which it can derive income for its people. It is clear from this why the inclusion of tangible non-produced (environmental) assets in balance sheets accounts is important. On the one hand, their exclusion leads to a situation where the national wealth figure calculated from the balance sheet would understate a nation's actual income generation potential. On the other hand, their exclusion means that the national accounts of the nation would show no loss in income generating potential when environmental assets were depleted or degraded.

The concept of economic rent

As for the SNA, the valuation of natural resource asset stocks in the SEEA asset accounts would ideally be based on observed market values for transactions in these assets. Such values are not available for most resource assets however, since there are few transactions in resource assets in their "natural" state.

The indirect estimation of market values of natural resource stock assets in the SEEA rests first on the estimation of a return to the resource, often referred to as **economic rent** (or resource rent).

The revenue generated from selling natural resources reflects both the costs of their extraction[6]–including the costs of materials, labour and produced capital–and a return to the resource itself. The latter is the economic rent attributable to the resource, which serves as the basis for estimating the market value of the total stock of the resource asset. Resource rent for a given resource asset is defined empirically as the difference between total revenue generated from extraction of the resource and all costs incurred during the extraction process, including the cost of produced capital, but excluding taxes, royalties and other costs that are not directly due to the extraction process.

Estimating resource rent

In many countries, governments are the primary owners of the nation's natural resources. As landlords, governments should in theory collect the entire rent derived from extraction of the resources they own. Resource rent is normally collected by governments through fees, taxes and royalties levied on companies that carry out extraction. The ideal means of estimating the economic rent attributable to a resource would be to equate it with the fees, taxes and royalties collected from the companies involved in the resource extraction. However, data on these charges are incomplete or missing in many countries, so resource rent must be imputed using various indirect methods.

As noted above, resource rent is defined as the revenue generated from the sale of a resource asset less all costs incurred in its extraction, including the cost of produced capital. It is

[6]The term "extraction" when used to refer to natural resources in the general sense should be understood to include both the extraction of subsoil resources as well as the harvesting of renewable resources like timber or fish.

relatively straightforward to estimate the non-capital costs of resource extraction (that is, the costs of materials and labour). The data necessary to estimate non-capital costs are typically available directly from surveys of natural resource extraction industries. Estimating the cost of the produced capital used in resource extraction, in contrast, is more difficult.

In theory, the annual cost, C_K, of the produced capital[7] used in a resource extraction activity can be calculated as:

Eq. 1 $C_K = rK + \delta$

where ∗ is the **annual rate of depreciation** of the produced capital stock and *rK* is the **return to produced capital**.

The **annual rate of depreciation** (∗), or capital consumption allowance, is an approximation of the value of produced capital that is lost (or "used up") in each year that the capital is employed.[8] The depreciation estimate is based on the current replacement cost (rather than the original purchase cost) of the produced capital stock employed in the activity. The data required to make this estimate are normally available from capital stock data.

Estimating the **return to produced capital** (*rK*) is less theoretically straightforward than estimating depreciation, as there are at least two ways in which the concept of return to produced capital can be interpreted. It can be interpreted, for instance, as the opportunity cost of the investment in the produced capital assets. This opportunity cost could be estimated as the average real rate of return on investment elsewhere in the economy. Alternatively, return to produced capital could be seen as covering the cost of financing the acquisition of the produced capital stock. In this case, use of the interest rate on bonds and/or the return on shares in resource industries is appropriate for use as the value of *r* in Eq. 1. Financing costs could be estimated using either the nominal interest rate (reflecting actual payments made) or the real rate (adjusted for inflation by deducting the expected rate of inflation from the nominal rate). Use of a real rate requires the assumption that produced capital stocks appreciate in value with time, offsetting part of the interest cost. This gain in value is realizable only if the capital goods are sold however.

The second interpretation of return to produced capital is the one adopted in the SEEA asset accounts. An interest rate based on long-term industrial bond rates is taken as the value of *r* for use in estimating the return to produced capital in the accounts (written as r_i in what follows). A nominal value of this interest rate is used, on the assumption that capital goods used in resource extraction are fully depreciated and not sold in order to realize any gain in the assets' value.

[7]The produced capital stock used in a resource extraction activity is measured at the end of each year as the sum of the extraction industry's capital investments, net of accumulated depreciation.

[8]The depreciation of the produced capital stock, which is a purely monetary measure, should not be confused with the physical depletion of the resource stock that occurs as a result of extraction.

Text Box 1

Alternative Methods of Valuing Subsoil and Biological Resource Stock Assets

A. Estimation of resource rent

Eq. 2 $RR_{I} = TR - C - (r_{i}K + \ast)$ (lower bound)
Eq. 3 $RR_{II} = TR - C - \ast$ (upper bound)

B. Valuation of subsoil assets

1. Net price I (positive return to produced capital)
Eq. 4 $V_{I} = (RR_{I}/Q)S$

2. Net price II (zero return to produced capital)
Eq. 5 $V_{II} = (RR_{II}/Q)S$

3. Present value (zero return to produced capital)
Eq. 6 $$PV = \sum_{t=1}^{T} \frac{RR_{II}}{\left(1 + r_{g}\right)^{t}}$$

C. Valuation of timber assets

1. Present value I (positive return to produced capital)[1]
Eq. 7 $PV_{I} = RR_{I}/r_{g}$

2. Present value II (zero return to produced capital)
Eq. 8 $PV_{II} = RR_{II}/r_{g}$

Definition of symbols:

∗ = depreciation of the produced capital stock
C = annual non-capital extraction costs, including fuel, electricity, materials, supplies and wages
K = produced capital stock valued at replacement cost
PV = present value of the resource stock
Q = annual quantity of the resource extracted
RR = annual resource rent
S = stock of remaining recoverable or established reserves
T = life of the reserve
TR = total annual revenue from resource extraction
V = net price value of the resource stock
r_{g} = real provincial government bond rate
r_{i} = nominal long-term industrial bond rate
t = current year

Note:
1. The expression for calculating the present value of an income stream simplifies to (annual income)/(interest rate) when the time period is infinite.

Starting from Eq. 1 as the basis for estimating the cost of produced capital, two estimates of resource rent are made (Section A of Text Box 1). In the first of these estimates (Eq. 2 in Text Box 1), the cost of produced capital is taken to be equal to the annual depreciation of the produced capital stock employed in extraction (δ) plus the return to produced capital (r_iK). This estimate yields a lower bound on resource rent, as a portion of the total return to capital in the resource extraction activity is explicitly assigned to the produced capital; this portion is represented by r_iK.

In theory, Eq. 2 is the correct method of estimating resource rent. Rent should be net of all extraction costs, including full produced capital costs, to accurately represent the return to the subsoil asset. There is, however, uncertainty regarding the estimation of the return to the produced capital (r_iK), particularly when resource rent is small. In the case of coal and gold, for example, resource rent sometimes becomes negative after the deduction of the return to produced capital. The reasons for this are discussed in Born (1995). Negative resource rents suggest that the assumptions made regarding the return to produced capital in Eq. 2 may be inappropriate. By fixing the return to produced capital at r_iK, no allowance is made for relatively low rates of return to produced capital that are observable in the subsoil resource extraction industries.

The second estimate of resource rent (Eq. 3 in Text Box 1) addresses the uncertainty associated with estimating the return to produced capital. As can be seen in Text Box 1, Eq. 3 includes only the depreciation of the produced capital stock in the cost of produced capital. Thus, the total return to capital in the extraction activity is assigned to the resource, the return to the produced capital stock being given a zero value. The resulting estimate yields an upper bound on resource rent.

The "true" rent attributable to a given resource asset will lie somewhere between the lower and upper bounds established by Eq. 2 and Eq. 3.

Estimating resource stock values

As shown in sections B and C of Text Box 1, the two estimates of resource rent resulting from the contrasting assumptions regarding the cost of produced capital are applied in the estimation of subsoil and biological asset stock values (Eq. 4 to Eq. 8). The use of both rent estimates results in lower- and upper-bound estimates of the value of resource asset stocks. Until a sound empirical means of estimating the return to produced capital can be found, both estimates of resource rent could continue to be used in stock valuation in the SEEA. As just mentioned for rent, the "true" stock values will lie somewhere between the lower and upper bounds established by the methods presented in Text Box 1.

Estimating the market value of any resource asset stock is complicated by the fact that extraction of the stock takes place over a long time period. In theory, the market value of a resource asset stock should equal the discounted value of the future stream of resource rent realizable from the stock. Discounting future rent to a present value is necessary because, from today's perspective, income earned from resource extraction in the future is worth less than that earned today.[9] This is the essence of the present value methods that are presented in

[9]Unless the price, or rent, of the resource asset rises at a rate matching the rate of income growth attainable in alternative investments; that is,

Text Box 1 (Eq. 6, Eq. 7 and Eq. 8).

A second method of stock valuation–the net price method– is applied to subsoil assets in the SEEA (Eq. 4 and Eq. 5 in Text Box 1). As explained below, this method, which is based on the so-called Hotelling model,[10] eliminates the need for discounting future income by making certain assumptions about the rate of increase of resource prices. International consensus has not yet settled which method of subsoil asset valuation is the most appropriate, net price or present value. The SEEA therefore presents stock value estimates for subsoil assets based on both methods and will continue to do so until such time as consensus is reached on a single valuation method.

Valuation of non-renewable resources

As just noted, the valuation of non-renewable resource stocks (subsoil assets) is carried out using both the present value method and the net price method in the SEEA (Section B of Text Box 1).

The net price method is based on the Hotelling model, which assumes that under certain market conditions non-renewable resource rent will rise at a rate equal to the rate of discount (or interest rate) as the resource becomes scarce.[11] Under these circumstances, the value of the resource stock can be calculated simply as the current rent per unit of resource times the size of the stock (Landefeld and Hines, 1985). Because rent rises over time at a rate that is exactly sufficient to offset the discount rate, there is no need to discount future resource income.

Two net price calculations are employed for valuing subsoil assets in the SEEA, (Eq. 4 and Eq. 5 in Text Box 1), one for each of the two methods of estimating resource rent described above.

It is well documented in the literature that the net price method suffers from several empirical and theoretical weaknesses. An alternative valuation of subsoil assets based on the present value method is therefore presented. The present value method is implemented first by assuming that the current annual rent from a subsoil asset extraction activity will remain constant for the life of the reserve. The stock value is then calculated as the discounted present value of a series of constant rent returns over the life of the asset (Eq. 6 in Text Box 1).

Valuation of biological resources

If one assumes that harvesting can be sustained indefinitely, the value of a biological resource stock asset can be calculated as the discounted present value of an indefinite annual stream of rent generated from harvesting the stock. This approach is used to value biological resource assets in the SEEA. Two variations of this present value method are shown in Text Box 1 (Eq.

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unless the price increases at the rate of interest. Historically, this has not proven to be the case for most resource assets.

[10]After the seminal work on natural resource valuation by Harold Hotelling (1931).

[11]The Hotelling model is generally assumed not to apply to renewable resources, which, if sustainably managed, do not become scarce. Renewable resources that are not sustainably managed, but depleted instead, can in theory be valued using the Hotelling model.

7 and Eq. 8), one for each of the two methods of estimating resource rent described above.

What discount rate to use?

As discussed above, resource assets for which returns are either delayed (growing timber) or spread over a lengthy period of time (mineral deposits) can be valued by discounting the expected future income to a present value. Doing so first requires the choice of a discount rate, a choice which is often the subject of considerable debate.

The discount rate (that is, the rate used to discount future income) expresses a time preference: the preference of an asset's owner for income today rather than in the future. This time preference will vary depending on the ownership of the asset. In general, individuals and businesses will have higher rates of time preference than governments. That is, individuals and businesses will tend to demand a quicker return from ownership of a resource asset than will governments. Higher rates of time preference translate into higher discount rates. A typical "private" discount rate appropriate for individuals or businesses might be in the range of seven or eight percent annually. A government, or "social," discount rate might be a few percentage points lower, reflecting the longer time perspective (that is, lower time preference) that governments are able to take.

In addition to time preference, discount rates can also reflect the risks associated with the future returns expected from resource assets. These risks include the possibility of price and cost changes or uncertainty about the amount or quality of the asset available for extraction. In the NRSA, these risks are accounted for otherwise in the stock valuation methods and the discount rate does not include a risk factor. Uncertainty about prices and costs is eliminated by the assumption that recent average prices and costs will remain constant into the future. Uncertainty about the extent or quality of resource stocks is dealt with by choosing conservative stock estimates as the basis for valuation.[12]

Another type of risk, the risk that price inflation will erode the relative value of future returns, is also excluded from the discount rate used. Excluding inflation from the discount rate by using a real (or inflation adjusted) discount rate is consistent with the assumption that recent average prices and costs will remain constant into the future.

Valuation for national balance sheet accounts

As mentioned earlier, a principal function of the SEEA asset accounts is to provide estimates of resource asset stock values for inclusion in national balance sheet accounts. Although the SEEA asset accounts present a range of values for subsoil and timber assets, a single value is chosen for inclusion on balance sheet accounts so that only one estimate of national wealth is presented there.

The 1993 SNA's recommended method of valuing natural resource assets for inclusion in balance sheet accounts is based on a present value calculation. Thus, the present value

[12]The physical stock estimates on which the subsoil asset values are based can be considered conservative since only reserves with a high probability of existence are measured. Similarly, valuation of timber asset stocks is based on harvest volumes set by provincial forest managers; these volumes are determined by considering probable future growth and natural loss and, therefore, can be considered reasonable estimates of the sustainable harvest level.

methods presented in Text Box 1 are used as the basis for estimating the values of timber and subsoil asset stocks that are entered in balance sheet accounts. In the case of biological assets, present value II (Eq. 8) is used as the basis for the balance sheet valuation. This calculation assumes no return to capital in the estimation of biological resource rent, yielding an upper bound on the value of these assets. Only one present value calculation is done for subsoil assets (Eq. 6); like present value II for timber assets, the present value calculation for subsoil assets assumes no return to capital in estimating subsoil asset rent.

Relation between changes in assets and economic aggregates

The changes in value that result from other changes in asset accounts although they modify the net worth of institutional sectors and the national economy, cannot be related with the current and capital accounts, and in particular the production account and the use of income account. However some of these other changes flows are directly linked with economic activities.

This is in particular the case for depletion, changes in economic uses and the degradation of economic assets due to economic activities (decrease of the productivity of land due to erosion, etc.).

Need for a modification of the way these changes are recorded in SNA in order to account comprehensively for the impact of economic activities.

3.4 SEEA asset accounts

3.4.1 Physical accounts

The SEEA extends the 1993 SNA asset boundaries to include as economic assets environmental assets, such as virgin forests, stocks of water, wild biota (fauna and flora) etc. in so far as their state is influenced by economic activities and as they contribute to production or welfare.

Environmental assets may be described in physical quantities using units such as ha, tons, cubic meters. Physical accounts may also be compiled by quality classes. For example, forest, measured in ha. or cubic meters may be subdivided on the basis of cover species, ownership, management regimes, naturalness, degrees of defoliation etc.

Changes in assets

Changes in the stock of economic assets are brought about by changes due to direct use, economic decisions and natural causes. The physical accounts do not have a direct counterpart in the monetary accounts. Table 1, presented the asset accounts in the 1993 SNA in monetary terms. Categories such as land improvement, acquisition less disposal of assets, revaluation, are characteristic of monetary accounts. One item, which is very important in the

SEEA, is the depletion of natural assets. Depletion costs are, in the SEEA, moved from other changes in asset accounts into the production accounts and deducted from the value added of the causing industry. In the 1993 SNA, depletion is defined as the reduction in value of natural stock assets (e.g. subsoil assets, natural forests, fish stocks in open seas and other non-cultivated biological resources) as a result of the physical removal and using-up of the asset. In the SEEA, depletion is defined on the basis of the physical characteristic of the asset. For non-renewable resources is the quantity of the resource extracted. For renewable resources, it is the part of harvest, which exceeds the sustainable yield.

For environmental assets changes are recorded only when they are due to economic decisions and if they affect the capacity of environmental assets to provide their "free services". For example in the case of water, accounts are developed if there are activities of water abstraction and if the services to production and consumption provided by the water bodies are threatened or actually diminished.

In the description of changes in assets one should distinguish between changes in the quantity of the asset, without changes in classification and changes in classification (changes in quality).

Opening stocks

Changes in quantity

+ gross capital formation, including entry in inventories (natural growth of cultivated assets)
- withdrawals from stocks of non produced assets due to economic use (extraction of minerals, withdrawals of water, felling of trees, gathering, fishing and hunting of biota)
+ natural growth (non produced biota)
+/- other changes in quantity (reassessment of stocks, inc. discoveries)
- changes in stocks due to political events or catastrophic technological or natural events

Changes in quality/classification

+/- changes in economic use/status
+/- changes in quality due to environmental degradation (erosion/discharge of residuals)
- changes in quality due to catastrophic technological or natural events

Closing stocks

Some of the flows are directly related to economic activities: withdrawals from stocks, production of biota. They constitute the main entry for physical input-output tables for raw materials (see chapter 3).

For environmental assets, it is often necessary, in order to have a full picture to develop specific supplementary physical accounts. These accounts should mainly focus on the qualitative aspects of assets, e.g. the health status of forests, the quality of water bodies.

For water which is mainly considered in 1993 SNA as a non economic asset, and therefore not described in balance sheets, these accounts may go far beyond the description of water stocks and flows in cubic meter. They may for example integrate the functioning of hydro-systems, the economic availability and quality of water, etc.

Ecosystems would also be described in supplementary accounts. They would be classified according to their stability, their assimilation capacity, their fragmentation, etc.

Degradation of ecosystems and hydro-systems, including land and soils, caused by pollution, should be analyzed by establishing links with emission accounts, and more generally with material flow accounting discussed n Chapter 3.

3.4.2 Monetary accounts

[STILL A ROUGH DRAFT - DISCUSSION ON TREATMENT OF DEPLETION, DISCOVERIES AND OTHER CHANGES IN VOLUME TO BE INCLUDED]

For economic assets (either produced or non produced), the SNA provides the basis for the monetary assets accounts (valuation of stocks and transactions or flows). However whereas SNA balance sheets put the focus on the cross classification of changes in assets by institutional sectors, monetary assets accounts in a environmental perspective put the focus on the cross classification of the changes in assets by category of assets, a link being established with the use of the assets by industries, disregarding institutional sectors[13]

For economic assets, the general structure of monetary accounts is similar to the SNA presentation (see above). However, a reclassification of some flows to transactions can occur (e.g. the value of the extracted non-produced asset may be reclassified as a "cost" for the extracting activity …and - partially or in totality as a withdrawal from inventory/consumption of fixed capital for the "owner" …). Discussion of the different alternatives to be continued in various fora.

Some specific categories of economic - produced - assets - are worth to be specified, as they relate either to environmental protection or to the management of non-produced assets:

- Gross fixed capital formation in man made fixed assets for environmental protection (landfills, waste water treatment plants, sewage systems, etc.)
- Cleaning of contaminated land is also important to identify as a separate item (as a "of which" position of land improvement and, when relevant, as a change from non economic to economic).

[13] A presentation of flows and stocks, cross classifying assets and institutional sectors should also be considered.

– Capital formation for sub-soil assets and water exploration (and/or extraction), as well as capital formation for forestry and logging, aquaculture and fisheries, etc.

For environmental assets, which in general do not receive a monetary value, monetary accounts records only the monetary value of the increase or decrease of their capacity to provide "free" productive or consumer services (see Chapter 5 : valuation of degradation), according to the classification of the changes.

Environmental assets (only changes in the environmental quality are recorded)

Opening stock (no value for opening stocks)

+/- changes due to changes in land use/status
- changes due to pollution and/or other impacts of economic activities
+/- changes due to other economic decisions (protection ?)
- changes due to catastrophic natural or technological events
+/- changes due to changes in prices, interest and discount rates

Closing stocks (no value for closing stocks)

Relation between changes in assets and economic aggregates in SEEA

As has been said, there is a need for a modification of the way changes like depletion, changes in economic uses and the degradation of economic assets due to economic activities (decrease of the productivity of land due to erosion, etc.) are recorded.

There is no consensus as concerns the way these changes should be introduced within the production account[14] and subsequent sequence of accounts, and which should be the consequences on main economic aggregates.

[14] Even the need for a modification of the present SNA treatment is controversial

Annex I:

Physical and monetary accounts

	Economic assets						Environmental assets						
	Produced		non produced										
	Man made	Biota	Wild biota	Subsoil assets	Land	Water	Wild biota	Subsoil assets	Land	Water	Eco-systems	Soil	Air
Opening stocks													
Transactions													
Gross fixed capital formation													
of which land improvement/decontamination													
Consumption of fixed capital													
Changes in inventories													
of which work in progress on cultivated assets													
Changes in non produced assets due to:													
Direct economic use													
Withdrawals from stocks/depletion													
Soil erosion													
Changes in quality due to (change in) economic use													
Economic decisions													
Reassessment													
Transfers to economic assets													
Changes in quality (environmental degradation)													
Changes in classification													
Natural growth													
Changes in status													
Natural causes													
Changes due to political and catastrophic events													
Changes in prices													
Revaluation													
Closing stocks													

Monetary

Monetary and physical

4. SELECTED RESOURCES ACCOUNTS

4.1 Sub-soil Assets

1. Types of sub-soil assets

The following list of subsoil assets is drawn from the SNA, the annex to chapter XIII:

Subsoil assets:

Coal, oil and natural gas reserves	(in present SEEA: Fossil subsoil assets)
Metallic mineral reserves	(e.g.: copper, cobalt..)
Non-metallic mineral reserves	(e.g.: gravel and sand, limestone..)

Subsoil assets are non-renewable and non-produced assets. They have many possible uses in the economy. Different subsoil assets may present very different physical characteristics. In most cases, it is difficult to calculate aggregate measures of physical stocks of sub-soil assets. For this reason, it may be necessary to use a detailed product list to present physical stocks. A draft product list is included in the Annex at the end of this section.

2. Physical accounts for subsoil assets

Units of measurement for physical data

The measurement units used in physical asset accounts must be the same as the ones used in physical flow accounts, which are discussed in details in Chapter 3. The physical unit most commonly used is metric tonnes, however other volume measures are also common for measuring natural gas and crude oil. Conversion factors that link the various physical units are reported in the publications of International Energy Agency (IEA 1999 a, b and c), and should be made available along with the physical units.

For fossil assets, conversion to energy content may offer a possibility of aggregation in the context of accounts of energy supply and use. Data could be converted to Joules or to tonnes of oil equivalents and this is usually done, for presentation purposes, for example in the publications of IEA (IEA, 1999 a,b,c). The energy content of the energy subsoil assets varies according to the physical characteristics of the assets. The IEA publications report country specific data on average energy contents of different energy products.

For metals, physical resources could be measured in tonnes of metal contents.

Categories of reserves and uncertainty of stock estimates

In general, there is much uncertainty about the stocks of subsoil assets. Both the physical sizes of the deposits, as well as the profitability of the exploitation is uncertain. According to the expected proportion of geologically available reserves that can be recovered, the deposits can be classified as proven, probable, possible and potential / undiscovered. According to the 1993 SNA, only proven reserves are to be valued in the asset accounts. While there is general acceptance of the principle that the resources should be classified according to the probability that they can be recovered, the concepts used for this classification differ from country to country. The terms used here are drawn from Eurostat (1999).

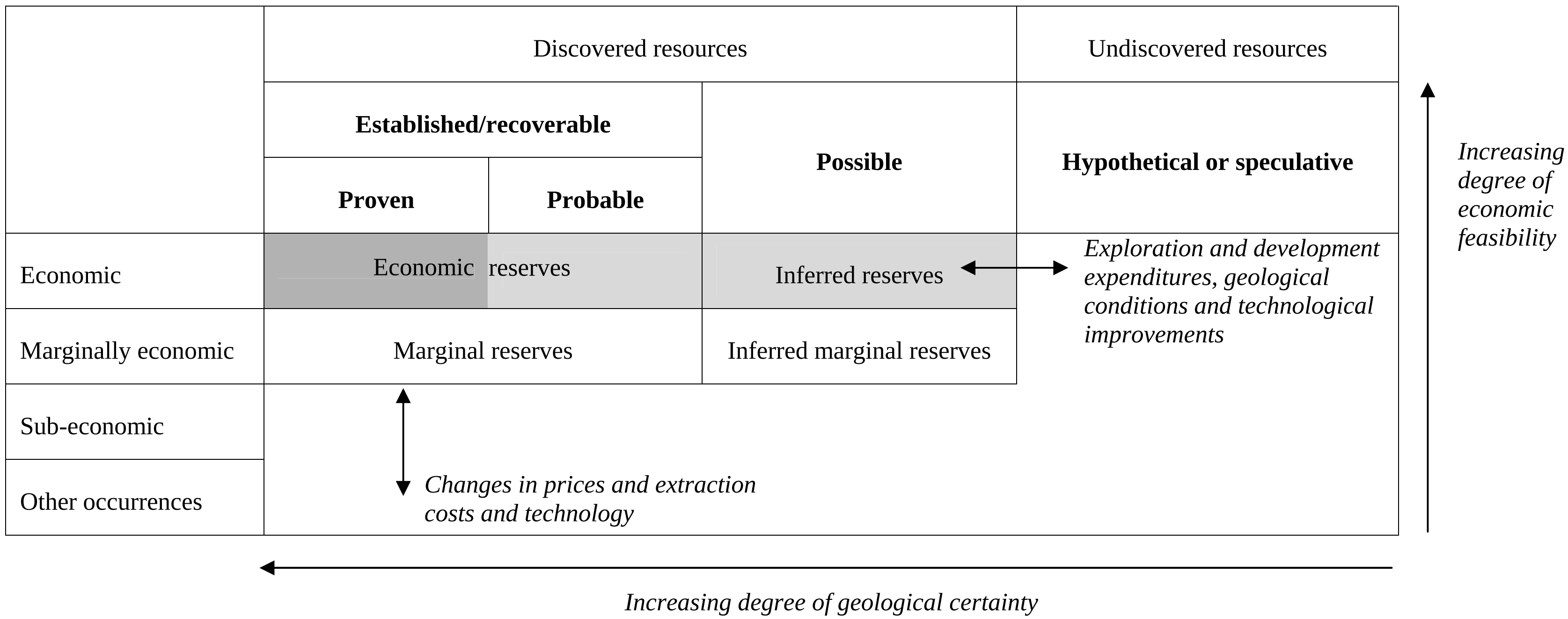
The McKelvey Box illustrates the classification of the resources. The dark grey area is the one that should be used for compiling asset accounts according to 1993 SNA. The light shaded area is suggested for compiling asset accounts in the SEEA.

The terms proven, probable and possible are applied to each deposit/field. For each field, available evidence is used to assess the chances that the field is technically and economically exploitable. Proven reserves are those which are virtually certain to be technically and economically exploitable, i.e. having a better than 90 per cent chance of being exploited (Department of trade and industry (1999)). Probable reserves are those which are not yet proven, but which are estimated to have a better than 50 per cent chance of being technically and economically exploitable. Possible reserves are those, which at present cannot be regarded as ‘probable’ but are estimated to have a significant but less than 50 percent chance of being exploitable.

It follows that the expected quantities of the resources that are technically and economically exploitable are larger than the proven resources. In order to present the best available estimate of the expected size of the stocks, given the present state of technology and economic conditions, it is necessary to include not only the proven, but also other categories of reserves not included in the 1993 SNA.

In the SEEA, deposits/fields, which are not proven should be weighted according to the probability of being technically and economically exploitable, before being added to the reserves. The resulting resource provides a better estimate of the expected exploitable quantities. Sometimes, data for the reserves, already weighted by the probability of being exploitable, are ready available. Alternatively, weights have to be determined on the basis of the categorization of the reserves used. Weights that have been used in the calculation of the resource are 0,5 for the probable reserves and 0,1 for the possible reserves (Eurostat 1999).

MCKELVEY BOX



Changes in the physical stocks of subsoil assets

Changes in the stock during the accounting period, include:

- **Extraction –** Since subsoil assets are non-renewable resources, the quantities extracted are a physical measure of the depletion of the asset.
- **Other volume changes –** It includes reclassification of the assets and discoveries. Discoveries only enter into the asset accounts if the probability that they are technically and economically producible is sufficiently high. Developments in technology may cause reclassification of previously unrecoverable deposits/fields. Changes in prices and costs of extraction may also cause a reclassification of the physical reserves, making previously sub-economic reserves economic (or vice versa). Reclassification of deposits/fields into the category proven resources usually is the result of production activities (exploration activities).

Lifetime of subsoil assets

The lifetime of a subsoil asset is uncertain because of the uncertainty of the size of the physical reserves as well as of future extraction. A simple measure of the lifetime can be calculated by dividing the stock at the end of the accounting period by the extraction during the period. The closing stock of the reserves should be used as it incorporates all information on the flows, e.g. extraction and other volume changes (reclassifications, discoveries) during the accounting period. If the calculation of lifetime is limited to proven reserves, it may be possible to find projections of future reclassifications of the reserves into proven. If it can be expected that the reclassifications into proven reserves remains constant in the future, the lifetime of the reserve can be better approximated by dividing the reserves by the extraction minus reclassification.

3. Valuation and monetary accounts

Monetary valuation allows for easier aggregation over products than physical accounts. Depending on the methods of valuation and data sources, it may be necessary to have monetary accounts, which are more aggregated than the physical accounts.

Subsoil assets may be valued using direct or indirect valuation methods. Direct valuation is based on the payment for the rights of extraction. Direct valuation methods usually underestimate the value of the assets and indirect methods are commonly used. Net present value and its simplifications are discussed in Section 2.3.

The present value assessment depends in principle on future prices and costs. If forecasts of prices and costs are not available, as it is often the case, the most common assumption is that's prices and costs would remain constant. In some cases, however the following information on prices and costs is readily available and should be taken into consideration:

- plans for the time profile of extraction;

- if net prices of past years show large fluctuation, then the present value should be calculated on basis of some average for a reference period;

- if cost differences between different resource categories are known, this should be taken into account, assuming that the most profitable resources are utilised first. If no such information is available, however, the valuation of the asset should be similar for all categories, given the expected physical quantities of the asset that are present.

Data needed for the calculation of net present value are by establishment and not by commodity, as would be relevant for subsoil assets. Complications may arise in the following two circumstances:

- the establishments (or the relevant industry group in the national accounts) produce several different subsoil assets and/or other products in addition to the subsoil products. It may be difficult to identify the unit costs of extraction by asset, as the same capital and labour may be used for the extraction of one or more mineral; and

- there are integrated production processes, such as extraction/refining or mining/raw metal processing. In this case, it is difficult to identify separately the extraction costs from all the other costs.

In the first case, one possible solution is to split costs among the various products (1993 SNA, para 15.4). An example of this approach is reported for instance in ABS 1995, section 3.8. If no information on how to associate the inputs with specific outputs is available, the 1993 SNA suggests two possible types of assumptions. One may assume that all products produced by an industry are produced using the same input structure (industry technology). Alternatively, one may assume that at all products in the same product group have the same input structures, whichever industry produces them (product technology).

In case of integrated production processes, the extraction activity is likely to be treated as ancillary activity. In this case, the value of the extracted products used internally is a not a part of the reported value of production. The costs for the extraction activities are included in the total cost of the enterprise, but the part of the total cost that is related to the extraction is not separately specified. If detailed data is available from the enterprise, it may be possible to assess incomes and costs associated with the extraction activity. Alternatively, it may be necessary to impute the resource rent from the combined activities of the enterprise, assuming that all profits above the ‘normal’ return to capital are due to the use of the subsoil assets.

Changes in the value of stocks of subsoil assets do not have a direct correspondence with changes in physical quantities. Changes in the values are calculated as changes of net present values. If discoveries are extracted at the end of the lifetime of the present resources, discounted incomes from this extraction could be considerably less that the physical volume of the discoveries, valued at present (net) unit prices. Moreover, depletion is not simply the value of the physical extraction, but it is reduced as time passes, subjecting the incomes from the remaining reserves to less severe discounting as they come closer to the time of extraction.

Monetary asset accounts contain an element that is not present in the physical accounts, revaluation. Revaluation is a consequence of changes in prices/extraction costs. It may be very large for subsoil assets as prices of subsoil assets are subject to large fluctuations.

Changes in the value of the asset caused by extraction are in SEEA considered to be a cost of production (consumption of natural capital), to be treated in the same way as consumption of fixed capital.

4. Asset accounts for institutional units

Physical stocks are compiled for the owner of the asset. For monetary accounts, it is suggested to split the resource wealth between owner and extractor, even when the extractor is not regarded as the formal owner of the resource. The extractor has the right to the income from the extraction, which may take the form of wealth in the absence of physical ownership of the resource. The owner's wealth is based on the present value of the income received in the form of royalties, specific taxes etc., in addition to the incomes coming from own-account extraction. The extractor would record in his balance sheet the rest of the national asset wealth.

5. Links to other industries

Asset accounts describe stocks and changes therein. Some of the changes are flows of products into the economy. They are described in details in Chapter 3. Flow accounts that are relevant when describing subsoil assets are the production account for the extractors (mining industry, oil extraction industry), and the accounts recording the use of the extracted commodities.

Crude oil is the product of the extracting industry and is used for exports or in refineries. The product 'crude oil' is in fact different from the petroleum products used for heating, as petrol, etc. Describing supply and use of crude oil is therefore more limited than describing the supply and use of petroleum energy products. Similarly, the output of metal mining activities should be described at metal ores, which in turn are inputs to the industry producing raw metal or exports.

Exploration costs to discover new resources and prove existing ones are costly. Exploration activities are production activities in their own right, producing exploration services, which are then used by the extractors /owner of the resource for gross fixed capital formation in intangible fixed assets (1993 SNA, para10.90).

The reclassification of deposits from 'sub-SNA' categories into proven resources is usually the result of exploration activities. Some countries interpret proven resources as the result of production of the exploration activity. The position of 1993 SNA (para. 12.14) is that changes in proven reserves of subsoil assets are examples of economic appearance of non-produced assets and hence are not created by processes of production. Exploration activities do not produce the asset itself, but more information on it.

6. Data sources for subsoil assets

Possible primary data sources for the compilation of subsoil assets are government agencies or private enterprises in the oil extracting or mining industry. Usually, management of subsoil assets is the responsibility of a specialised government institution, which is also responsible for collecting statistics of physical resources by type and category. Private enterprises may, in some cases, record the value of their extraction rights in their balance sheets. In general, they supply the data used for the calculation of indirect valuation methods. National accounts are a secondary source of information that often can be used for indirect valuation of the assets.

ANNEX 1: A LIST OF SUB-SOIL ASSETS

The following list proposes a four-level classification of subsoil assets. The categories should be adapted to national needs.

The classification levels are constructed in the following way:

- 1st level: The first level is found in annex 5 to SNA under list D: Classification of assets; Tangible Non-produced assets category AN.212, the group 'subsoil assets'.

- 2nd level: This level may be found in the Annexe D to the present SEEA.

- 3rd level: This is the (4-digit) relevant part of the CPA product classification. The CPA is used in the European union for implementing their SNA version (ESA95) (with the exception for the classification of Natural Gas Liquids).

- 4th level: For metals the classification is the one used in UN Environment Programme: Environmental Data report 1993-94, figure 7.2.

The definitions are supported by reference to the HS (Harmonised system) classifications, in order to give as detailed description as possible.

1. Fossil subsoil assets

1.1	*Coal and lignite, peat*		
	1.1.1	Hard coal	HS 2701.1, 2701.2
	1.1.2	Lignite	HS 2702
	1.1.3	Peat	HS 2703
1.2	*Crude petroleum and Natural Gas Liquids*		
	1.2.1	Petroleum oils and oils from bituminous minerals, crude	HS 2709
	1.2.2	Natural gas liquids	HS 2711.11
	1.2.3	Bituminous or oil shale and tar sands	HS 2714.1
1.3	*Natural gas*		
	1.3.1	Natural gas, in gaseous state	HS 2711.21

Note: In the CPA classification, natural gas and natural gas liquids are grouped together. It is usual, however, to group natural gas liquids together with crude petroleum at an aggregate level. This is done in the UNEP Environmental data report and in the OECD Environmental data compendium (for instance in table 8.1b of the 1997 edition). 'Solids' in UNEP Environmental data report 1993-94 includes hard coal, lignite, peat and oil shale (1.1 + 1.2.3), 'Liquids' include Crude petroleum and Natural gas liquids (1.2.1, 1.2.2), 'Gas' is natural gas (1.3).

2. Metal and other ores

2.1 Uranium and thorium ores

	2.1.1	Uranium and thorium ores	HS 2612
2.2	*Metal ores*		
	2.2.1	Iron ores	HS 2601.1
	2.2.2	Non-ferrous metal ores other than uranium and thorium ores	
		2.2.2.1 Copper ore and concentrates	HS 2603
		2.2.2.2 Nickel ore and conc.	HS 2604
		2.2.2.3 Aluminium ore and conc.	HS 2606
		2.2.2.4 Precious metal ores and conc.	HS 2616
		2.2.2.5 Lead ores and conc.	HS 2607
		2.2.2.6 Tin ores and conc.	HS 2609
		2.2.2.7 Zinc ores and conc.	HS 2608
		2.2.2.8 Manganese ores and conc.	HS 2602
		2.2.2.9 Chromium ores and conc.	HS 2610
		2.2.2.10 Cobalt ores and conc.	HS 2605
		2.2.2.11 Molybdenum ores and conc.	HS 2613
		2.2.2.12 Tungsten ores and conc.	HS 2611
		2.2.2.13 Vanadium ores and conc.	HS 2615.909 (Eurostat version of HS)
		2.2.2.14 Titanium ores and conc.	HS 2614
		2.2.2.15 Lithium	(not explicitly referenced)
		2.2.2.16 Other ores and conc.	HS 2615, 2617 except 2615.909 and Lithium

Note: It could be desirable to split the group 'precious metals'. On the most detailed level, the CPA aggregates 2.2.2.5-2.2.2.7 and 2.2.2.8-2.2.2.16.

3. Non-metallic mineral reserves

3.1	*Stone, sand and clay*		
	3.1.1	Stone for construction	HS 2515, 2516
	3.1.2	Limestone, gypsum and chalk	HS 2509, 2518, 2520.1, 2521
	3.1.3	Slate	HS 2514
	3.1.4	Gravel and sand	HS 2505, 2517
	3.1.5	Clays and kaolin	HS 2507, 2508
3.2	*Other minerals*		
	3.2.1	Chemical and fertiliser minerals	HS 2502, 2503.001, 2510, 3104.1, 2511, 2527, 2528, 2529.2, 2530.2-2530.9
	3.2.2	Salt	HS 2501
	3.2.3	Other mining and quarrying products, n.e.c	HS 2714.9, 7102.1, 7102.31, 7103.1, 2513, 7102.21, 2504, 2506, 2512, 2519, 2524, 2525, 2526, 2529.1, 2529.3, 2530.1, 2621

Note: It could be desirable to have a fourth level of classification also for the non-metallic minerals, for instance the one used by The US Bureau of Mines (see their Internet address *http://minerals.er.usgs.gov/minerals/pubd/mcs/1997/). No natural aggregation is available for these physical values.*

4.2 Forest accounts

1. Introduction

This section describes asset accounts for forest and forestland. It covers accounts dealing with quantitative and qualitative aspects of the forest. Quantitative aspects include stocks of forestland and standing timber and changes therein. Qualitative aspects related to timber and non-wood products and services refer to ecozones, structure, biodiversity, carbon-binding and protection status of forests and changes therein.

Quantitative aspects are directly connected to the 1993 SNA categories of economic produced and non-produced assets defined in 2.1. The following entities are already included in the 1993 SNA balance sheets:

- forestland and other wooded land;
- forestland used for recreational purposes (e.g. natural parks, etc.)**;**
- cultivated forests, semi-natural managed forests, plantations;
- natural forests available for wood production.

Forests are classified to be economic assets. This is obvious for forests available for wood supply, but even forests non-available for wood production can provide economic benefits other than timber production, e.g. non-wood products and services which have economic value. Non-wood products and services are also provided by forests available for wood supply, often contemporaneously with timber.

A distinction between forests mainly used for economic activities and forests whose major function is provider of environmental services is not always very clear (Note 0.1). For SNA purposes forests available for wood supply can be classified as economic forests, and strictly protected forests and forests under economic restrictions as non-economic forests, if economic activities refer mainly to availability and actual measures for wood supply.

Forestland is non-produced asset, although the forestland can also be classified according to timber on it. Timber in natural forests is purely non-produced assets, and plantations are very close to produced assets. Timber in semi-natural managed forests can be seen as a mixture of non-produced and produced assets.

Only plantations should be included into produced assets. Still, the division of timber into natural, semi-natural and plantations in physical quantitative accounts allows the option chosen in the SNA to treat timber in both semi-natural forests and plantations as produced asset.

Stocks and flows of quantitative aspects of forests are also presented as monetary accounts. Monetary timber accounts cover only timber in forests available for wood supply, including both produced and non-produced assets which are treated differently in the SNA. Non-wood products cover all forests, since the volume and value of those products may be considerable in forests both available and non-available for wood supply

Quantitative and qualitative aspects are to some extent combined in physical accounts. Some aspects like area of predominant tree species, timber volumes of tree species and age structure of timber are both quantitative and qualitative. Protection status of forestland have a strong qualitative dimension usually reflecting high level of naturalness of forestland, and quantitative dimension is related to availability/non-availability of forests for wood supply. In addition to these, timber and non-wood products and services provided by forests often rely on ecofloristic zones, introduced tree species and mono-cultures, biodiversity, forest health, and carbon binding.

2. Physical quantitative accounts

Physical accounts of forest include accounts for forest area, timber and non-wood forest products.

2.1 Land

Forest area can be classified according to the following characteristics of the forest. A draft classification, based on CNFA is reported in Annex I to this section.

- forestland and other wooded area
- availability/non-availability for wood supply
- cover by predominant tree species
- natural/cultivated forests and authenticity/naturalness of forests

Changes in forestland may be brought about by:
- total decrease and increase in forestland
- changes in land classification and reassessment of stocks

Forestland and other wooded areas

- **Forestland** is defined as land under natural or planted stands of trees with tree crown cover of more than 10 percent and area of more than 0,5 hectares. The trees should be able to reach a minimum height of 5 m at maturity.
  Primary use of forestland is forestry, which includes activities related to the management of forest and other wooded land for the production and supply of wood and/or other goods and services of forest and other wooded land. The definition of forestry differs from that used in ISIC -classification, in which forestry is restricted to timber production and related activities.

- **Other wooded land** is defined as land that serves some of the purposes of forestry with crown cover of either 5-10 percent of trees able to reach a height at least 5 m at maturity or of more than 20 percent of trees not able to reach a height of 5 m at maturity or with shrub or bush (woody perennial plants of generally 0,5-5 m in height and without a definite crown) cover of more than 20 percent.

Forestland does not include forest and other wooded land areas of less than 0,5 hectares; with stocking level (equivalent to crown cover) below 5 percent; with trees not able to reach height of 5 m at maturity, in areas where stocking level is less than 20 percent; scattered trees in permanent meadows and pastures; permanent tree crops; trees in parks, gardens, around buildings and in lines along streets, roads, rivers, canals etc., and trees in shelterbeds of less than 20 m width and 0,5 hectares area.

Availability for wood supply

Forestland is further sub-divided according to its availability for wood supply, as follows:

- **Forestland available for wood supply** includes areas where legal, economic, or environmental restrictions do not have a significant impact on wood (including cork) supply. Areas where harvesting of timber is not taking place because of long term utilisation plans or intentions, are included into available for wood production -class.

- **Forestland not available for wood supply** includes areas where legal, economic, or environmental restrictions have a significant impact on wood production. Legal and/or environmental restrictions refer to protection for environmental and biodiversity conservation and other protection for special environmental, scientific, historical, cultural or spiritual interest. Economic restrictions appear in areas where physical productivity or wood quality is too low or harvesting and transport costs are too high for warrant wood harvesting, apart from occasional cuttings for own consumption.

Forestland not available for wood production can be further sub-divided into:

- strictly protected (IUCN classes I and II)
- forestland under economic restrictions

This disaggregation is useful, since changes in economic restrictions may occur e.g. by increasing market prices, improved technology, and new human settlements and road networks entering areas previously isolated.

Natural/cultivated forests and authenticity/naturalness of forest

Forestland can be further sub-divided according to the authenticity/naturalness of the forest. Such characteristics are very closely related to the definition of cultivated and natural assets, described in 2.2. As discussed in section 3, this distinction is very important as it has an impact in the calculation of production of the forest industry. The 1993 SNA in fact treats natural growth of cultivated assets as a process of production, and hence it is accounted for as output of the forest industry. Natural growth of non-managed forest is, instead, a natural process and therefore not included in the production accounts. Since forest statistics in general collects data on forest area, and timber volume is calculated on the basis of average timber volume per hectare, it is important to classify the forest area according to whether the forest is natural, semi-natural or plantations. The following is the FAO classification of forest:

- **Natural forests -** forests with natural species and ecological processes and for which there has been continuity of ecological processes over a very long period of time (e.g. 250 years);

- **Semi-natural managed forests**: management has substantially altered the structure and ecological processes of the forests;

- **Plantations**: forests for intensive fuel or industrial wood production, planted or artificially regenerated and made up of exotic (non-indigenous) species and/or mono-cultures.

Although the definitions in the 1993 SNA and FAO are a result of different considerations, natural forests in the FAO classification are very close to natural forests in SNA. Timber in semi-natural forests and plantations can be considered as cultivated according to the 1993 SNA definition. Natural and cultivated-dimensions are mixed in semi-natural forests, since management does not necessarily substantially alter the ecological processes or end the continuity of those processes of the forests. The time period of continuity of more than 200 years for natural forests may not be very relevant for all types of forests.

Cover by species

Forestland can also be classified on the basis of predominant tree species:

- **Coniferous**, (botanically as *Gymnospermae)*
- **broadleaved** (*Angiospermae*)
- **bamboo, palms etc**. (*Gramineae etc.*)

Forests are forestland, on which more than 75 percent of the tree crown cover consists of mentioned tree species. In **mixed forests** neither of the species groups account for more than 75 percent of the tree crown area.

Changes in forest land

Total decrease in forestland consists of:

- complete loss of tree cover and transfer of forestland to other uses than forestry (agricultural land, land under construction of houses, roads etc.) or to no identifiable uses. It is usually a result from man-made deforestation;
- degradation of the forest to a point where tree cover falls below 10 percent and the land thus becomes classified as other wooded land. Degradation may appear for natural reasons, for man-made reasons or for a mixture of them.

Total removals of standing timber by fellings are not decreases in forestland, if the use of the does not change after the fellings.

Total increase in forestland consists of:

- establishment of new forest on land which is previously not classified as forestland, as a result of silvicultural measures or natural extension;

- up-grading of other wooded land as a result of silvicultural measures or natural restoration, including restoration after shifting cultivation.

Total increase in forestland can also be classified as man-made afforestation (silvicultural measures including planting and seeding) including plantations, and natural extension resulting from natural seeding, sprouting, suckering or layering. Forest renewal by natural or silvicultural measures after clear cutting does not qualify as increase in forestland.

Changes in classification due to economic decisions. These decisions include decision to protect, or to cancel protection of forestland and changes in economic conditions and in infrastructure with respect to forestland under economic restrictions for wood supply.

Reassessment of the stock due to improved knowledge include discoveries of new resources, and adjustments of area and volume due to new data and estimation methods.

Catastrophic events (fires, tempests, avalanches etc) affect volumes of standing timber in forestland, although they do not necessarily decrease the forestland area. Areas where fires and catastrophic events decrease the crown cover below the level defined in forestland should be separately identified.

Changes in forestland can also be divided into elements based on economic decisions and natural causes. Changes due to economic decisions consist of afforestation and deforestation, degradation, re-assessment of the stock and changes in classifications. Changes due to natural causes refer to natural extension, degradation and natural catastrophic events.

Preliminary tables (in Annex to this section)
1. Forestland; area 1000 hectares
1b. Forestland available for wood supply; area 1000 ha

Timber

Timber volumes are linked to land accounts, material flow accounts, physical input-output tables and monetary accounts. They can be classified according to the following characteristics:

- availability / non-availability for wood supply
- main groups of tree species

Changes in stocks are brought about by:

- growth and fellings of standing timber
- harvested timber for own consumption and markets
- catastrophic losses
- changes in classification and reassessment of stocks

Timber in forests available for wood supply is divided into natural, semi-natural and plantations. Produced timber available for wood supply include timber in plantations. Non-produced timber includes timber in natural and semi-natural forests. Only timber in forests available for wood supply enters the monetary balances of produced and non-produced timber.

Timber in strictly protected forests and forests under economic restrictions for wood supply should be separated, since possibility for changes in economic restrictions may have effects on the availability for wood supply. It is assumed here, that only non-produced forests occur in strictly protected areas or in areas under economic restrictions (possible exception to this as in Note 0.2).

Timber in over-mature forests (of age higher than the length of rotation period) is a special case of semi-natural managed forests. It refers to possible division of semi-natural forests into regularly managed and non-regularly managed, which could allow the separation of semi-natural managed forests into more-or-less natural forests and forests under more-or-less intensive economic activities. Because the intensivity of economic activities is not directly included into SNA definition of economic assets, over-maturity should be described in physical qualitative accounts as one of age-class categories when basic data is available, and it should not be mixed to quantitative and monetary accounts.

If only timber in plantations is regarded as produced asset, there is no need to separate over-mature and other timber in semi-natural managed forests for physical quantitative and monetary accounts. In physical qualitative accounting the separation is useful, since in countries where pure natural forests are protected, separation of over-mature forests from other semi-natural forests may considerably reflect the naturalness -dimension of semi-natural forests. Anyway the separation faces some definition and data availability problems: in forest inventories and surveys over-mature forests are usually reported as area in hectares, if reported at all, and the distinction between natural forests and over-mature semi-natural forests is not very clear with respect to the data availability. (Note 0.1.)

Stock of standing timber includes above-ground stem volume over bark of living and dead standing trees, all tree species and all diameters down to a stated minimum diameter (7 cm).

Changes in stocks are due to growth of timber, fellings of timber, catastrophic natural events, changes in land classification and reassessment of stock. In physical accounts growth of timber is not divided into natural and man-made growth, although in the SNA the growth of produced timber (semi-natural and plantations -forests) and non-produced timber (natural forests) are treated differently. In monetary accounts only growth in plantations should be treated as man-made produced growth. Growth of trees in semi-natural forests is affected by human measures and inputs with varying intensity, but the growth is mainly dependent on, and a result of natural biological processes.

Growth is average volume of biological increment of standing timber over given period. It also includes ingrowth of small trees when they reach the minimum diameter. Growth is expressed as natural growth, which is increment less natural losses over given period. Natural losses are losses due to mortality from other causes than cutting by a man, e.g. disease, insects, windblow etc. Natural losses related to natural forest ecosystem dynamics should be separated from significant catastrophic events such as large forest fires, tempests, occasional large insect invasions, floods etc.

Fellings include stem volume over bark of all trees, living or dead, to a minimum diameter of 7 cm that are felled during a given period, whether they are removed from the forest or not. In FAO forest statistics fellings exclude felling residuals which are left in the forest and are not salvaged at the time of felling or later, and silvicultural and pre-commercial thinnings and cleanings of less than 7 cm of diameter, whether left in the forest or not.

In forest accounts felling residuals of more than 7 cm of diameter should be included into fellings, since they are of importance in calculating the balance of standing timber. Therefore total fellings consist of 1) felled timber removed from the forest for own consumption and markets as harvested timber, and 2) felled timber left in the forests, which includes felling residuals and other timber of more than 7 cm of diameter.

For material flow accounting and physical input-output tables harvested timber is to be separated from felled timber not removed from the forest. The volume of fellings which is removed from the forest should be in flow accounting and I-O tables further divided into saw logs, pulp wood and fuel wood by tree species or main group of tree species of most economic importance. When wood less than 7 cm of diameter from fellings, pre-commercial thinnings and cleanings have remarkable use as fuel, construction material etc., the amounts should be recorded in MFA and I-O tables.

Net growth is net increment less total fellings. Net growth in forest accounts refers to difference between increment and fellings, not to biological net growth or increment (growth or increment of trees less natural losses) as often expressed in forest statistics.
(Note 1.)

Sustainable yield of renewable natural resources is traditionally defined as extraction of the resource that doesn't exceed the growth. With respect to timber sustainable yield refers to fellings which are not higher than growth of timber during the accounting period (net growth is positive or zero). Sustainable yield as defined above refers to total fellings, and not only to harvested timber for own consumption and use. Sustainable yield can be expanded to the difference between opening and closing stocks. If closing stock is higher than opening stock or equal to opening stock, it refers to sustainable yield for the accounting period. It should be noted here, that even when the difference between opening and closing stock in physical accounts is positive or zero, a depletion of asset may occur in monetary units.

Standing timber, net growth and fellings, are divided into main tree species as conifers, broadleaves, and others (e.g. tree-form members of the bamboo). A separation should be made on economically most important tree species or groups of tree species. All volumes are to be expressed in solid cubic metres over bark. It should be noted that volume in solid cubic metres by tree species is not equal to area in hectares by dominant tree species -cover. In total -columns area and volume correspond each other, and volume per area (m3/ha) can be calculated.

Preliminary tables
2. Standing timber; volume 1000 solid cubic metres
2b. Standing timber available for wood supply; 1000 m3

Non-wood products (including cork) **of forests**

Non-wood products are linked to material flow accounts, physical input-output tables and monetary accounts by volumes for own consumption and markets. Value of non-wood products is presented in monetary accounts

<u>Non-wood products</u> for own consumption and industrial uses are aggregated as:
- food; game, berries, fruits, mushrooms, nuts, palm oil, honey etc.
- medicines
- fodder/forage for animal breeding
- industrial extracts; cork, rubber, gum, tar, chemicals
- forest-growing animals as agricultural products (wild boar, reindeer etc.)

Flows of non-wood products are expressed as extracted kilograms (cork as m3?) for own consumption and industrial use. If possible, a separation should be made between forests available and non-available for wood supply. Stocks and balances can be presented to products, for which data availability is sufficient.

Preliminary table
3. Non-wood products; volume kg, (m3)

3. Monetary accounts

Monetary accounts on forest assets link physical quantity aspects to monetary asset and flow accounts of SNA. Physical accounts can be expressed in monetary terms in cases where monetary data is available or reliable monetary valuation is possible to accomplish, including values of products and services which are not currently accounted in the SNA (non-SNA values).

Monetary accounts of forest assets consist of:
- Stocks and flows of standing timber
- Flows of non-wood products
- Expenditures on forest management
- Expenditures on forest conservation and protection

Physical accounts on volume of standing timber and non-wood products are directly reflected in monetary asset and flow accounts as physical quantities times current market prices or prices deduced from market prices. Value of harvested timber as production and expenditures on forest management are included into branch of forestry and logging in SNA flow accounts. Monetary flows on conservation and protection of forests and on non-wood services of forests are also included into SNA, but the forest-related part of them is seldom dissaggregated from parts related to other land or services. Current monetary expenditures on forest management, conservation and protection are also linked to forestland area concerned.

Principles for the valuation of economic assets according to SNA are presented in Chapter 5. Special cases in economic valuation of forest assets are:
- value of forestland
- value of stocks and flows of standing timber
- value of non-wood products

Land
The value of timber and pure land value should be separated, since the value of forestland is, in addition to timber stocks on it, strongly dependent on location, soil type, and availability and demand of land to other uses than forestry. Value of land related to forestry and logging uses is often based on soil type, standing timber and market prices of timber, and the value of land and value of timber are very integrated. It is not clear, whether the value of land and value of standing timber can be separated in monetary balances of forestland. Therefore it may be in many cases necessary to use the timber value to reflect the value of forestland used for forestry purposes.

Potential alternative uses of forestland may effect the value heavily, but in those cases timber values do not necessarily give very much information about the value of forestland in alternative uses to forestry. Exception would be cases, where losses of forestry-related economic benefits are the main factor in price determining processes of forestland concerned. When forestland is taken to other purposes then forestry, the timber and forestry -related values lost represent the minimum value of forestland.

Timber
Valuation of stocks and flows of standing timber is closely related to actual market prices of timber. Still a distinction in economic valuation has to be made between stocks, natural growth and felling, for the range of methods applicable differs for each of these elements. When closing stock is calculated as a sum of flows and opening stock, valuation methods used for elements of opening stock and flows should not strongly differ from each other.

For timber stocks net present value, consumption value method and stumpage value method are applicable, and transaction price method for combined value of land and standing timber. Net present value (NPV) is recommended in the SNA, but it requires substantial data inputs, and is very sensitive to assumptions on discount rates, future costs and prices, and the present and future structure of stocks and fellings. NPV also includes into values future benefits and costs, which may be lost in the near future due to possible conservation and other changes in forestland and timber.

Fellings (harvested timber) are valuated by applying stumpage prices, or road-side pick-up prices less logging and short-range transportation costs to physical quantities of felled timber. Value can also be deduced from export values (c.i.f) of roundwood, saw logs, pulp wood and -particles, wood residues and other industrial roundwood presented in FAO statistics on forest products.

For natural growth valuation is made by consumption value or stumpage value method, costs of forest management method, or by net present value method. When some part of annual natural growth is not recoverable e.g. for environmental reasons, a deduction from natural growth is made as non-recoverable increment.

In countries where felling are relatively close to growth, stumpage and consumption valuation methods are quite well applicable for both growth and fellings. These methods could also be used in valuation of stocks, which would make all elements of monetary balances consistent with each other.

Non-wood products

Value of non-wood products for own consumption and industrial uses are obtained from market prices. Collection and other acquisition costs are included in market values, as market values are determined at the point of selling the non-wood products.

Monetary tables

Timber balance (preliminary table 4.)

Monetary timber balance for forests available for wood supply consists of opening stock, flows, changes in classification and revaluation. Flows include natural growth, harvested timber, timber left in the forests and catastrophic losses. Revaluation records the change in value due to changes in prices of standing timber between the beginning and the end of the period. (Other definitions in physical quantitative accounts.)

Disaggregation of timber balance to natural, semi-natural and plantation forests is needed for SNA-purposes. In SNA natural growth and difference between opening and closing stock in cultivated forests, corresponding semi-natural and plantation forests, are treated as production and changes in inventories. In natural forests only harvested timber is accounted as production. However, as current practice of SNA in many countries only harvested timber is accounted as production in all forests (output based on controlled but not cultivated growth is recorded at the moment of harvest, according to 1993 SNA annex 1 paragraph 71).

Dissaggregation of monetary timber balances according to institutional or related sectors sectors (e.g. private, companies, state, others) is not always possible for all elements of balances. Dissaggregation is strongly dependent on basic data. Forestland area by ownership categories may often be available, but timber volumes, changes in them and actual market prices by same categories can only be derived from area and statistics on timber resources and forest products. With respect to data availability at least the main elements of monetary timber balances (opening stock, fellings, closing stock) should be presented, if necessary as estimates of shares of the totals, by private (including companies) and governmental ownership. Corresponding data on area and timber stock can be presented as complementary tables for relevant physical quantitative accounts.

Felled timber left in the forests as felling residuals or for economic reasons does not have any direct economic value. Nevertheless, it represents decrease from the opening stock of standing timber and should be in balances valuated by appropriate timber price lower than marketed timber.

It should be noted, that because of forest legislation and/or environmental and economic reasons total amount of natural growth is not available for utilization. If the value of this non-recoverable share is considerable, it clearly lowers the value of growth. This is also the case in forests, which are available for wood supply but protection (IUCN categories III-V) decrease felling potentials.

Output of forest-related products (preliminary table 5.)

Values of forest-related products reflect directly the physical quantities accounted for timber and non-wood products. Values of products are separated to own consumption and to branches of industries (ISIC, NACE) which use forests as a support for their activity.

Values of non-wood products should be comparable with values of timber. Only value of marketed and auto-consumed timber should be recorded in this table, but not the imputed value of net growth of timber. Market values of non-wood products occur only when they are collected and delivered to markets, and comparability of timber and non-wood values is not fully consistent, if the value of timber is calculated directly as stumpage prices times volumes of harvested timber, and thus not include acquisition (logging) costs.

Expenditures on forest management and protection (preliminary table 6.)

Expenditures on silviculture, forest improvement and logging activities in ISIC -branch forestry and logging are recorded in SNA. Costs of environmentally sound forestry and logging methods, which aim at e.g. improving biodiversity and multiple use of forests, should be separated from conventional forest management. Since they are strongly linked with forestry and logging activities, they should be recorded as a sub-category of expenditures on forestry and logging activities.

Expenditures on environmental protection defined are described on detailed level in Chapter 4. Expenditures on forest protection include forest conservation (protected forests according to IUCN categories), and costs of environmental protection activities such as prevention of forest degradation and pollution, and restoration and reparation of forests. Restoration and reparation cost of forests are often linked to forestry and logging activities, and they should be separated form cost of forestry and logging for pure wood production purposes. Actual expenditures can be expressed as investments and maintenance costs. Costs are divided by branches of industry in which they occur and also to public and private sector.

4. Physical qualitative accounts

Qualitative aspects of forests are linked to quantitative accounts, uses of forests, and with respect to data availability to emission accounts. Qualitative accounts are presented only in physical units. Main quality aspects are:

- ecofloristic zones
- authenticity/naturalness of forest (defined in quantitative aspects)
- protection status: protected (IUCN) / non-protected
- biodiversity and ecosystems to be dealt in land
- forest health
- age structure of forests
- introduced tree species and mono cultures
- carbon binding
- non-wood services

Basic data on qualitative aspects are mainly presented in national and FAO statistics on forests, environmental statistics and statistics made for UN Framework Convention on Climate Change.

The main division of <u>ecofloristic zones</u> is 1) tropical forests, 2) dry (Mediterranean-type) forests, 3) temperate forests, and 4) boreal forests. Since more than one or two main types of ecofloristic zones are not situated in a single country, national dissaggregation of one ecofloristic zone to subcategories can be done on the basis of information needs on ecological and forest quality, climate condition and geographical aspects.

<u>Tropical forests</u> can be subdivided into:
1a) rainforests; lowlands with pluvial regime (more than 2000 mm/year of rain)
1b) moist deciduous forests; lowlands with moist regime (1000-2000 mm/year of rain with a short, less than 3/4 month dry season)
1c) dry deciduous forests; lowlands with moist regime (1000-2000 mm/year of rain with a long , more than 6/7 month dry season)
1d) very dry deciduous forests; lowlands with tropical dry regime (500-1000 mm/year)
1e) desert zone; lowlands with less than 500 mm/year of rain
1f) hill and montane zone; forests within the altitude range of 1000-3000 metres
1g) other tropical and sub-tropical forests

<u>Dry (Mediterranean-type) forests</u> include forestland characterized by evergreen and clerophyllous tree species associated with dry, hot summers.
<u>Temperate forests</u> are forestland with predominantly broadleaved, mixed and on certain sites, e.g. higher elevations, coniferous tree species associated with mild or cool climate conditions and precipitation around the year.
<u>Boreal forests</u> include forestland in the northern latitudes with predominantly coniferous tree species associated wit harsh winter conditions and short growing season.

The proportion of <u>introduced tree species</u> of forestland area should be recorded in quality accounts as hectares or percentages of the forestland. Introduced tree species (also termed as non-indigenous or exotic species) are species occurring outside their natural biotope, area or region. Like introduced tree species, pure mono-cultures occur mainly in man-made plantations, and only occasionally in natural and semi-natural forests.

A division of forestland into protected / non-protected should be done on the basis of IUCN classification. In this classification two categories of five include total restrictions for the wood production use. Protection of forests in other classes do not always have significant impacts on wood production, and protection according to IUCN classification does not perfectly match to division of forestland available / not available for wood production.

Totally (strictly) protected areas are maintained in a natural state and are closed to extractive uses. These areas consist of scientific reserves and strict nature reserves (IUCN category I), national and provincial parks (II), and natural monuments and natural landmarks containing unique geological formations, special animals or plants, or unusual habitats (III). In cat. I public access to the area is limited, in cat. II access for recreation and study is allowed, and in cat. III areas may be managed for specific uses.

Some extractive use is allowed (not strictly protected areas) in categories IV and V. In category IV managed nature reserves and wildlife sanctuaries are protected for specific purposes (e.g. conservation of significant plant or animal species). Category V consists of protected landscapes and sea-scapes, which may be entirely natural or include cultural landscapes (e.g. agricultural areas).

Forests available for wood supply can be dissaggregated to not-protected and not strictly protected land and timber. Timber in not strictly protected forests available for wood supply is not usable for forestry and logging activities to the same extent than in not-protected forests, and this may have effects on monetary value of timber

It may in several cases be unclear, whether category III belongs to totally protected areas or to areas where some extractive use of timber is allowed. Category III should be included in not strictly protected areas, since the possibility of management for specific uses including applicable fellings and monetary output of timber exists.

In forest accounting biodiversity is focused on diversity of forest ecosystems and diversity of forest-occurring species. Some elements of biodiversity are included into accounting of qualitative aspects including ecofloristic zones, protection status, and authenticity/naturalness of forests. Biodiversity is also connected to tree species -proportions of total standing timber and of forestland area. In addition to these, number of forest-occurring endangered (a high risk of extinction in the near future) species of flora and fauna are biodiversity factors affecting to all forest types. The number of endangered species should, if possible with respect to data availability, be further dissaggregated to areas for predominant tree species, to ecofloristic zones, and to natural and semi-natural forests. (Note 2.)

Forest health is affected by natural and man-made factors and mixtures of them. Correlation of forest health to single factors, e.g. air pollutants, are only seldom very clear. Defoliation is the most used factor in describing the forest health. Defoliation is expressed as amount and/or proportion of defoliated trees (defoliation percentage of tree crown more than 25 percent).

Other symptoms of forest damage that reduce stand quality are e.g. amount and percentage of dead trees, fallen and broken trees, decayed trees, stem defects, top damage, dis-colouration and multiple symptoms. It should be noted, however, that amount and percentage of dead and decayed trees is also often seen as an element improving biodiversity.

Defoliation and other elements of forest health are applicable for forest area as hectares or percentages, but data on them is not directly transferable to volumes of standing timber. Defoliation data should be presented by authenticity/naturalness classes and by predominant tree species or groups of tree species.

Age structure of forests includes both quantitative and qualitative aspects of timber and forestland cover. Age structure is a difficult aspect to be expressed as timber volumes, and it is thus included into quality accounts. Age structure can be expressed as area of forest stands (stands consisting mainly on even-aged trees) by age classes, or for proportions of trees in different age classes. Age class -division used in accounting is dependent on variety of ages of trees (natural age up to x years) of different species, or rotation periods of stands of predominant species defined by natural and economic factors.

Over-maturity is a combination of biological and economic aspects (age of trees compared to average rotation period by tree species, soil productivity and climate conditions). Over-mature forests, which are defined as forests of age higher than the length of rotation period, can be recorded as natural forests, if no silvicultural and/or logging activities has been accomplished in those forests during previous 30 years. Age structure expressed as areas or proportions should be presented to semi-natural forests.

The amount of carbon or carbon bound into wood and tree biomass can be derived from volumes, growth and fellings of standing timber. (Average co-efficients for biomass by tree species from national sources, FAO and FCCC). Carbon binding is related to protection services concerning climate, under non-wood services of forests. Carbon balances should correspond to data provided to FCCC.

The emphasis is on above-ground stem wood biomass and other tree biomass. Biomass of trees is divided into above-ground biomass of stem wood (including bark) and other above-ground tree biomass (branches, leaves, needles etc.). Other above-ground biomass related to woody plants is the biomass of bushes, schrubs and twigs (including foliage). Carbon balances derived from stem wood and other above-ground tree biomass are accounted for forests available and non-available for wood supply, and for main groups of tree species. Balances can be expanded to total carbon stored in the forest ecosystem by adding the carbon bound into ground vegetation and forest soils.

Non-wood services

Use of non-wood products and availability of forests for non-wood services are linked and are strongly related to quality aspects of forests. In physical qualitative accounts non-wood services are represented by areas providing those services. Monetary accounts for non-wood services are not presented in forest asset accounts. Valuation principles for non-wood services are discussed in chapter 5.

Non-wood services can be listed as (adapted from FAO preliminary proposition):
– protection services; avalanche, erosion, water, climate, shelter, homeland, living
– social and economic services; recreation, tourism, educational and research possibilities, hunting and fishing, grazing
– aesthetic, cultural and spiritual services
– biodiversity services; genetic resources and reserves, nature conservation.

The amount of game is recorded in non-wood products, and area referring to hunting is here non-wood service. Area used for grazing has no direct link to fodder/forage for animal breeding. Availability of non-wood services is included into quality accounts due to e.g. availability and non-availability for wood supply or protection status, which can be dissaggregated by protection purpose on detailed level. Areas for single non-wood services are overlapping.

Preliminary tables
7. Protection status of forests available for wood supply; area 1000 ha
8. Origin of tree species; area
9. Forest-occurring endangered species; number of species
10. Forest health, defoliation
11. Age structure of forests; area or percentages by age categories
12. Carbon balance of tree biomass; million tons of carbon
13. Carbon balance of forest ecosystems
14. Non-wood services; area 1000 ha

5. Data sources of the physical accounts

Structure, definitions and classifications of the forest assets accounts in the SEEA framework are as far as possible compatible with international forest and forestry products statistics. Statistical framework used in these statistics form a minimum level of disaggregation for forest asset accounts, which is applicable for every country.

Statistics compiled by FAO cover tropical, temperate and boreal forests world wide. FAO has undertaken periodic forest assessments since 1946. Latest assessments have been compiled for reference years 1980 and 1990. For next assessment the reference year is 1990, and the framework has been updated from the previous version. In the FAO assessment original national data have been reorganised in order to obtain a common classification, format and reference date. The FAO framework is emphasized on quantitative accounts, but it includes many qualitative aspects as well.

Forest assessments of FAO are based on national forest inventory or survey data, or estimates made by FAO. The length of national forest inventory periods is 1-15 years, and number and density of inventories and surveys accomplished varies between countries. Continuous annual forest inventories or surveys are hardly accomplished in any country. Reference year or period for opening and closing stocks or balance sheets are available, but the time span between opening and closing figures usually varies between 5-20 years. Data on exact annual opening and closing stocks are not available.

United Nations' Framework Convention on Climate Change (FCCC) is currently preparing guidelines for the preparation of national communications on annual reporting of greenhouse gases. In section 'sectoral background data for land use change and forestry' of the quidelines definitions and classification concerning forest assets are compatible with this preliminary draft version of forest assets accounting of SEEA, although they are not fully harmonized. FCCC reporting and forest assets accounts will be significant data sources for each other in the future, and it may be essential to notice possible needs to update forest assets accounting with respect to final version of FCCC guidelines.

A considerable amount of data on physical and monetary flows related to forests are available on annual basis or periods shorter than in national forest inventories or surveys. This makes it possible to build asset accounts according to its general structure 'opening balance sheets - changes in balance sheets - closing balance sheets'. Still, physical forest asset accounts, especially in opening and closing stocks and balance sheets, are only seldom possible for one-year accounting period without violating statistical reliability related to forest inventories and surveys. An element of inconsistency with respect to forest statistics exists, when a beginning of any year and an end of any other year are placed as an exact point of dates for opening and closing stocks or balance sheets.

Notes, discussion

Note 0.1. Natural, over-mature and economic forests. (According to SNA (10.2) economic assets are defined as entities, over which ownership rights are enforced, and from which economic benefits may be derived by their owners by holding them or using them over a period of time. Different kind of benefits may be derived from different kind of assets, e.g. property incomes and assets as stores of value that may be realized by disposing them or terminating them (SNA 10.3.)).

It would be possible to classify only semi-natural forests and plantations as economic forests. Natural forests (and also over-mature forests) available for wood supply would be non-economic, because intensity of forestry and logging measures in those forests have in previous years been lower than in semi-natural forest and plantations, and also because it could be assumed that the main purpose of natural forests have been to provide environmental services.

Natural forests are related to 'over-mature forests' which are available for wood supply, but timber in them have not been felled for various reasons (e.g. long term utilization plans or intentions as in FAO classification, voluntary and temporary protection by the owners, or simply because the land owner does not currently need any forest incomes or wants to save the timber to her/his children). It is not very clear, whether it is possible to know, when over-mature forests in semi-natural forests should in fact be classified as 'natural forests'.

Timber in natural and over-mature forests in forests available for wood supply is an economic asset, since there are no economic restrictions for wood supply and utilization. For those forests ownership rights are enforced, economic benefits may be derived, but currently and perhaps temporally those forests have not been mainly used for economic activities. Timber in over-mature forests have economic value as an asset, although economic activities such as fellings have not been accomplished during previous years (taxes and other costs are still running). Rate of annual biological growth of timber in over-mature forests is usually lover than in younger forests, but it is not necessarily zero or negative. Major function of over-mature forests available for wood supply is not necessarily to provide environmental services, as defined for non-economic forests. (In some cases timber in over-mature forests can be seen as inventories of the forest owner.) The separation of over-mature forests from other semi-natural forests available for wood supply is not clearly necessary or well applicable in quantitative accounts.

On the other hand it is true that in many countries much pressures are laid on conservation of old-growth forests (including over-mature forests). Therefore it is important to know the area and volume of timber in over-mature forests, since possible conservation may have considerable effects to the amount and value of economic forests in the future. Anyway the over-maturity is merely a quality aspect, and it becomes a quantity aspect and is recorded in the SNA when conservation, and thus also change in classification actually take place, not before that.

Over-maturity faces many problems with respect to data availability. It is e.g. quite impossible to know, how much fellings are accomplished in over-mature forests. Over-maturity is not always recorded in forest inventories and surveys etc. I wonder what are the real possibilities in practise to have information on area and timber separated to over-mature and other forest available for wood supply, or even to separate natural forests from semi-natural forests.

Note 0.2. Produced non-economic forests. Forest artificially founded for environmental protection services (avalanche, erosion) on area, which has previously been other than forestland. If such forest serves both environmental protection and forestry purposes, it is treated as produced economic forest.

Note 1. Standing timber. Sum of natural losses, harvested timber, and timber left in the forest (only felling residuals in some countries) is also called drain in many national forest statistics. A share of felling residuals may be used as fuel, but this share is not included into fellings of fuel wood, which is one component of harvested timber. Net growth (accounting term) of timber is further calculated as stock increment (gross natural growth) less stock drain.

Note 2. **Biodiversity** is a very wide concept, and on national level preferences and importance of biodiversity issues varies from one country to an other. Important factors are e.g. forest soil types (mineral, peat, wetland etc.), altitude of forest areas (lowlands, ridges, hills, mountains etc.), forest connected to water areas such as inland waters, groundwater, estuaries and archipelago, and forests forming border zones to agricultural areas. Biodiversity is also closely connected to multiple use of forests and forest products, which makes it important for accounting to describe the biodiversity and its development in semi-natural managed forests by ecofloristic zones and predominant tree species.

ANNEX I. DRAFT CLASSIFICATION OF FORESTLAND

- 2.1.3 Land(with ecosystems and soil)
  - 2.1.3.1 Cultivated (economically used) land areas (with connected ecosystems)
    - 2.1.3.2.1 Land underlying buildings and works (includes parks in the city.
    - 2.1.3.2.2 Agricultural land
    - 2.1.3.2.3 Forest and other wooded land
      - 2.1.3.2.3.1 Available for wood supply
        - 2.1.3.2.3.1.1 Coniferous
        - 2.1.3.2.3.1.2 Broadleaved
        - 2.1.3.2.3.1.3 Bamboo
        - 2.1.3.2.3.1.4 Mixed
      - 2.1.3.2.3.2 Not available for wood supply
        - 2.1.3.2.3.2.1 Strictly protected
          - 2.1.3.2.3.2.1.1 Coniferous
          - 2.1.3.2.3.2.1.2 Broadleaved
          - 2.1.3.2.3.2.1.3 Bamboo
          - 2.1.3.2.3.2.1.4 Mixed
        - 2.1.3.2.3.2.2 Under economic restrictions
          - 2.1.3.2.3.2.2.1 Coniferous
          - 2.1.3.2.3.2.2.2 Broadleaved
          - 2.1.3.2.3.2.2.3 Bamboo
          - 2.1.3.2.3.2.2.4 Mixed
      - 2.1.3.2.3.3 Other wooded land
    - 2.1.3.2.4 Recreational and other open land for economic purposes

[*The numbering gets complicated, we can rethink about it. I used them simply to see the relation with the SEEA CNFA]*.

ANNEX 2: ILLUSTRATIVE TABLES

PHYSICAL QUANTITATIVE ACCOUNTS (tables 1-3)

1. FOREST LAND AREA 1000 hectares	Forest land																Other wooded land	Other land
	Available for wood supply					Not available for wood supply												
						Strictly protected					Economic restrictions					Total		
	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total			
Opening area																		
Changes in cover (net)																		
Man-made changes (net)																		
+ Afforestation																		
- Deforestation																		
Natural events (net)																		
+ Natural extension																		
- Degradation																		
Changes in classifications (net)																		
+/- Political, economic etc.decisions																		
- Polit. or catastrophic events																		
Reassessments of stocks																		
Closing area																		

Changes can also be presented as 'Due to natural causes'
'Due to economic decisions'

1b. FOREST LAND AVAILABLE FOR WOOD SUPPLY 1000 hectares	Natural forests					Semi-natural forests					Plantations					Total			
	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Grand total
Opening area																			
Changes in cover (net)																			
Man-made changes (net)																			
+ Afforestation																			
- Deforestation																			
Natural events (net)																			
+ Natural extension																			
- Degradation																			
Changes in classifications (net)																			
+/- Political, economic etc.decisions																			
- Polit. or catastrophic events																			
Reassessments of stocks																			
Closing area																			

2. STANDING TIMBER 1000 m3	Forest land													
	Available for wood supply				Not available for wood supply									Total
					Strictly protected				Economic restrictions				Total	
	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total		
Opening stocks														
+ Natural growth (including nat.losses)														
- Fellings														
- Political or catasrophic events														
+/- Changes in land classification														
+/- Reassessments of stocks														
Closing stocks														

2b. STANDING TIMBER AVAILABLE FOR WOOD SUPPLY 1000 m3	Non-produced								Produced				Total			
	Natural forests				Semi-natural forests				Plantations							
	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Grand total
Opening stocks																
Natural growth																
- Fellings																
Harvested timber																
saw logs																
pulp wood																
fuel wood																
Timber left in the forest																
felling residuals																
other timber																
- Political or catasrophic events																
+/- Changes in land classification																
+/- Reassessments of stocks																
Closing stock																

Semi-natural can be included into 'Produced' in SNA
If fellings are accomplished in Natural forests, the (total volume of standing timber less felled timber) corresponding the felled area is shifted to Semi-natural forests as Changes in land classification.
The area is recorded in table 'Forest land area available for wood supply' as Changes in classification due to political, economic etc. Decisions.

3. NON-WOOD PRODUCTS **kg (m3)**	Forest land		
	Available for wood supply	Not available for wood supply	Total
Food			
fruits			
game			
berries			
mushrooms			
nuts			
palm oil			
honey			
others			
Medicines			
Fodder/forage			
Industrial extracts			
cork			
rubber			
tar			
chemicals			
other			
Forest growing animals as agric. Products			

MONETARY ACCOUNTS (tables 4-6)

4. STANDING TIMBER AVAILABLE FOR WOOD SUPPLY MONETARY VALUE at current prices	Non-produced								Produced				Total			
	Natural forests				Semi-natural forests				Plantations							
	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Grand total
Opening stocks																
Natural growth																
- Fellings																
Harvested timber																
saw logs																
pulp wood																
fuel wood																
Timber left in the forest																
felling residuals																
other timber																
- Political or catasrophic events																
+/- Changes in land classification																
+/- Reassessments of stocks																
Closing stock																

Semi-natural can be included into 'Produced' in SNA

5. OUTPUT OF FOREST PRODUCTS MONETARY VALUE at current prices	Branches of industry (ISIC)					
	Agriculture	Hunting as branch of indust.	Forestry and logging	Charcoal production	Others, including own consumption	Total
Timber						
conifers						
broadleaves						
others						
Industrial extracts						
cork						
rubber						
tar						
chemicals						
other						
Forest-growing animals (e.g. reindeer)						
Food						
fruits						
meat from hunting						
berries						
mushrooms						
nuts						
palm oil						
honey						
others						
Medicines						
Fodder/forage						
TOTAL						

6. EXPENDITURES ON FOREST MANAGEMENT AND PROTECTION MONETARY VALUE at current prices

	Forestry and logging	Environmental protection serv.	Public administr. other public serv.	Other branches of industry	Total	Of which public sector
Forestry and logging						
forest improvement and silviculture						
logging						
environmentally sound fores. and logg.						
Forest protection						
prevention						
restoration						
Forest conservation						
Total						

PHYSICAL QUALITATIVE ACCOUNTS (tables 7-14)

7. PROTECTION STATUS OF FORESTS AVAILABLE FOR WOOD SUPPLY AREA 1000 hectares	Forest land available for wood supply									
	Not protected					Not-strictly protected IUCN categories III-V				
	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total	Conifer-ous	Broad-leaved	Bamboo, palms	Mixed	Total
Opening area										
Changes in cover (net)										
Man-made changes (net)										
+ Afforestation										
- Deforestation										
Natural events (net)										
+ Natural extension										
- Degradation										
Changes in classifications (net)										
+/- Political, economic etc.decisions										
- Polit. or catastrophic events										
Reassessments of stocks										
Closing area										

8. ORIGIN OF TREE SPECIES
AREA 1000 hectares

	Plantations							
	Coniferous		Broadleaved		Bamboo, palms		Total	
	Indig-enous	Intro-duced	Indig-enous	Intro-duced	Indig-enous	Intro-duced	Indig-enous	Intro-duced
Opening area								
Changes in cover (net)								
Man-made changes (net)								
+ Afforestation								
- Deforestation								
Natural events (net)								
+ Natural extension								
- Degradation								
Closing area								

9. FOREST-OCCURRING ENDANGERED SPECIES Number of species	Total number of known species	Number of endangered species
Vascular plants		
Trees		
coniferous		
broadleved		
others		
Other vascular plants		
Non-vascular plants		
mosses		
macrofungi		
algae		
lichen		
Vertebrates		
mammals		
birds		
other		
Invertebrates		
insects		
others		

10. FOREST HEALTH DEFOLIATION Defoliation percentage of tree crown cover more than 25 %	Forest land								
	Natural forests			Semi-natural forests			Plantations		
	Conifers	Broad-leaves	Bamboo, palms	Conifers	Broad-leaves	Bamboo, palms	Conifers	Broad-leaves	Bamboo, palms
Opening stocks Closing stocks									

11. AGE STRUCTURE OF FORESTS Area or percentages	Semi-natural forests							
	Age class 1	Age class 2	Age class 3	Age class 4	Age class 5	Age class 6	Age class 7	Over-mature
Opening stocks Closing stocks								

12. CARBON BALANCES AND ACCUMULATION RELATED TO TREE BIOMASS Million tons of carbon	Forest land													
	Available for wood supply				Not available for wood supply									Total
					Strictly protected				Economic restrictions				Total	
	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total	Conifers	Broad-leaves	Bamboo, palms	Total		
Opening stocks														
+ Natural growth														
- Fellings														
- Political or catasrophic natural events														
+/- Changes in land classification														
+/- Reassessments of stocks														
Closing stocks														

13. CARBON BALANCE IN FOREST ECOSYSTEM Million tons of carbon	Forest land						
	Stem wood	Other wood	Foliage	Total tree biomass	Ground vegetation	Forest soils	Total
Opening stocks							
Change in carbon							
Closing stocks							

14. NON-WOOD SERVICES
AREA 1000 ha

	Forest land					
	Available for wood supply		Not available for wood supply		Total	
	Beginn. of the period	End of the period	Beginn. of the period	End of the period	Beginn. of the period	End of the period
Protection						
climate						
avalanche						
erosion						
water						
shelter						
others						
Social and economic						
recreation and tourism						
education and research						
hunting						
grazing						
Aesthetic, cultural and spiritual						
Biodiversity						
nature conservation						

4.3. Fisheries resources accounts

1. Asset accounts for commercial fisheries

There are some practical problems associated with the implementation of the accounting treatment of produced and, especially, non-produced fish asset stocks suggested by 1993 SNA.

The first practical difficulty is to distinguish between produced and non-produced assets. The distinction between acquaculture and the capture fishery can be used. This distinction is at present still somewhat ambiguous, but it seems reasonable to assume that a useable definition of acquaculture (the practices that are considered acquaculture, as opposed to fisheries enhancement) is already available from the FAO or soon will be. Among produced assets, a further distinction is made between fixed assets (fish used for breeding) and inventory of work in progress (fish cultivated for sale). Most aquaculture would presumably be included in inventory. The treatment of produced assets as inventory can follow the guidelines of 1993 SNA, that is, the change in value of fish stocks due to natural growth and withdrawals from inventory can be recorded in the production and asset accounts as change in inventory of work in progress. The value of work in progress should be recorded by allocating the value of the final product fractionally to the periods during which the value grows. If data are unavailable, or the future selling price is expected to fluctuate, additions to work in progress could be valued as the costs incurred during the period plus some markup to account for operating surplus or mixed income.

1 AN.11 Fixed Assets

2 AN.1114 Cultivated Assets

3 AN.11141 Livestock for breeding (including fish)

4

5 Changes in accumulation accounts

- **Capital account – (gross fixed capital formation and consumption of fixed capital)**
- **Other change in volume of assets – (catastrophic loss, uncompensated seizure)**
- **Revaluation**

AN.12 Inventories

AN.122 Work in progress

AN.1221 Cultivated assets

Changes in accumulation accounts

- **Capital account – (changes in inventory)**
- **Other change in volume of assets – (catastrophic loss, uncompensated seizure)**
- **Revaluation**

2. Monetary accounts for non-produced fish stocks

The treatment of non-produced assets, wild fish stocks, presents a number of potential difficulties related to the definition of the boundary between economic and non-economic assets, and the definition of change in the volume of assets.

The fish stocks which are an economic asset are those which currently provide economic benefit and which are 'owned'. A nation's extended economic zone (EEZ) can be used as a criterion of ownership if allowance is made for fish stocks which straddle or migrate between the EEZs of two or more nations. In cases where there is an enforceable agreement among the nations on the size of the catch, the value of the economic asset of each nation could be based on the value of the allowable catch (the value of the part of the total stock) of each nation. The fish stock that is within a nation's EEZ or the part of a migrating or straddling stock allocated to a nation is considered an asset of that nation. The right to fish can be considered an asset as well, and if sold to another nation, could be treated analogously to a financial claim.

Fish stocks within a nation's EEZ, but over which the nation cannot enforce ownership would not be considered an economic asset. High seas fish stocks would also be excluded (perhaps an exception for enforceable agreements among nations?). In practice, it may be difficult to value separate parts of a nation's fishery, that is, to determine the origin of the catch.

The entries in the asset account would in theory include economic appearance, natural growth and (catastrophic) loss, and harvesting, and could also include losses due to economic activity other than harvesting. The estimation of data for these categories (except for harvest or catch, which is observable) is problematic. The suggestion in 1993 SNA that the value of harvest (net of growth) could be recorded as a change in volume of assets is not easily applicable. The use of a similar measure for depletion advocated by earlier versions of the SEEA is also contentious. There is not necessarily a simple link between the physical measures of change in the stocks (assuming that these data are available) and monetary value.

Depletion of fish stocks has been measured using historical data (Repetto, Costa Rica), although it does not seem reasonable

To propose a simple measure of depletion using data readily available for a current or recent period. Depletion could be defined as the reduction in value of fish stocks due to overfishing. The stock value can be measured as the present value of an indefinite annual catch that is sustainable. A reduction in the allowable catch set by the agency controlling a fishery would presumably reflect a reduction in the sustainable yield and the value of the stock, but this could only be considered depletion if the reduction can be attributed solely to overfishing. It is possible that the reduction in catch is a temporary measure to allow the stock and future catch to increase, so that the apparent reduction in value of the stock is actually an increase. Valuing changes in stocks is complex - it could, or should only, be done in cooperation with the agency managing the fishery.

Valuation of fish stocks can in some cases be based on the value of purchased quotas or licenses. In many cases the value must be derived by calculating a rent residual, for example by subtracting costs from the value of the catch, and using the annual or per unit rent as the basis for valuing the future catch which the stock will yield. The calculated value of rent based on observed costs and prices could be lower than best current practice would show. It could in some cases be higher, reflecting an economy of scale in an unsustainable production rate. Alternative measures could be made, based on more efficient harvest methods, etc. These would not reflect the value of the asset as it is actually being used, but could be of interest as supplementary information

Other adjustments have been proposed in earlier versions of the SEEA to measure the effect of environmental degradation on economic assets. Examples this type of degradation could be loss of spawning habitat due to the damming or diversion of rivers or losses due to water pollution. The effect would be measured as the resulting reduction in the value of the fish stock. Degradation, which affects non-economic assets, can also be valued, based on maintenance cost.

Classification of natural assets in the SNA

(the categories in the balance sheet and some of the corresponding changes)

AN.2 Non-produced assets

AN.21 Tangible non-produced assets

AN.213 Non-cultivated biological resources

Changes in accumulation accounts

- **Other change in volume of assets – (economic appearance, natural growth, depletion, other economic disappearance, catastrophic loss)**
- **Other change**
- **Revaluation**

3. Physical accounts

The physical stock data are important information, because they help to assess the validity of some of the assumptions made in estimating the monetary data. Ideally, an asset account in physical data would show a time series the stocks of all commercially important species (the species currently harvested) detailed by geographical area or local fishery. Additional information on related (prey) species could also be included, as could other relevant information on spawning habitat or environmental quality. All of these data are useful in assessing the viability of the economic activity. Geographical detail may be important if local or regional economies are dependant on the fisheries or if fisheries shift activity to different areas if new stocks are discovered or stocks in some areas are depleted. Ideally, stock data would be shown not only for economic assets, but also for all of the stocks on which fishing activity depends or which are affected by the activity.

ASSET BOUNDARY FOR NON-PRODUCED FISH STOCKS

Fishing activity				
Fishing within a nation's own EEZ	Fishing in another nation's EEZ, with purchased quota or catch agreement	Fishing in international water, subject to agreements which are enforceable	Fishing in another nation's EEZ, or in international water without enforceable agreements or quotas	Fish are not harvested, but within a nation's EEZ and under 'control'.
	Economic assets	*Non-economic assets*		
THE ASSET				
The stocks (or part of migratory fish stocks) are a non-produced asset of the nation	The right to harvest is a claim on the fish stock asset of the 'owner'.	Stocks are not owned by any individual nation.	Stocks are either not owned or ownership is not enforced.	Stocks of fish which *could* be harvested profitably could be part of 'economic assets', at least potentially.
VALUATION				
The present value of the rent expected from future harvests (or sale of quotas, licenses) yielded by the stock.	Value of a purchased quota or estimated value of the quota or agreement during its life is asset of fishing nation. 'Owner' can show expected value of stock.	Not valued, although it may be difficult to isolate (exclude) economic data for harvest from this source.	Not valued, although it may be difficult to isolate (exclude) economic data for harvest from this source	Not valued, although value could be based on the expected value of a hypothetical catch or sale of fishing rights - if this is imminent.

PHYSICAL ACCOUNTS				
Stocks within EEZ and migratory stocks with indication of share belonging to a nation.	Useful information both for owning and fishing nations	Useful information	Useful, if available.	Useful, if available.

4.4 Land and Ecosystems Accounts (LEA)

1. Role of Land and Ecosystems Accounting

In **national accounts** land is treated as a non-produced economic asset that provides economic benefits to its owner and as an important part of balance sheets. The existence of balance sheets encourages analysts to look more broadly in monitoring and assessing economic and financial conditions and behavior (SNA, 13.4).

In **environmental accounting** this economic view of land is integrated but constitutes only part of the picture. The objective of a better understanding of the relationship between economic activities and the environment requires to take into account (1.) the use of land by different economic activities and (2.) the potentials of land from an ecological view. The latter relates e.g. to the extent and quality of habitats and ecosystems or the characteristics of the soil. In this context land is treated as an environmental asset. Economic use of land is often connected with short- or long-term processes of deterioration (or improvement). Agricultural use could cause soil erosion. The opening of uncultivated land (such as virgin forests or wetlands) for recreational or agricultural purposes may upset ecological balances. The use of areas for traffic or human settlement has radically changed the characteristics of land and ecosystems. On the other hand, the introduction of less intensive management practices (e.g. organic farming) or restoration activities may lead to improvements.

It is often difficult to find suitable **indicators in physical terms** to describe these processes. 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 effects of ambient concentrations that result in a contamination of biota and soil and the final effect on health of biota, ecosystems and human beings (1993 SEEA, 41 and 42).

Land and ecosystems as environmental assets are the most suited categories of assets for the **integration of ecological and**, in particular, **regional aspects** in environmental accounting. The ecological debate on natural assets also hinges on this point. The science of ecology is inclined to see natural assets as the stock of functioning ecosystems as basic units and not merely as a list of single elements. From an ecological point of view, one cannot e.g. 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 or elements (1993 SEEA, 35).

A comprehensive set of land and ecosystems accounting tables allows the **linking** of **the economic and** the **environmental dimension** and permits to derive aggregated sustainability indicators. These indicators provide the background framework for area-related policies (e.g. nature protection, agricultural and transport policy). However, there are different opinions as to which extent the environmental dimension should be covered by environmental accounting or in separate natural science information systems. A decision has to be taken on a national level in the light of national priorities and the importance given to an integrated view of economic and ecological aspects in the context of sustainable development policies or in physical planning.

In general the integration of a more comprehensive land and ecosystems accounting module in the SEEA can be **useful for several reasons**:

- It provides a complete picture of land cover and land use for a nation and allows deriving trends and indicators of change.
- It aids the integration of diverse data sources on land cover and land use as well as other data including population, economic activity, and water balances, species or fertilizer use.
- It aids standardization and classifications of land cover, land use and causes of changes in land cover and land use.
- It allows linking changes in land use, land cover, habitats and biodiversity as far as possible to the driving forces.
- It can be applied at national, regional watershed or landscape type level. (Eurostat Task Force on Land Accounting, 1999)

In the following section general features of accounting for all land and ecosystems categories are described. More details on integrated descriptions of selected land and ecosystems types can be found e.g. in the sections on forest, fishery and water accounts (see sections 4.2, 4.3 and 4.4).

2. State of development of Land and Ecosystems Accounting

The concepts for the economic description of **land as an economic asset** are well developed in the SNA and practical experience exists on the implementation of these concepts on the basis of land statistics. Land statistics have in general a long tradition in the statistical system but are caricaturized by different objectives and corresponding differences in methods and classifications.

The extensive use of accounting methods in this field and the **development of land and ecosystems accounts** that adequately deal with the complexity of land and ecosystems as environmental assets is a rather new development and closely linked to the appearance of geo-referenced land use or land cover data.[15] The current situation is characterized by various aspects: On the one hand, a general consensus on the need and the basic structure of a comprehensive approach of land and ecosystem accounting emerges in many countries. On the other hand, conflicts concerning the use of land and ecosystems are often characterised by specific regional or national interests or circumstances. This results in a high heterogeneity of observation methods and reporting formats because current land accounting activities are not

[15] A major input has been the work done by the Conference of European Statisticans of the United Nations from 1992 to 1994 and the following discussions in meetings of the International Association in Income and Wealth and of the London Group.

only dominated by global but also by national or regional objectives and by the data available at these different level.

In addition it proved to be very important to take the **national and regional natural conditions** into account in order to derive policy relevant trends. Environmental impacts may be different according to local environmental conditions. This is true for the emissions of more or less harmful substances (such as nutrients, toxics and other pollutants), their deposition and the subsequent impact. This is true, as well, for other pressures resulting from natural resource use, either through withdrawal and operation or by in situ use (including land use) and the structural or functional degradation of the environment these uses may result in (Parker et al.). Policy interest in land and ecosystems accounting is therefore not restricted to general tables with a high level of aggregation, but focuses often on issue-oriented accounts (e.g. biodiversity, quality of land and habitats) or regionalised accounts (e.g. catchment areas, coastal zones), which require more detail.

The consequence of this situation is a **lack of internationally agreed classifications** and a **high diversity** of data collection methods with different observation units and scales. First attempts to develop internationally comparable reporting systems can be noted in Europe and at world level. However, a common set of accounting tables has still to be developed and then tested in different countries. As a consequence a land and ecosystems accounting module must be characterised by a compromise between standardisation and flexibility.

Further progress in the field of land and ecosystems accounting depends on the right mix of development of concepts, long-term orientation in the improvement of the data situation and a strong orientation towards practical implementation. The design of a framework and of a statistical programme for obtaining the primary data must go hand in hand. Finally, a co-operation between statisticians, geographers and biologists seems to be essential in the development and implementation of land and ecosystems accounting.

3. Observation units and classifications

3.1 Land cover and land use

In the field of land and ecosystems accounting a special feature seems to be the extremely close **link** between the **objectives** of the studies, the determination of the observation or **accounting units** and the **scale** and the **classifications** used. The economic treatment of land in the SNA is rather simple from a conceptual point of view: Land is defined as the ground itself, including the soil covering and associated surface water, over which ownership rights can be exercised and which can, therefore, be the subject of transactions between institutional units (SNA 10.121). In the SNA only economic land that is owned and has the potential to provide economic benefits to its owner is considered. An aggregated classification with four types of land is included in the asset classification (see annex to chapter 13 of the SNA: land underlying buildings and structures; land under cultivation; recreational land and associated surface water; other land and associated surface water). A draft classification is also included in Section 2.3.

The treatment of land and ecosystems as environmental assets in environmental accounting leads to a **high** variety of rather different **user needs** (e.g. subject to interest, political scales) with the consequence that standardisation can only succeed within rather narrow limits. It seems to be extremely difficult (or impossible) to develop a single standard land classification that serves all the different purposes in a meaningful way.

A **basic distinction** in land and ecosystems accounting is that between **land cover** and **land use**. Land cover reflects the biophysical dimension of land, land use the functional dimension for human purposes. Land use may result in changes in land cover (deforestation, building a road, urbanisation...) or in changes of the conditions of the natural or modified biotopes (due to use of fertilizers or pesticides or to leaving land fallow, due to intensity of traffic on a road, due to the density of population in a town...). In principle land use can be better linked to economic activities. The land cover results from both the use of land by activities and the natural processes, whether modified by human activities or not. (IFEN: UNECE).

Sometimes the land **cover** at a large scale is considered **as a proxy for the use**. Actually, land use is an issue much more complex than land cover because of the different functions a single land cover unit can fulfil (multiple uses). A forest, for example, has functions as a producer of timber, a regulator of climate and water regimes, an absorbing medium for carbon dioxide, a retainer of soil, a habitat for animals and plants and recreational functions. The use of one function of the natural environment can impair its capacity to serve others. These trade-offs among functions of natural assets are one of the focuses of the ecological-economic interrelationships that are studied in environmental accounting (1993 SEEA, 39).

3.2 Observation units

Land use and land cover data are produced for different units. In the SNA the delimitation of the land accounting unit is not discussed. The concepts demand to take the ownership into account that is in general documented in land registers. In environmental accounting, **different types of land units** are used. Because of the costs of high quality in spatial databases the input data for accounting are not determined by accounting concepts but by data availability. In remote sensing the scale of the study determines the delimitation and the homogeneity of the basic land units, defined as surface areas with certain cover characteristics. At a small or medium scale, the land cover units are largely composite and must be classified according to their main characteristics. In large scale studies including fieldwork, rather homogenous land units – such as biotopes – are common. The measurement used in accounting is often the surface area (hectare or km^2), but length units or number of zones can be relevant in some cases (Parker et. al.)

Biotopes in the strict sense of the word are abiotic areas that can be geographically clearly defined and that feature a combination of specific abiotic factors (regarding climate, soil, light, temperature, water, nutrients, etc.) They therefore offer specific habitat conditions for organisms. Biotopes in the pragmatic sense in vegetation science incorporate both the spatial components and the natural vegetation within an area, i.e. parts of the biocoenosis. Where there are no plants, the existing abiotic land cover (e.g. buildings, roads, and landfills) is used for descriptive purposes.

Ecosystems are inhabited spaces and cover both the abiotic biotopes and the biocoenoses for communities – in other words its organisms. Ecosystems are best seen as the system of interactions between the abiotic habitat and the organisms in a spatial unit. They form a superior whole: the holistic system does not react in the same way as its individual components would. Ecosystems can be defined for different hierarchical levels. Examples of higher-ranking ecosystems are the sea, the forest, the meadow, etc. with all the organisms, which live there, and their interactions. Such systems consist of subsystems (e.g. pond, river, marshland, etc.). There is no classification that allows for the clear geographical separation of ecosystems in the landscape. For a pragmatic differentiation of ecosystems on a low hierarchical level the biotopes in the pragmatic sense in vegetation science are often used. As species are part of the ecosystems, they are included twice in the asset classification of the SEEA: as individual plants or animals (species) and as parts of ecosystems (Gilbert...). Landscapes can be understood as aggregates of connected ecosystems (biotopes). (Hoffmann-Kroll et. al.)

3.3 Classifications

In the **asset classification of the SEEA** (see chapter 2, section 2) the classification of land focuses on land use (CNFA 2.1.3) and 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 soil is different from that of, for example, sand and stone (CNFA 2.1.3.1) extracted by the mining industry. Soil is shown, therefore, in connection with land, not mineral ressources. 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 accounting in physical accounting seem to be acceptable, because the different 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 (1993 SEEA, 148).

The **distinction between cultivated and other types of land** could also be difficult, requiring further conventions. In the case of forest and other wooded land, the distinction between cultivated and non-cultivated forestland 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, sports 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. (1993 SEEA, 149)

For **land use** the ECE land use classification is the standard option for the time being. However, this classification is rather old and not entirely satisfactory (e.g. need of further disagregation for agriculture). Several international bodies are currently working towards an improved land use classification. In principle pure land use classifications are difficult to develop and to apply. From an environmental accounting point of view, they should as much as possible allow direct links to economic activities so as to facilitate the analysis of causal relationship among policy initiatives, economic activities, land use, land cover and changes in landscapes and habitats. Often there are parallel or multiple land uses, in particular with regard to recreation /tourism and to use restrictions due to protection status of land. When a primary or dominant use is hard to determine, multiple allocation or a separate recording of multi use could be considered. (Eurostat Task Force, 1999)

In the asset classification of the SEEA (see chapter 2, section 2), the aspect of land cover is taken into consideration by notifying that ecosystems are included in the different land categories. However, no classification of **land cover, biotopes or ecosystems** is proposed. At the moment, internationally agreed land cover classifications are available only for selected regions, e.g. the CORINE land cover classification in Europe. When land cover and biotopes or ecosystems aspects are included in a land and ecosystems accounting module, in the current situation this has to be done on the basis of these regional or national classifications. For classifications of the **regional dimension** of land use or cover, e.g. for ecozones as surfaces of a land cover unit or land classes as spatial units which are characterised by rather homogenous natural conditions, the situation is more or less the same. However, even if internationally standardised classifications existed, the parallel use of different classifications for land use and land cover/ecosystems aspects would be necessary in land and ecosystems accounting.

4. Structure of the land and ecosystems accounts

4.1 Land in the SNA 93

- **Land as an economic asset and as** part of balance sheets **in the SNA, description of stocks and flows in monetary accounting, link to chapter 2, section 3 (structure of the accounts).**

- Monetary **valuation** of land restricted to land use, market prices, valuation of stocks and flows, link to monetary valuation section 2.3 of chapter 2 (Rob Smith).

- **Particularities of land valuation**: Separation of land from other assets. For built-up areas, for example, the main problem is how to separate the value of the actual land from the value of the buildings on it. Often there are very few market transactions, which makes undifferentiated multiplication of areas by market prices impossible or at least questionable. In such cases, an attempt is made to determine the value of land via other indicators such as rents or revenue. Market price valuations are entirely useful and relevant when it comes to an economic assessment of nature as a fixed asset. They are not suitable for representing ecological aspects, however, as market prices are based on human use and exploitation potential and do not reflect the ecological value of an area. Areas of high ecological value that are, for example, protected or use-restricted have considerably lower market prices than normal agricultural land or city centers heavily used for economic purposes.

- As a consequence from the point of view of environmental accounting **priority is often given to physical accounts**.

4.2 Physical accounts

4.2.1 Core accounts

- The structure of the physical accounts reflects the **distinction** between **core accounts**, concentrating on the changes in land cover/land use and **supplementary accounts**, which are issue-oriented. Core accounts establish the interface between the treatment of land in the SNA and the description of ecosystems.

- Inclusion of the **environmental assets** in core and supplementary accounts.

- Description of stocks and flows of **land use in the SNA in physical units**.

- **Extension of the economic perspective** in physical units: land as production factor, allocation of direct land use to industries or products (not only to institutional sectors on the basis of ownership like in the SNA):

  A table on **land use by industries** (or products) **and households** is very important and allows deriving, for example, indicators for land productivity. However, the allocation rules of land use to producers (industries) are sometimes problematic and standards are not yet developed. Often there are parallel uses, in particular with regard to recreation (e.g. agricultural land, forests or waters may be used for several purposes) or protected areas. It is often hard to determine a ‚primary‘ or ’dominant‘ use so that multiple allocation or a separate recording of multiple use should be considered. (Eurostat Task Force)

  See **illustrative table** 4 in the annex.

Different options exist for the allocation of land to industries and households: The first one would make a close reference to national accounts classifications and categories (e.g. based on ownership for transport infrastructures or recreational areas). The second one would include indirect land use of products. A third one would be more use-oriented, by allocating areas for selected public goods (e.g. roads, parks) to the units that actually use these areas.

- Stock matrices:

  Land use / land cover matrix: see **illustrative table 1** in the annex, based on georeferenced data; accounting periods often 5-10 years.

  Land use change matrix and **land cover change matrix**: cross-tabulating land use or cover of two different points in time; based on georeferenced data; see **illustrative table 2** in the annex for a simple land use change matrix.

- Flow matrices:

  matrices of changes of land use and land cover by categories describing the types of gross flows in a period; see **illustrative table 3** in the annex; link to chapter 2, section 3.3.1 changes in assets in physical accounts.

  Analysing gross flows is **especially important** in the context of sustainability. From an ecological point of view, it is not enough to control the net changes of stocks. Analysis of gross flows needs a georeferenced data basis.

  Standard taxanomies of causes of changes are not readily available at international level and should be developed – separately for land use and land cover – as these refer to key questions on the reasons for changes; selected approaches exist.

  Two levels of changes can be distinguished: changes between categories of land use or land cover (**external changes**, changes in classification) and changes within categories (**internal changes**). External changes can be described to some extent by more detailed classifications of land use and cover. Internal changes will typically be described in supplementary accounts. (Eurostat Task Force)

4.2.2 Supplementary account

4.2.2.1 General aspects

- The supplementary accounts are more driven by policy interest. They can be divided into **two groups**: The first group concerns problems of naturalness and intensity of **land use** respectively and tries to establish links between such phenomena such as sealing or fragmentation and the economic activities that caused them. The second group focuses more strongly on **land cover** aspects or the state of the environment and biotopes/ecosystems, i.e. natural development potential or aspects such as biodiversity.

- Higher significance of **regional accounts** (e.g. ecozones, landscape types, watersheds)

- Integration of land use, land cover data with data from a great variety of other economic and ecological **data sources**; bottleneck data availability and statistical instruments/ monitoring programmes.

4.2.2.2 Land-use oriented accounts

- **Changes in artificiality** and influences of human activities: link to the land use categories of the core accounts, more direct link to human driving forces and pressures.

- First, the accounts describing **changes in artificiality** have to be linked with the origin of the process. Artificialisation can be due to **economic activities** such as manufacturing and mining industries, agriculture, construction and public works, tourism, transport... An opposite process can take place, for example in the case of abandoning of previously agricultural land. **Consumption patterns** have to be considered as well, both individual and collective (municipal waste landfills, nature conservation...). For a given production, the intensity of land use depends on the **technologies** implemented. Artificialisation can be described in terms of changes of land cover (i.e. consumption of natural land by artificial features) or in changes in the intensity of use of land for which cover remains the same during the accounting period. (IFEN)

- **Typical issues** are e.g. agricultural use of chemicals and water or intensity of use for agricultural, urban or infrastructure land.

4.2.2.3 Land cover-oriented accounts

- Land potentials and biodiversity**: Link to the land-cover categories of the core accounts. Link to economic activities more complex.**

- The **potentials of land** relate to the richness of the natural habitats in terms of extent and biodiversity, to their vulnerability, to the characteristics of the soil, to the availability of water (quantity and quality of the surface and underground waters, regularity of the flows...), to the social and economic activities of which it is the support (...). The potentials can be assessed from several points of view, one of them being the capacity of the landscape to sustain natural life under the pressure of human activities. (Parker et. al.)

- **Often** more homogenous land units are used: **ecosystems/biotopes**, landscapes as basic units. For ecosystems/biotopes, analysing stocks and flows (surface) is in principle possible in the same way as for more heterogeneous land cover units. Inclusion of linear features that are not covered as surface areas.

- Changes in **biodiversity** in most cases are a consequence of human activities. In the case of biodiversity the parallel use of different accounting units is necessary: habitat diversity can only be analysed on a landscape level, species diversity on an ecosystem/biotope level. Biotopes/ Ecosystems accounts better targeted to nature conservation policy or to (ecosystems) theory.

- The surface area balances for landscapes and ecosystems/biotopes that are required to reflect biodiversity can be linked not only to diversity indicators but also to the relevant **material** (e.g. degradation by residuals) **or functional indicators** for describing the state of the environment. It leads to a systematic, theory-based description of the state of environment, which would extend (from a conceptual point of view) the current data reporting conducted on a medial or sectoral basis.

4.2.2.4 Integration of quality aspects

- Possibilities and limits to **integrate quality aspects** in the physical description of natural assets by quality classes (see RIO-version of the SEEA: quality classes):

  Quality aspects can only be integrated in the accounting structure (see 4.2.1) as long as they can be described as **external changes by more detailed classifications**. In the more detailed version of SEEA as discussed in Rio it is therefore clearly stipulated that land and ecosystems types should be further subdivided in a classification system based on quality. The description of the stocks and changes of land and ecosystems would accordingly be extended to such quality classes. However, there are two clear **limitations** to such an approach from a methodological and practical point of view:
  - There are no concise breakdowns by quality classes of land or ecosystems types, which do justice to the quality of the units. For the forest ecosystems, for instance, the state of the trees, the soil, other plants and animals would all have to be included. At the current state of the art, a quality classification integrating these aspects would be feasible only if normative standards as well as statistical descriptions were applied when aggregating individual factors to quality classes.
  - Because of the combination of different quality characteristics (e.g. the state of trees, soil, other plants and animals in a forest), any attempt to avoid normative elements in the assessment by cross-classifications results in a very large number of quality classes which it would be unrealistic and/or extremely costly to quantify statistically at present.

- describe the relation to **quality (state of environment) indicators**:

  The only practical solution is a pragmatic approach in which the surface of ecosystems or land cover units is depicted with the help of integrated **accounting methods**, whereas the **indicator method** is used for any further qualitative differentiation of these units. If suitable non-additive quality indicators are defined for the classes used for describing land use, land cover or biotopes in the corresponding accounts, the quality indicators can be added to the surface values as separate columns in stock matrices.

Parallel to monetary valuation: from the economic point of view, the additive measure is value as an expression of the productivity of land; from an ecological point of view, internal quality is expressed by different quality indicators.

Opens the field for a lot of **politically important analyses** by combining the advantages of accounting and indicator methods. For example, aspects of biodiversity (especially habitat and species diversity) can be reflected by accounting methods only to a very limited extent. The consistent methodological link between accounting methods such as surface area balances and the respective biodiversity indicators are imperative for a satisfactory result.

Degree to which quality indicators are combined with the accounts depends on the objectives of the analysis; in environmental accounting **more limited** use of quality indicators as in natural science reporting systems on the state of environment is adequate.

4.2.2.5 Integration of soil

- Soil as part of the **asset classification**; treatment of soil in connection with land and not with mineral resources

- **Land quality changes**: changes of soil quality from soil erosion, contamination with residuals, salination.

- Land quality changes and **market value** of land

- **Soil erosion**: only physical data on flows; problem to distinguish economic and natural causes of erosion; categories of flows

- **Soil degradation**

ANNEXES: ILLUSTRATIVE TABLES

The objective of the following tables is to demonstrate the character of tables proposed in the land and ecosystems account section.

The tables that will be included in a draft version of SEEA will be adapted to the classifications and concepts presented in the text.

Table 1: Land use / land cover matrix - stocks (Main-Taunus Kreis in Germany)

[hectares]	Land Cover 1953							
Land Use 1953	1 Artificial cover	2 Woody vegetation	3 Grass and other non-woody vegetation	4 Woody and non-woody vegetation	5 Land without or with sparse vegetation	6 Water surfaces	**Land Use total [ha]**	Land Use [%]
01 Dwelling	874	-	-	-	-	-	**874**	*3.5*
02 Industrial and commercial use	79	-	-	-	-	-	**79**	*0.3*
03 Housekeeping / commercial use	747	-	-	-	-	-	**747**	*3.0*
04 Private / public administration, culture, education, health service	57	-	-	-	-	-	**57**	*0.2*
05 Supply services	5	-	-	-	-	-	**5**	*0.0*
06 Disposal services	-	-	-	-	-	-	**-**	-
07 Mineral extraction	-	-	-	-	84	-	**84**	*0.3*
08 Transportation	312	-	-	0	-	-	**312**	*1.3*
09 Recreation areas	106	-	-	65	-	-	**171**	*0.7*
10 Agriculture	4	3421	11716	-	-	-	**15141**	*61.2*
11 Forestry	-	7010	-	-	-	-	**7010**	*28.3*
12 Mixed use of water bodies	-	-	-	-	-	163	**163**	*0.7*
13 Mixed use of natural and semi-natural areas	-	8	-	51	-	-	**59**	*0.2*
14 Transition land and construction sites	48	-	-	-	-	-	**48**	*0.2*
Land Cover total [ha]	**2233**	**10439**	**11716**	**116**	**84**	**163**	**24750**	
Land Cover [%]	*9.0*	*42.2*	*47.3*	*0.5*	*0.3*	*0.7*		*100.0*

Table 2: Land use change matrix (Main-Taunus-Kreis in Germany)

[hectares]	Land use (STABIS) 1972											
Land use (STABIS) 1953	1 Built-up areas	2 Pit heaps, open pits, disposal areas	3 Traffic areas	4 Leisure and recreation areas	5 Agriculture areas	6 Forest	7 Bodies of water	8 Wetland, heathland, rocks, dunes	9 Fallow areas	**Land use ´53 total**	Land use ´53 [%]	Decrease (total)
1 Built-up areas	1746	2	3	4	7	0	0	-	0	**1763**	*7.1*	17
2 Pit heaps, open pits, disposal areas	10	30	1	11	9	7	0	-	16	**84**	*0.3*	54
3 Traffic areas	5	0	298	0	8	1	0	-	0	**312**	*1.3*	14
4 Leisure and recreation areas	56	-	2	103	6	2	0	-	2	**171**	*0.7*	67
5 Agriculture areas	2000	266	129	162	12263	112	9	-	200	**15141**	*61.2*	2878
6 Forest	76	8	8	10	36	6920	0	-	10	**7069**	*28.6*	149
7 Bodies of water	0	0	0	0	1	0	161	-	0	**163**	*0.7*	2
8 Wetland, heathland, rocks, dunes	-	-	-	-	-	-	-	-	-	-	-	-
9 Fallow areas	1	-	16	-	32	-	0	-	-	**48**	*0.2*	48
Land use ´72 total	**3894**	**306**	**457**	**290**	**12363**	**7042**	**171**	-	**228**	**24750**		
Land use ´72 [%]	*15.7*	*1.2*	*1.8*	*1.2*	*50.0*	*28.5*	*0.7*	-	*0.9*		*100.0*	
Increase (total)	2148	276	159	186	100	122	10	-	228			
Net change	2131	222	144	119	-2778	-27	8	-	180			
Flow coeff. [%]	*38.3*	*84.7*	*22.5*	*55.1*	*10.8*	*1.9*	*3.7*	-	-	*13.0*		

	Area [ha]	**Area [%]**
Total Area	24750	*100.0*
Change due to human impact	24420	*98.7*
Change due to natural process	331	*1.3*

Table 3: Changes of land use by categories (Main-Taunus-Kreis in Germany)

Land Use (STABIS classification)	Stock initial state 1972 (ha)	Net flow: due to human activity (ha)	Net flow: due to natural processes (ha)	Stock final state 1992 (ha)
1 Built-up land	3 893.8	1 128.7	-4.7	5 017.8
2 Quarries, pits, mines, and land under disposal facilities incl. dumps	305.9	-81.1	-107.3	116.7
3 Land used for traffic purposes	456.7	-80.2	0.0	376.7
4 Recreational land	289.6	204.5	-2.8	491.2
5 Agricultural land	12 363.0	-1 025.0	-80.4	11 257.7
6 Forests and other land under trees and shrubs	7 041.8	31.2	33.2	7 106.3
7 Waters	171.3	32.9	0.0	203.9
8 Wetlands and arid land. Land with sparse vegetation	0.0	0.0	89.0	89.0
9 Fallow land	228.3	-210.2	73.1	91.2
Total Area (abs.)	24 750.5	4 136.1	221.1	24 750.5
Total (%)	*100.0*	*16.7*	*0.9*	*100.0*

	Area (ha)	Area (%)
Total change 1972 - 1992	4 357.2	*100.0*
Change due to human activity	4 136.1	*94.9*
Change due to natural process	221.1	*5.1*

Table 4: Land use by industries 1953 (Main-Taunus-Kreis in Germany)

[hectares]	**Economic Activities 1953**															
Land Use 1953	Agriculture, Hunting and Forest.	Fishing	Mining / Quarrying	Manufacturing	Electric., Gas / Water	Construction	Wholesale / Retail Trade, etc.	Hotels / Restaurants	Transport, Storage / Communic:	Public administration etc.	Other service activities	Private Households	Additional Division Z, non profit = without use	Not classif.	**Area [ha]**	Area [%]
01 Dwelling	-	-	-	-	-	-	-	-	-	-	-	874	-	-	**874**	*3.5*
02 Industrial and commercial use	-	-	-	36	-	12	31	-	-	-	-	-	-	-	**79**	*0.3*
03 Housekeeping, commercial use	280	-	-	81	65	-	5	70	-	85	5	156	-	0	**747**	*3.0*
04 Administr., culture, educ., health	-	-	-	-	-	-	-	-	-	29	29	-	-	-	**57**	*0.2*
05 Supply services	-	-	-	-	-	-	-	-	-	-	-	-	-	5	**5**	*0.0*
06 Disposal serv.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07 Mineral extr.	-	-	84	-	-	-	-	-	-	-	-	-	-	-	**84**	*0.3*
08 Transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	312	**312**	*1.3*
09 Recreation	-	-	-	-	-	-	-	-	-	-	-	171	-	-	**171**	*0.7*
10 Agriculture	15141	-	-	-	-	-	-	-	-	-	-	-	-	-	**15141**	*61.2*
11 Forestry	5396	-	-	-	-	-	-	-	-	-	-	1614	-	-	**7010**	*28.3*
12 Mixed use of water bodies	-	54	-	-	54	-	-	-	-	-	-	0	56	0	**163**	*0.7*
13 Mixed use of natural and semi-natural areas	20	-	-	-	-	-	-	-	-	-	-	12	27	0	**59**	*0.2*
14 Transition land and constr. Sites	-	-	-	-	-	-	-	-	-	-	-	-	-	48	**48**	*0.2*
Sum of Area [ha]	**20838**	**54**	**84**	**116**	**119**	**12**	**36**	**70**	**-**	**114**	**34**	**2826**	**83**	**366**	**24750**	*100.0*
Area [%]	*84.2*	*0.2*	*0.3*	*0.5*	*0.5*	*0.1*	*0.1*	*0.3*	-	*0.5*	*0.1*	*11.4*	*0.3*	*1.5*		

4.5 Water accounts

Description of the asset

As a starting point one could easily be led to try to perceive water as a resource in line with other natural resources like mineral deposits or forests. But because of the elusive nature of water which influences the potential economic or environmental 'usage', water cannot be dealt with in accounts the same way as other resources. This means that the usual balance for assets can only be used for accounting for water to a limited degree:

Water travels (by itself) at a much higher speed than other types of resources, escaping the control of humans. Continual monitoring of the dimensions of quality, time and place is much more crucial than with other resources. In reality water satellite accounts encounter some of the most fundamental problems of environmental accounting.

A main difference to other natural resources is that water is not considered to be an 'economic' resource as e.g. forests or mineral deposits. Natural water as such is rarely owned, thus the natural 'stocks' of water are not considered to be part of the monetary balance sheets of the national accounts. In most countries ownership rights on water resources are not enforced, neither by individual units nor by the communities. Water resources, prior to abstraction and ‘processing’, have no price. In some cases, though, the existence of water influences the value of land, but the water resource is not valued separately. In all cases when the water ‘leaves’ the owned property the ownership rights ceases. In a few countries the water supply system is privatised but this does not mean that ownership rights to water resources are assigned to these economic units.

A part of the water resources, though, is under the effective control of economic units. The regulation of water bodies, storage of water in reservoirs are examples of this. On the other hand water is rather uncontrollable. The fact that part of the water in a country comes and goes as it pleases (precipitation, evapotranspiration) causing floods and drought shows that at least a part of the water resources available are not under the effective control of economic units. This can partly be redressed by change of land use and additional regulations of water bodies (drainage, extending the capacity of reservoirs, deliberate influence of evapotranspiration from agricultural land). I.e. it is possible to 'process' water to control the dimensions of time and place to a certain degree. These activities should be included in the economic part of satellite accounts for water.

This means that for water which is mainly considered in SNA a non-economic asset, these accounts go far beyond the description of water stocks and flows in cubic meter. They may for example integrate the functioning of hydrosystems, described in terms of river length or flows.

Classification of the asset

The aquatic resources include ground water, water of lakes, rivers etc and coastal and ocean water. These water groups include fresh water, brackish water and salt water.

Water classified in SEEA (92) as shown in Annex 1. In the SEEA (92) 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 meters (m^3). This classification needs further specifications when compiling most of the Accounts mentioned here.

Eco-systems connected to aquatic resources are not included so far within physical accounts. They have to be described in supplementary accounts. Generally they will, in these supplementary accounts, be classified according to their stability, their assimilation capacity, their fragmentation, etc.

As far as the degradation of eco-systems, hydro-systems, concerned links must be established with pollutants accounts, and more generally material flow accounting.

Further, definitions of water related concepts are included in Annex 2.

1. Introduction

The purpose of water accounting is to compute the resource that is available for the various uses; either human or natural in order to detect possible stress or scarcity.

The resource to consider is partly stocks, partly flows.

The main uses of water to consider are those of the population, of farming, of industry, of hydroelectricity, of municipalities, as well as the needs of the natural life, either terrestrial or aquatic.

The needs corresponding to these uses can be expressed in quantity of water of a specific quality. Accordingly, both aspects are to be taken into account.

The availability of the water resource relates to a certain territory and for a certain period in time. Compensation between territories and/or between periods is sometimes possible, sometimes not.

The quality of the resource depends on three factors: the natural conditions, the emissions of pollutants to the water and the run off. Overcoming scarcity of the water resource in quantity and quality is possible but often very costly.

2. The structure of the water accounts

The sketch above suggests a structured design of water accounting in order to capture the main dimensions of the asset.

First, the territorial (river catchments, river drains, underground layers...) and time structure (at least the seasons) are essential for assessing the availability and the possible stress.

Second, the distinction between a « resource system » and a « users system », the latter being connected to the first by means of withdrawals and returns of water (see Annex 2 for a discussion of the definitions of flows between the two systems). The various aspects can eventually be described under this structure in a set of co-ordinated accounts dealing with quantitative and qualitative aspects:

3. Quantitative aspects

Aggregated core account of raw quantities, with stocks and net flows.
(… French/Spanish water accounts)

Detailed core account with an input-output table of the flows within the resource system.
In most countries the local water authorities or water management boards possess detailed information on not only the flows of water between the economy and the water system. Also data on the state of the water system are available, e.g. the water quality at certain points and the amount of available water. In some European countries (France, Italy, Spain) these water management systems form the basis of the development of regional and national water accounts encompassing e.g. the origins and uses by both economic and natural activities of flows of water resources and balance sheets on inland waters with stocks and flows for a given period. The local water management systems and the regional and national water accounts are used for strategic planning for the water resources on a local, a regional and a national level.

Users account, with an input-output table of the sectors.
Aggregated at the national level these users accounts should be consistent with the flow accounts described in Chapter 3. Examples on how to do that are described in Annex 2.

The detailed core account of the resource system and the users account are connected by linkage matrixes which describe the origin (rivers, lakes, underground water...) and fate (surface or underground water, soil, sea...).

4. Qualitative aspects

Accounts of water quality of rivers

These quality accounts are based on quality indexes weighted, for each drain of each catchment area, by the length of the drain multiplied by its flow. See Annex 3 for a preliminary description of the quality accounts.

Accounts of water quality of lakes and reservoirs and underground layers
These quality accounts are based on quality indexes weighted by the volume or the surface.

Accounts of emissions of pollutants to water by point and non point sources
These accounts are aggregated at the national level. These last accounts are consistent with the flows accounts as described in Chapter 3. Examples of this can be seen in Annex 2.

The production of these three accounts within the framework of the catchment areas is necessary for modelling non-linear relations such as emissions-flow-quality.

The results by catchment are aggregated in a second step for producing results about the average and critical quality of the resource at the regional and national level.

ANNEX 1: CLASSIFICATION OF ASSETS RELATED TO WATER IN THE SEEA AND THE SNA

Refers to the CNFA in the SEEA (92):

2.1.3 Land (with ecosystems and soil)
2.1.3.1 Soil
2.1.3.2 Cultivated (economically used) land areas (with connected ecosystems)
2.1.3.2.5 Areas of artificial watercourse or water impoundment
2.1.3.3 Uncultivated land areas (with connected eco-systems)
2.1.3.3.4 Water areas (except areas of artificial watercourse or water impoundment)

and

2.1.4 Water
2.1.4.1 Ground water
2.1.4.1.1 Aquifers
2.1.4.1.2 Other groundwater
2.1.4.2 Water of lakes, rivers etc.
2.1.4.2.1 Water in water reservoirs, artificial watercourses and water impoundments
2.1.4.2.2 Other
2.1.4.3 Coastal water
2.1.4.4 Ocean water

Further specifications are used in most of the accounts for water described in this chapter. Regarding the Material Flow Accounting described in Annex 2, further classifications and definitions are specified regarding water related (economic) products and the industry classification used.

Regarding the Administrative Water Accounts a much more detailed classification is used.

In the French Water Quality Accounts and Water Resource Accounts for example Rivers are further described by sub-groupings of rivers.

ANNEX 2: FLOW TABLES

Scarcity is the main problem for both human users and 'natural' users of the aquatic environment. Floods and draughts have big impacts for both the economy and the environment but are difficult to manage. The only way to do so is to invest in infrastructure capable of managing the water to the benefit of both humans and the environment.

In the case of scarcity, monitoring, and thus better management of the water resources, can be done by focusing on the flows of water between the economy and the environment. These effect the quantity and the quality of the water in nature and thus the asset aquatic systems.

A framework and a set of tables is proposed in order to expose the extent of water-related infrastructure, economic transactions related to water and finally the physical flows of water and pollutants between the economy and the aquatic environment. This framework is connected to the material flow accounts in Chapter 3.

Some of the main pressures, i.e. abstraction and discharges of emissions, placed on the water system by the economic activities and some of the responses (wastewater treatment) can easily be described in a NAMEA-type framework for water. The matrix presentation of flows of water and substances in physical units is organised by economic activities in the same way as are the monetary transactions connected to water.

To begin with the scope of the satellite accounts for water in the present context is restricted to cover inland fresh water only. This excludes salt water and brackish water, but extensions in this direction should not be that difficult. Further excluded is water occurring in certain states not usable for or influenced by human activities. Secondly the aspiration should be to deal not only with water (H_2O) but the contents of other substances contained in water too. This implies that quality aspects of water and the connected flows of substances have to be included in the accounts.

The framework

An extended NAMEA for water could consist of four parts. Rows and columns are added to a simplified social accounting matrix (SAM) in order to describe flows of water and emissions due to the economic activities between the economy and the environment.

A) A SAM is adopted for the presentation of economic transactions, i.e. the supply and use tables of the national accounts together with income, capital and rest of the world accounts. Additionally, monetary flows corresponding to ancillary activities may be specified through "of which" columns. Supply and use tables for distributed water in physical units perhaps by quality classes may be developed relating directly to the monetary data on water distribution and water protection activities.

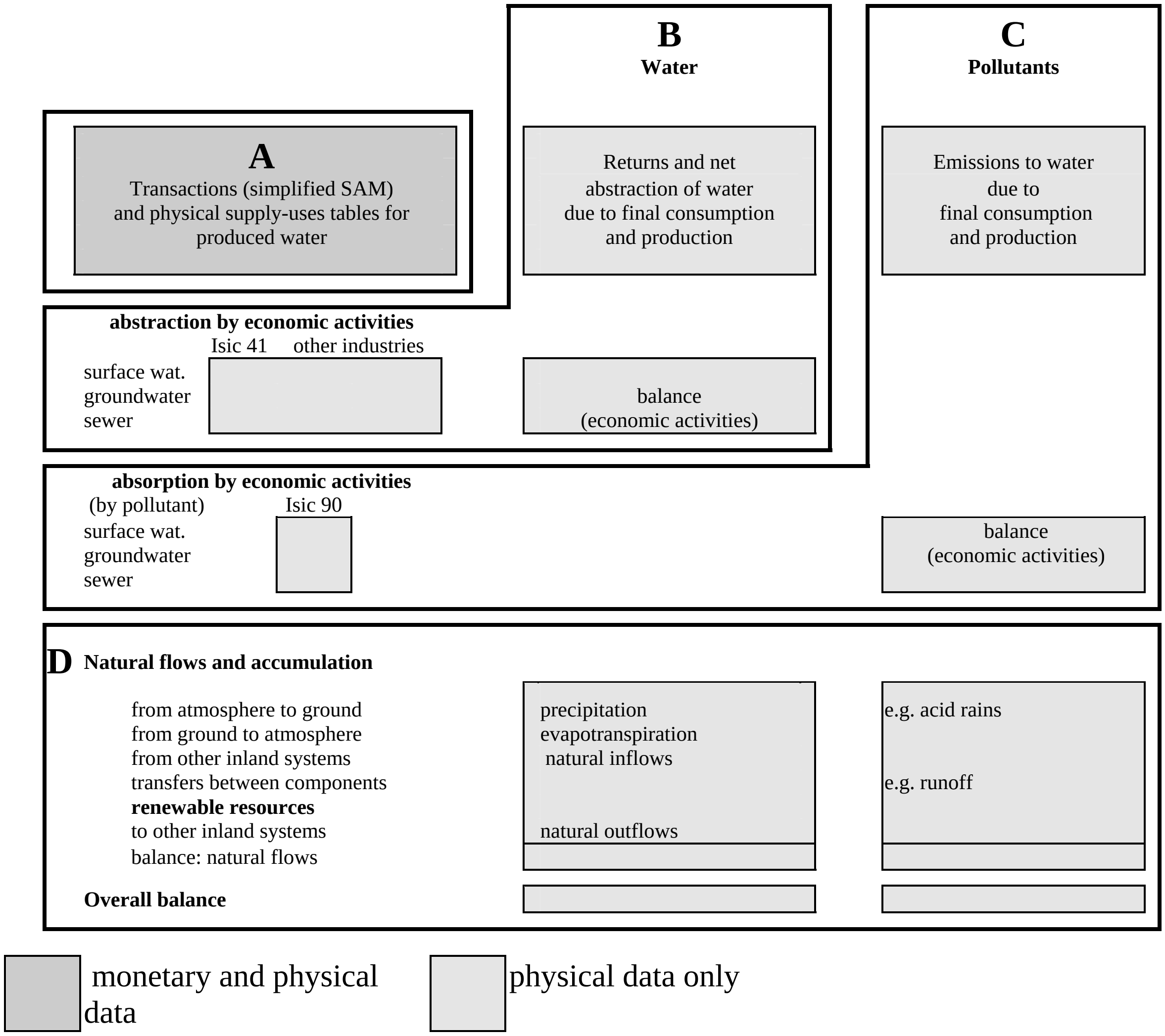
B) This second part, which is in cubic meters only, first shows gross abstraction including direct abstraction by economic activities with a corresponding component in the part of the water system from which the water is abstracted. Returns of (waste) water into the various components of the hydrological system and into the sewer system are described.

Net uses of water for intermediate and final consumption, increases in inventories and exports should be recorded too.

C) The direct emissions of pollutants to water are recorded according to their origin and where they are emitted. The abstraction of pollutants is presented by water pollutant, though also by component of the water system, in connection to waste water treatment, cleansing of surface water bodies. This part contains withdrawals of pollutants from abstracted water too.

D) A fourth part regarding the flows of water and water pollutants within nature described in physical units could be added. These flows are not under the (total) control of any institutional unit even though possibly influenced by human activities. Precipitation, inflows from other inland water systems, evapotranspiration, natural transfers between components of the water system (infiltration, runoff etc.) and the corresponding indirect emissions to and from water bodies (e.g. indirect pollution from fertilisers, pesticides and acid rain) could be included in this section.

What is described in the tables included in this annex 2 concerns parts of A) (economic transactions related to water, flows of water inside the economy), all of B) and C), while D is not included but should be described under the quantity and quality accounts mentioned in sections 4.4.3 and 4.4.4.



Limitations of the NAMEA framework for water

The supply and use tables for water in physical units as described in part A only encompass supply and use of distributed water. The flows corresponding to internal activities within the economic activities, such as re-circulated water, are therefore not directly visible in the accounts.

The indirect emissions are flows of pollutants which originated in the economy which at some point in time ends up in the water system via air, soil etc. could be included in the NAMEA for water as described in part D. The initial emissions of pollutants to the air or on the soil are described in other parts of the SEEA but a bridge should be introduced in the water satellite accounts regarding these indirect emissions. This might create problems in connection with calculation of the themes of NAMEA which are connected to environmental effects that might influence more than one medium.

The description of the interactions between the economy and the environment is limited to flows of water and pollutants. I.e. there is no aspects referring to the state of the water system and of the changes which may affect it, partially due to economic activities. The water accounts in quantities developed by the OECD, France, Spain and Italy which are integrated into the proposed framework in part D would have to be extended in order to include a description of the state of the environment. The biggest problem is that in order to identify the impacts of economic activities on the water system as an environmental medium, we need to specify a complete integrated model of this environmental medium, which does not seem possible for the moment.

Classification of industries

A specification of water related economic products could be: operation of irrigation systems, distributed water, waste water treatment services. The economic activities related to water are: abstraction, purification and distribution of water, collection and treatment of wastewater and finally production of administrative services for water supply and sewage systems.

For the classification of industries NACE Rev.1 is proposed, with three main amendments:

In order to isolate the producers of services of operation of irrigation systems, these services are isolated from the rest of Agriculture in NACE group A (see the classification of water related products below).

It can also be useful to isolate the producers of administrative services related to water supply and sewage systems in NACE 75.

Further NACE 90 has even been broken down into 2 sub-classes : the part (90*) corresponding to the activity of sewage removal and treatment (producing CPA 90.00.11 product) has bee isolated from the other activities of NACE 90.

Classification of water related products

Operation of irrigation systems only constitutes part of CPA 01.41.11 “Services necessary for agricultural production”. These irrigation systems are a specific provision of water to farmers, especially through a network of open-air canals, the feeding and allocation of which is managed. It should be noted that irrigation water could also be provided by NACE 41 through normal pipes (as drinking or non-drinking water).

NACE 41 Collection, purification and distribution of water includes activities that produce water as the principal product of interest. Note that desalting of seawater to produce water is included in NACE 41. On the other hand irrigation system operation that is classified as a "service incidental to agricultural production" (NACE 01.41) and treatment of wastewater solely in order to prevent pollution (NACE 90) are excluded from NACE 41.

According to the CPA, NACE 41 produces three types of products :

- drinking water (CPA 41.00.11)
- non-drinking water (CPA 41.00.12)
- distribution services of water (CPA 41.00.20), including reading and maintenance of meters.

If no distinction is possible between drinking and non-drinking, the total "distributed water" can be used.

Drinking water does not refer to the use of water, but to its quality (= water usable for drinking purposes).
Non-drinking water implies less purification is needed than for drinking water, but some purification might be necessary.

The introduction of part of administrative housing and community amenity services (CPA 75.12.13) is due to the fact that these services are often the official owners of the water supply networks or of the sewage systems, while not directly operating them. The investment made could be underestimated if economic activities are restricted to NACE 41 and 90.

CPA 90.00.11: Sewage removal and treatment services consist of : "Sewage removal and disposal services. Such services are usually provided using equipment such as waste pipes, sewers or drains and processes utilised may be dilution, screening and filtering, sedimentation, chemical precipitation, etc." Does not include construction, repair and alteration works of sewers.

Definition of categories of water resources

The categories of water resources have bee defined in the Eurostat/ OECD questionnaire. Which, in spite of small inconsistencies, are concordant with the classification in SEEA's CNFA as described in Annex 1.

(Fresh) Surface water

"Water which flows over, or rests on the surface of a land mass, natural watercourses such as rivers, streams, brooks, lakes, etc., as well as artificial watercourses such as irrigation, industrial and navigation canals, drainage systems and artificial reservoirs."

(Fresh) Ground water

"Fresh water which is being held in, and can usually be recovered from, or via an underground formation. All permanent and temporary deposits of water, both artificially charged and naturally, in the subsoil, of sufficient quantity for at least seasonal use. Includes phreatic water-bearing strata, as well as deep strata under pressure or not, contained in porous or fracture soils. Includes also springs, both concentrated and diffused, which may be subaqueous."

Other water

"Includes atmospheric precipitation, sea water, permanent bodies of stagnant water both natural and artificial, mine water, drainage water (reclamations) and transitional water, such as brackish swamps, lagoons and estuarine areas."

Definitions of flows between economy and environment

Abstraction (or withdrawal):

"Water removed from any source, either permanently or temporarily. Mine water and drainage water are included." And "Water abstractions from groundwater resources in any given time period are defined as the difference between the total amount of water withdrawn from aquifers and the total amount charged artificially or injected into aquifers. The amounts of water artificially charged or injected are attributed to abstractions from that water resource from which they were originally withdrawn."

Discharge :
"The amount of water (in m^3) or substance (in kg BOD/ d or comparable) added/ leached to a water body from a point or a non point source."

Return :
"Water abstracted from any fresh water source and discharged without use into fresh surface waters or groundwater. Occurs primarily during mining or construction activities. When abstracted fresh water is discharged without any use into "other water", it is not considered to be returned water."

There seems to be some inconsistencies between these definitions. For example, the case of mine and drainage water appears in several definitions : it belongs to the "other water" category but should probably have been first abstracted from a ground or surface water body. However, "returned" water "occurs primarily during mining or construction activities", but no "return" into "other water" can be considered. It is apparently contradictory. These definitions will probably be revised, but it could take a long time as a number of States and international organisations are concerned. In the meantime, we could apply them as the changes new definitions will make are hoped to be slight.

BOD :
"Mass concentration of dissolved oxygen consumed under specific conditions by the biological oxidisation of organic and/ or inorganic matter in water."

COD :
"Mass concentration of oxygen consumed under specific conditions by the chemical oxidisation with bichromate of organic and/ or inorganic matter in water."

The tables
Tables 1 to 4 are in monetary units, the tables 5 to 8 describes physical flows of water, whereas tables 10 to 12 report the corresponding flows of pollutants and finally the different prices are derived in table 13:

Table 1 Supply table of some water related products in monetary units
Table 2 Use table of some water related products in monetary units
Table 3 Economic accounts for some water related economic activities
Table 4 Expenditure for some ancillary water related activities
Table 5 Supply of water within the economy (physical flows corresponding to table 1)
Table 6 Use of water within the economy (physical flows corresponding to table 2)
Table 7 Total abstraction of water from and discharge of waste water directly into water bodies
Table 8 Water abstracted from the water bodies for the preparing of drinking water

Table 9 Balance of flows of water between economy and water system
Table 10 Pollutants discharged by economic activities into the sewage network
Table 11 Pollutants discharged to water bodies by direct discharge of waste water
Table 12 Pollutants subtracted by economic activities
Table 13 Average purchaser's prices of some water related economic products

There is a direct correspondence between the proposed economic and physical tables except for tables 9 to 12. The interactions of some economic actions with the environment, though, are difficult to translate into physical units. This applies for records of economic instruments such as prices, taxes etc. and construction works and their maintenance (of interest here are investment grants for waste water treatment, transfers to local authorities in charge of treatment, capital formation which are included in table 3). In order to expose how the activities of water supply and control are arranged in the different countries it might be interesting to investigate further the possibilities for inclusion of such data within the accounts and maybe a division between user and owner.

Table 1 and 5

The purpose of this table is to report the *major economic output related to water* (as well as possible imports): production of drinking, non-drinking, irrigation water, production of sewage removal and treatment services.

The products and activities listed above correspond to activities implying a displacement of water into controlled networks in order to use it. A use could be defined as any economic action, which :

- either makes water temporarily disappear from the aquatic environment, e.g. is evaporated or incorporated in a product (consumption)
- or temporarily makes physical characteristics of water change (e.g. temperature)
- or adds biological or chemical elements to it (pollution).

This first table is a monetary table and is an extraction from ESA, but with more detail : more than 6 digits CPA. Environmental taxes and subsidies are isolated.

Table 5 correspond to table 1 but is in physical units. In table 5 purely monetary lines (e.g. taxes) have been eliminated and services have been converted into corresponding flows of water to which they apply. In order to keep the equality of supply and use of the monetary tables, flows of water to be recorded here correspond to the flows that make the economic transaction, i.e. flows of distributed water and flows of waste water collected, at the end of the production process for the product of NACE 41, at the beginning of the production process for NACE 90*.

Table 2, 6 and 13

Table 2 is also a re-composition of ESA accounts. While table 1 presents the supply table of conventional input/ output, table 2 reports the "use" side of the same economic products: industries and households are users of drinking water and of waste water removal and treatment services, while generally only industries use non-drinking water.

Government and NPISH (= non-profit institutions serving households) have been introduced as possible consumers, in case they are producers and their production is non-market. Changes in inventories are probably insignificant: this line corresponds to already prepared water stored in the distribution networks (water towers).

Table 6 correspond to table 2 but is in physical units. In table 6 purely monetary lines (e.g. taxes) have been eliminated and services have been converted into corresponding flows of water to which they apply.

Table 13 can be derived from tables 2 and 6 and allows to compare prices between industries, and maybe between regions, according to the geographical level retained for the preceding tables.

Not included in the tables but still important are *Other economic actions involving water*. These activities are represented by the column "minor products". Example could be:

- the arrangement of flows (e.g. regulation for navigation) consequently resulting in a different allocation of water resources in time and space
- treating polluted water bodies by dredging or reintroducing wild life species resulting in an improvement of water quality of water bodies
- controlling water quality in water bodies
- etc.

With regards to the activities mainly aiming at water supply or wastewater treatment, some attention should be paid to the delimitation of NACE 41, 75 and 90. Depending on the Organisation of water management differs between countries and even between the regions or districts. Some activities are carried out by governmental agents, general or local, and are thus classified as "public administration and defence services activities" (NACE 75). For example, there is a possibility that the building of a dam to create an artificial reservoir is recorded as a fixed capital formation either by producers of distributed water (NACE 41) or by administrative services for water supply (NACE 75). Therefore it is proposed to include activities of public administrative services regarding water supply and sewage operations, too.

Not negligible economic actions also consist in *fighting against water*. Undesirable water may generate economic activities that include combat of floods, drainage of mining water, drainage urban water, drainage of roads, reclamation of marshes and polders, snow and ice clearing services, etc.

Table 7, 8 and 9

The flows with the environment will be studied through table 7 (abstractions and returns). Leaks, losses, or on the contrary additions (e.g. rain water drained into sewers) during the production processes will be made available through the reconciling table 9 which presents a whole balance of water between economy and the water system by reconciling the tables 5, 6 and 7.

Table 8 For abstraction of water for preparation of drinking water however, use of the politically norms is possible for a definition of a set of quality classes. This set of quality requirements will have to be decided according to use. The classes are defined by the parameters in a specified table.

Table 10, 11 and 12

These tables trace some of the flows of pollutants induced by uses of water. Purification and treatment steps are recorded. Table 10 traces the emissions of pollutants into the sewerage system. Table 11 trace pollutants discharged with wastewater into the different water bodies, either directly by the user or with the intermediary of wastewater removal and treatment services. Table 12 traces pollutants subtracted before or after use, respectively by NACE 41 and 90*.

ANNEX 3: QUALITY ACCOUNTS

As mentioned in section 4.4.4 qualitative accounts can be made for surface waters. Below is a short summary of the method, which is being developed in France, based on an internal working paper presented in the Eurostat Task Force on Water Satellite Accounting (*The Accounts of the quality of the watercourses. Implementation of a simplified method. On-going developments Synthesis of the general report AUGUST 1999*).

This summary deals specifically with the part of the Accounts of water/Quality and of its pilot application to France, carried out at the scale of the drainage basins of the RNDE catchment areas (BV RNDE). A simplified method, the only possible while waiting for the availability of the data necessary for the application of complete methodology, was developed and was used to this end. It summarises the principles and the alternate methodology of the project and presents the results of a report that will be published in the collection « Etudes et travaux » of the Ifen.

PRINCIPLES OF THE GENERAL METHOD

Quality expresses a state of the water that, in addition, is not measurable as such, because lacking of dimension equation. One can therefore estimate it by:

- Well defined and characterised volumes of water sorted by quality or
- Derived units, worked out especially or in particular those defined pursuant to the principle of conversion[16]

To mitigate the theoretical difficulties of constitution of quality accounts, the experts of the Commission Interministérielle des Comptes du Patrimoine naturel (CICPN) introduced the concept of *kilometre of standard river* (or water course), (**kmcn)**, which is a conversion unit. A kmcn represents therefore a watercourse of 1 km long where 1 m3/s runs out, or 0.5 km where run out 2 m3/s.

The application of this method places a number of constraints in terms of data, which it was not possible to collect or build without preliminary evaluation of the relevance of the quality accounts. To mitigate this difficulty, a much less binding, but obviously simplified model, was developed as a pilot test.

Simplified method

A simplified method was developed by the Ifen, with the aim:

- To produce quality accounts for each drainage basin RNDE ([17]), comparable at the national level, by using the weighting of qualities by the kmcn size, in such a way that this pilot test remains compatible with later developments using the basic method.

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16 A unit converted make it possible to count together different objects, but presenting common properties, which are used for conversion. Units like the oil equivalent tonne (TOE), the livestock unit (LU), population equivalent (PE) are common examples of such converted units.

17 The IFEN proposed and developed, under the RNDE, a breakdown of the European France territory in 55 large drainage basins, based on hydrographic coding. These basins, called «RNDE catchment areas» are the basis of national statistics on surface water. The application of this concept to a European level was also suggested to the European Environment Agency (EEA). Each RNDE basin is characterised by a numerical code of four digits, the two first pointing out the belonging of the catchment of the one of the 6 Water agencies. Each basin has a surface ranging between 6000 and 13000 km $^{2.}$

- To compile these accounts from the quickly available data, so as to produce them at the minimum cost, within the framework of a pilot test,
- Also to produce elements of evaluation so as to allow a judgement regarding the advisability of constituting the data sets necessary for the accounts, according to a more orthodox method than the simplified method production and which results could be aggregated according to different geographical units.

The data used is the ArcINFO ® format coverage of *maps on paper* of linear quality of the watercourses published by the RNDE with a twofold aim of development of the existing data and teaching.
They were not at all conceived to allow statistical and accounting use. Consequently, the rivers of the maps are not identifiable. These maps comprise however a classification of the rivers in 4 size classes, those were named, « main rivers », « large tributaries », « rivers » and « brooks ». According to the files attached to the maps, the overall length of watercourses ranges from 70 000 to 80 000 km, of which 55 000 at 33 000 km comprise a quality grade.

A method of approximation of the relevant water discharges has been developed. Thanks to simplifying hypotheses on the hydrological productivity of the various classes of watercourses, and of the hydrographic density by drainage basin, a reference flow could be allotted. The data used to fix this approximation of the flows comes of almost 200 measuring sites having been the subject of a regular 10-year monitoring at least until 1993, and published by the RNDE

Distribution of the kmcn by BV RNDE.
The presence of certain types of watercourses and of their relative importance, expressed by the kmcn size, varies widely from a region of France to another. These differences are illustrated by a map which shows that the presence of certain types of water-courses is not ensured in all RNDE basins, and especially that the relative importance of these various types is varies extremely from one region to another. It is noted in particular that the downstream reaches of the Rhone are of a considerable weight in the total kmcn of the "main rivers" class. It is clear that these results, presented within the framework of a pilot study based on data about which one could say they need some evaluation and improvement, have to be handled with precaution.

The future developments of the quality accounts will have to set out again of a database of the more complete watercourses than that currently used for the publication of the maps. However, it is recalled that the database CARTHAGE is not yet available for the whole European territory of France.

RESULTS OF THE QUALITY ACCOUNTS

The presented results disregard the water-courses for which quality information is not available, by considering that information available for each class of water-courses is representative of all of this class.

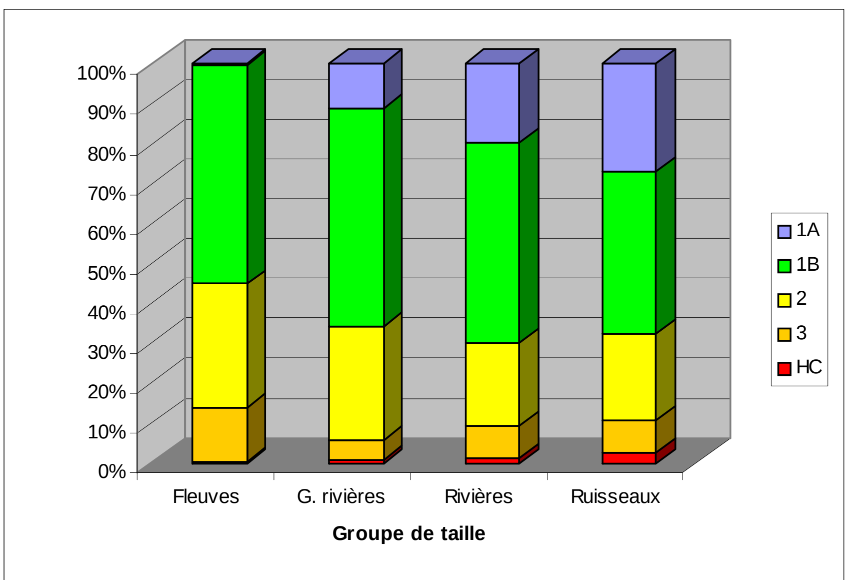
"Organic matter" indicator quality

The quality « organic matter » corresponds to the assignment of a quality grade according to the rules of the SEQ-eau. The SEQ-Eau defines indicators, which are groups of parameters and associated threshold values of these parameters. The indicator « organic and oxydable matter », takes into consideration the dissolved oxygen, the BOD_5 (biochemical oxygen demand at 5 days), the COD (chemical oxygen demand) and ammonium (ion NH_4^+). The resulting quality classes are expressed in 5 classes, noted 1A, 1B, 2, 3 and HC (not classified) respectively expressing the best case to the worst case and illustrated according to a color code going from blue to red.

Two data sources were included. The map of the 1992 state was not drawn up strictly according to the rules of assignment of the quality of the SEQ-eau. However, the methods of assignment of the « general quality » are in fact very close to those used subsequently to define the indicator « organic matter and oxydable ». One therefore considered the comparison between this map and the map of the 1994 state possible, in view of other very large uncertainties on the quality of the data. Before treatment, the files associated with this map were transferred on a cartographic base compatible with the later publications.

Figure 1: Distribution (in percentages) of the kmcn quantities per quality grade and per size class of watercourses. 1994 state. Organic and oxidizable matter indicator.

The 1994 state map benefited from improvements in its realisation, in particular according to the experience gained during the carrying out of the map of the 1992 state. This map comprises however a lesser linear of watercourses filled up with water quality class than the map of the 1992 state was. The compared assessment of both states suggests nevertheless a noticeable improvement of the quality of the watercourses, in particular with regard to the class «main rivers », in which quality expressed in red (« Out of Class ») is almost not found any more.



Source: Data water agencies, RNB via BNDE, Ifen calculations

Results can be presented in the form of a table of the accounting type. In theory, the same hydrographic base should be processed, which is not the case. The 1992 state was therefore recomputed by admitting that the distribution of the kmcn by basin and by class of water-courses is representative. The aggregated results are presented in the following table. It was established by referring both maps back to a common hydrographic base, calculated as from the 1994 state. States and differences were calculated separately, which demonstrates some data inconsistencies.

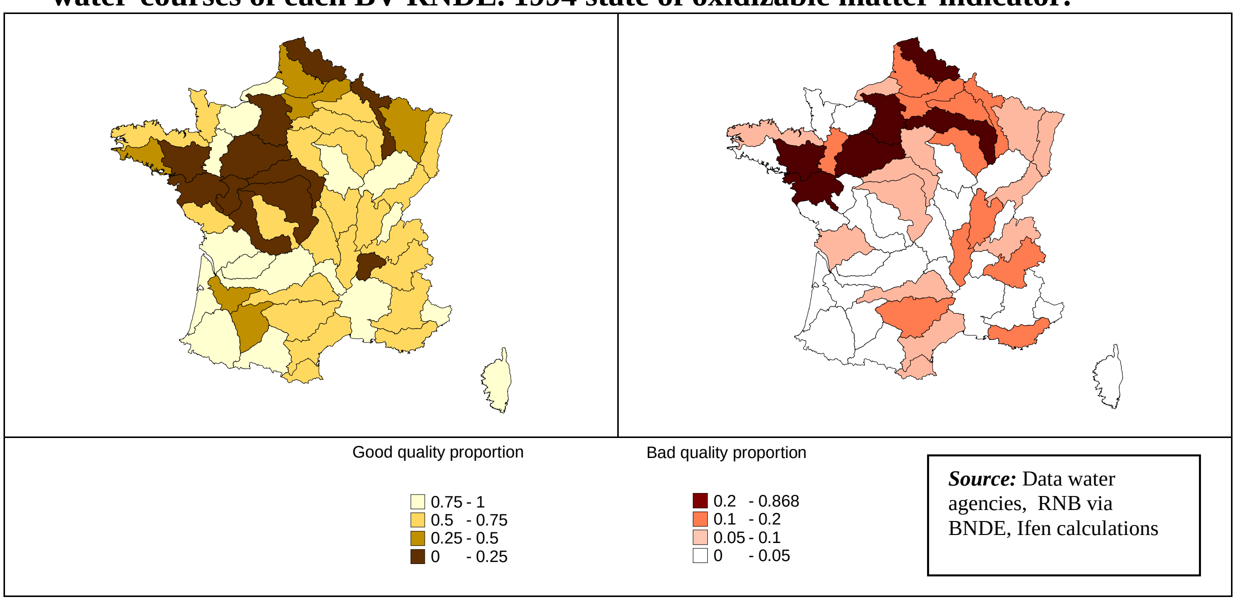
Table 1: Account (in kilo-kmcn) of the states of quality of water (organic matter indicator), all of France, broken down by group of size of watercourses.

Group of water-courses	1992 state					Differences by quality class					1994 state				
	1A	**1B**	**2**	**3**	**HC**	**D1A**	**D1B**	**D2**	**D3**	**DHC**	**1A**	**1B**	**2**	**3**	**HC**
(Big) Rivers	5	1253	891	510	177	3	*336*	*9*	*- 183*	*- 165*	8	1583	893	358	12
Large rivers	309	1228	1194	336	50	*16*	464	- 275	- 182	- 22	325	1691	919	154	28
Rivers	260	615	451	128	47	*44*	*130*	- 129	- 17	- 28	306	749	322	110	18
Brooks	860	1464	690	243	95	*- 44*	*- 176*	*228*	*15*	- 23	810	1295	917	258	72
Total	**1434**	**4560**	**3226**	**1217**	**369**	**19**	**754**	**- 167**	**- 367**	**- 238**	**1448**	**5318**	**3051**	**881**	**131**

Note: in the difference columns, the figures in italic give a slightly different calculated difference of the difference between the 1994 and 1992 states. This is because of the impossibility of connecting certain groups of water-courses in some BV RNDE.

The geographical representation of the 1994 state was summarised by aggregating, in each basin, the quantity of kmcn of good (classes 1A and 1B) or of bad (classes 3 and HC). The proportion of kmcn of good (to the left) or of bad (to the right) quality is represented in the two following maps. The range of the proportions is obviously different, the high quality being the rule while the bad has to represent only the exception.

Figure 2: Proportion of kmcn of good or of bad quality, reported to all the classes of water-courses of each BV RNDE. 1994 state of oxidizable matter indicator.



It is remarkable that certain basins present at the same time few kmcn of high quality and a great deal of bad one. This is understood as a sign of bad general quality (the downstream Seine, the Loir and Sarthe, the North basins, etc.). On the contrary, other basins (Charente, the upstream Seine, coastal rivers of the Mediterranean, etc.) are characterised by limited areas of bad quality, represented by a dark color on the right-hand side card, and by a clear color on left-hand side.

Other quality parameters

The simplified method was applied to nitrate and eutrophication indicators. Again, the quality grades were affected according to the respective “nitrate” or “plant blooms” indicator of the Water-SEQ. Regarding nitrate, the indicators deals only with the concentration of water in ion NO_3^-. The corresponding grades are expressed according to a scale N1 to N5. This indicator refers very explicitly to the conformity values for distribution water. Consequently, the limits that define the indicator levels are respectively 5, 25, 50 and 80 mg NO_3^- l^{-1}. Such values are excessive for watercourses, the natural contents of which are of about a mg NO_3^- l^{-1}. ; Hence, apparently satisfactory water quality classes may be reported.

Despite this, deterioration of watercourses due to nitrate appears clearly in the West of a North-East/South-Western line halving France. This finding is confirmed by other studies and data processing, which are in particular reported in the chapter « inland waters » of the last situation report on the environment, issued in 1999. An accounting table is not realisable, only one state being available at present.

The eutrophication of water is a specific problem, which is reflected mainly by plant (mainly phytoplankton) blooms in quantities exceeding the possibilities of grazing and aerobic degradation of the recipients in which it occurs. Consequently, eutrophication behaves as a secondary organic pollution, which consumes oxygen, asphyxiates water and causes leaching out of unwanted substances (methane, ammonia, hydrogen sulphide) in the most paroxystic cases. It is taken into consideration by means of specific indicator of the Water-SEQ.
Data analysis clearly demonstrates the strong regionalisation of the eutrophication problems. Their causes are principally the discharges of biodisponible phosphorus by the cities, industries and possibly, agriculture.

Constitution of overall indexes for the evaluation and the comparison

Tables, graphs and cards shown above are the basic elements of the Water Quality accounts. Two complementary analyses can nevertheless be envisaged by calculating an index of quality, which constitutes the overall quality of a basin or of a cluster of basins.

The definition of this index implies taking into account the actual weight of each quality grade that is used to establish it. Henceforth, the use of the Water-SEQ allows a sound approach. The design of the water quality grades of Water-SEQ was indeed based on a continuous value of each indicator, in the range 1 to 100. The 5 classes result from cutting it into equal intervals of 20. This is relevant since the relationship between the continuous value and the chemical threshold values of the parameters that constitute the indicator are linked by means of an ad hoc mathematical function. Consequently, the intervals of classes are made constant by the evaluation method itself. An overall type index « classifies average » was made up for the carrying out of the Quality accounts while being based on the definition of the classes of the SEQ.

For obvious calculation reasons, the designations of quality grades (1A,.., for the oxydable matters, N1, N2,.., for nitrate, E1, E2,.., for eutrophication), were recalculated into an index ranging between 1 and 5, from the best to the worst possible quality. The interest of this index is double. It makes it possible to free from the differences in the processed geographical coverages, the direct comparison of the kmcn being rather complex with the current data. Moreover, it yields a very aggregated and synthetic representation of the results.

In the case of national aggregation, a single value can be produced by this method. The thus obtained values of average quality are reported in the following table.

Table 2: Compared results of the aggregated water quality grades.

Indicator	Size class of water-courses				
	Main rivers	Large tributaries	Rivers	Brooks	**Whole**
Organic matter (1992)	3.32	3.05	2.88	2.68	2.98
Organic matter (1994)	3.06	2.82	2.69	2.75	2.83
Nitrate	2.49	2.30	2.35	2.44	2.39
Plant blooms	2.75	2.53	2.43	2.39	2.53

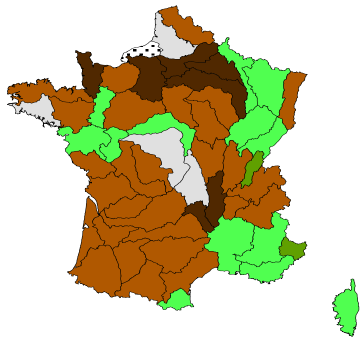
Warning: the column « whole is not the average of the previous columns, its calculation results from weighting according to the kmcn of each size class of water-courses.

The constitution of an overall quality index, which can be declined by group of watercourses and by indicator allows therefore to define the relative importance and the distance, expressed in quality grade, of any indicator compared to another. This comparison consequently constitutes a very powerful evaluation tool. It is seen for example, that the quality expressed in relation to nitrate in the large rivers *is on average better by a class* than quality with respect to the organic matter in the rivers in 1992.

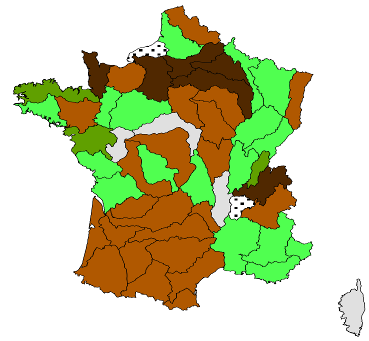
Relative importance of the various pollutions.

The comparison of the preponderance (difference of the values of the average quality grades) makes it possible to compare quickly the basins in which indicator presents the most marked problem, for a given class of water-courses. The two following maps present an example of preponderance between the organic matter, taken as reference, and respectively eutrophication and nitrate. In order to demonstrate the geographical diversity of the situations, the illustration comprises only the map of preponderance aggregated over all size groups of water courses and the map of the size group for which the largest number of RNDE catchments is concerned.

Figure 3: Examples of geographical distribution of the respective preponderance of eutrophication and of the organic matter in the quality of water. 1994 state of quality, by class of water-courses.



All watercourses



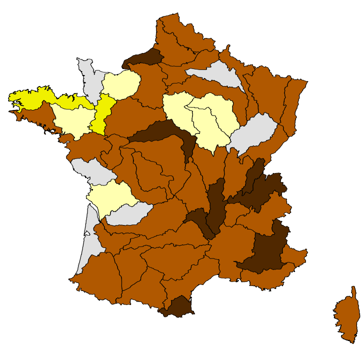
Main tributaries

The strong preponderance (>>) is defined for more than one weighted water quality class difference. Equivalence is defined for a difference by ±0,1 water quality class. The low preponderance is defined in the intermediate situations.

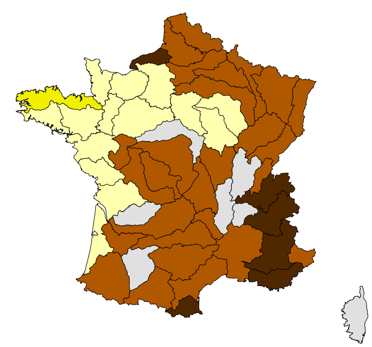
Source : data water agencies RNB via BNDE, calculations IFEN

- MO>>eutr.
- MO>eutr.
- Equivalence
- Eutr.>MO
- NEutr.>>MO
- NC

Figure 4: Geographical distribution of the respective preponderance of nitrate and of the organic matter in the quality of water. 1994 state of general quality, by class of water-courses.



All watercourses



Main tributaries

The strong preponderance (>>) is defined for more than one weighted water quality class difference. Equivalence is defined for a difference by ±0,1 water quality class. The low preponderance is defined in the intermediate situations.

Source : data water agencies RNB via BNDE, calculations IFEN

- MO>>nitrate
- MO>nitrate
- Equivalence
- nitrate>MO
- nitrate>>MO
- NC

CONCLUSION. PROPOSALS FOR IMPROVEMENT

The pilot study carried out with a simplified method allows a very promising valorisation of water quality data. This development results mainly from the use of a conversion unit, the kmcn, which results from theoretical and practical considerations on the comparability of the rivers.

The application of the simplified method to data that were not intended for this purpose yields results that are in conformity with what other interpretations had made it possible to conclude.

Consequently, one can envisage the method as an additional added value which makes it possible to carry out comparisons between successive states of quality considered by the same indicators or parameters, as well as a possibility of treating on a hierarchical basis the causes of water pollution.

The interest presented by the obtained results encourages therefore eliminating the errors, slants and uncertainties inherent in the simplified method. The principal uncertainties of the application of the simplified method are:

1. The taking into account of a low quality geographical coverage of water-courses, this can be corrected by using the base of the data base CARTHAGE, being prepared for the carrying out of the water accounts / resource.
2. The impossibility of calculating correct flows on the upstream reaches of the basins, which causes a bias, inherent in the simplified method. Generally, the carrying out of a hydrometric reference database, also on-going within the framework of the water accounts / resource sorts out a part of this problem.
3. Map drawing errors, such as thickening the width of a water course by multiple drawing, that are errorless for paper printing might cause double accounts, if not corrected at the time of the preparation of the datafiles to be processed. More fundamental errors of assignment of quality to a segment of watercourses interfere as well.

An improvement in two stages of the carrying out of the Quality accounts is envisaged. The first stage consists in developing the geographical and hydrological bases necessary for the accounts in resource. On the other hand, the linear data of quality will continue being used as a data of quality of water. This stage will be carried out using the said « semi-simplified » methodology.

In a second stage, the development of the representative networks, on behalf of EUROWATERNET, also leaded by Ifen in France, will make it possible to obtain results of water quality on a statistical basis

This second hypothesis is a very important and promising area of work. It is the only one which would make it possible to overcome all fundamental issues, using continuous figures of the values of quality indicators, according to the SEQ-eau procedure, instead of integer values of water quality classes. Data processing according to this method would yield results remaining comparable with those resulting of the methods simplified or semi-simplified, notwithstanding the precision near the result.

ANNEX 4: WATER SATELLITE ACCOUNTS - ILLUSTRATIVE TABLES

The proposed tables are still preliminary. A new version with minor changes will be finished in 2000.

Table 1 - Supply table of some water related products [1]

(in monetary units)

		Products	Water distribution and treatment (CPA codes)								Other products
			Part Operation of irrigation system	41.00.11 Drinking water	41.00.12 Non drinking water	41.00.20.01 Distribution services of drinking water	41.00.20.02 Distribution services of non drinking water	**41.00 Total distributed water**	**Part Water related administrativ service**	**90.00.11 Sewage removal treatment**	(second priority)
Total output at basic prices											
	01*	Operation of irrigation systems									
	A*	Agriculture, hunting and forestry, except 01*									
	B	Fishing									
	CA	Mining and quarrying of energy producing materials									
	CB	Mining and quarrying except energy producing materials									
	DA	Manufacture of food products; beverages and tobacco									
	DB	Manufacture of textiles and textiles products									
Producin	DC	Manufacture of leather and leather products									
	DD	Manufacture of wood and wood products									
industrie	DE	Manufacture of pulp, paper; publishing and printing									
	DF	Manufacture of coke, refined petroleum and nuclear									
by NACE	DG	Manufacture of chemicals, man-made									
	DH	Manufacture of rubber and plastic products									
subsection	DI	Manufacture of other non-metallic mineral products									
	DJ	Manufacture of basic metals and fabrication of metal products									
	DK	Manufacture of machinery and equipment									
	DL	Manufacture of electrical and optical equipment									
	DM	Manufacture of transport equipment									
	DN	Manufacturing n.e.c									
	41	Collection, purification and distribution of water									
	E*	Electricity, gas and water supply, except 41									
	F	Construction									
	75*	Public administrative services for water supply and sewage systems									
	90*	Sewage removal and treatment									
	R*	Other services (G to Q, except 75* and 90*)									
Taxes on products											
		Of which environmental									
Less subsidies on products											
		Of which environmental									
Imports CIF											
Total supply at purchasers' prices											

[1] *as reported in the ESA, but*

Table 2 - Use table of some water related products[1]

(in monetary units)

		Products	Water distribution and treatment (CPA codes)								Other products
			Part 01.41.11 Operation of irrigation systems	41.00.11 Drinking water	41.00.12 Non drinking water	41.00.20.01 Distribution services of drinking water	41.00.20.02 Distribution services of non drinking water	**41.00 Total distributed water**	**Part 75.12.13 Water related administrative services**	**90.00.11 Sewage removal and treatment**	(second priority)
Total intermediate consumption of industries											
	01*	Operation of irrigation systems									
	A*	Agriculture, hunting and forestry, except 01*									
	B	Fishing									
	CA	Mining and quarrying of energy producing materials									
	CB	Mining and quarrying except energy producing materials									
	DA	Manufacture of food products; beverages and tobacco									
	DB	Manufacture of textiles and textiles products									
Consuming	DC	Manufacture of leather and leather products									
	DD	Manufacture of wood and wood products									
industries	DE	Manufacture of pulp, paper; publishing and printing									
	DF	Manufacture of coke, refined petroleum and nuclear fuel									
by NACE	DG	Manufacture of chemicals, man-made fibres									
	DH	Manufacture of rubber and plastic products									
subsections	DI	Manufacture of other non-metallic mineral products									
	DJ	Manufacture of basic metals and fabrication of metal products									
	DK	Manufacture of machinery and equipment n.e.c									
	DL	Manufacture of electrical and optical equipment									
	DM	Manufacture of transport equipment									
	DN	Manufacturing n.e.c									
	41	Collection, purification and distribution of water									
	E*	Electricity, gas and water supply, except 41									
	F	Construction									
	75*	Public administrative services for water supply and sewage systems									
	90*	Sewage removal and treatment services									
	R*	Other services (G to Q, except 75* and 90*)									
Total final consumption											
	by government										
	by NPISH										
	by households										
Changes in inventories											
Exports FOB											
Total uses at purchasers's price											

[1] *as reported in the ESA, but detailed*

Tables 3 - Economic accounts for some water related economic activities [(1)]

(in monetary units, except for item 7)

	Non financial corporations	General Government	NPISH	Households	Total
Production and generation of income accounts					
1 Total intermediate consumption					
2 Total value added, gross					
2.1 Compensation of employees					
2.2 Other taxes on production					
Of which: environmental taxes					
2.3 Less other subsidies on production					
Of which: environmental subsidies					
2.4 Consumption of fixed capital					
2.5 Net operating surplus					
3 Total output at basic prices					
3.1 Market					
3.2 Non-market					
Supplementary information about fixed capital and labour inputs					
4 Investment grants					
5 Gross fixed capital formation					
6 Closing stocks of fixed assets					
7 Total hours worked					

[1] *Ideally, a table must be filled in for each of the following major activities:*

- *1 operation of irrigation systems (part of NACE 01)*
- *2 production of distributed water (NACE 41) if possible broken down into:*
  - *2.1 production of drinking water if possible broken down into:*
    - *2.1.1 abstraction*
    - *2.1.2 purification*
  - *2.2 production of non-drinking water if possible broken down into:*
    - *2.2.1 abstraction*
    - *2.2.2 purification*
  - *2.3 distribution services of water if possible broken down into:*
    - *2.3.1 for drinking water*
    - *2.3.2 for non-drinking water*
- *3 sewage removal and treatment (part of NACE 90) if possible broken down into:*
  - *3.1 removal*
  - *3.2 treatment*
  - *3.3 discharge*
- *4 administrative services related to water supply and sewage systems (part of NACE 75)*

Tables 4 - Expenditure for some ancillary water related activities[1]

(in monetary units, except for last column)

		Expenditure	Current expenditure				Capital expenditure	Consumption of fixed capital (second priority)	Closing stock of fixed assets (second priority)	Labour inputs in total hours worked (second priority)
			Intermediate consumption	Compensation of employees	Taxes related to water	Less subsidies related to water				
Total industries										
Industries by NACE subsections	01*	Operation of irrigation systems								
	A*	Agriculture, hunting and forestry, except 01*								
	B	Fishing								
	CA	Mining and quarrying of energy producing materials								
	CB	Mining and quarrying except energy producing materials								
	DA	Manufacture of food products; beverages and tobacco								
	DB	Manufacture of textiles and textiles products								
	DC	Manufacture of leather and leather products								
	DD	Manufacture of wood and wood products								
	DE	Manufacture of pulp, paper; publishing and printing								
	DF	Manufacture of coke, refined petroleum and nuclear fuel								
	DG	Manufacture of chemicals, man-made fibres								
	DH	Manufacture of rubber and plastic products								
	DI	Manufacture of other non-metallic mineral products								
	DJ	Manufacture of basic metals and fabrication of metal products								
	DK	Manufacture of machinery and equipment n.e.c								
	DL	Manufacture of electrical and optical equipment								
	DM	Manufacture of transport equipment								
	DN	Manufacturing n.e.c								
	41	Collection, purification and distribution of water								
	E*	Electricity, gas and water supply, except 41								
	F	Construction								
	75*	Public administrative services for water supply and sewage systems								
	90*	Sewage removal and treatment services								
	R*	Other services (G to Q, except 75* and 90*)								
Households for final consumption										
Total										

[1] *Ideally, a table must be filled in for each of the following activities:*
- *abstraction of water from water system*
- *purification of abstracted water*
- *internal recycling of water*
- *internal treatment of waste water before discharge*
- *discharge of waste water into water system*

and as much as possible for minor activities.

Table 5 - Physical flows of water corresponding to transactions recorded in table 1

(in thousands m^3)

		Products	Irrigation water delivered	Drinking water delivered	Non drinking water delivered	Total drinking + non drinking	Waste water collected by sewage networks[1]	Waste water treated by sewage networks[2]
Total output								
Producing industries by NACE subsections	01*	Operation of irrigation systems						
	A*	Agriculture, hunting and forestry, except 01*						
	B	Fishing						
	CA	Mining and quarrying of energy producing materials						
	CB	Mining and quarrying except energy producing materials						
	DA	Manufacture of food products; beverages and tobacco						
	DB	Manufacture of textiles and textiles products						
	DC	Manufacture of leather and leather products						
	DD	Manufacture of wood and wood products						
	DE	Manufacture of pulp, paper; publishing and printing						
	DF	Manufacture of coke, refined petroleum and nuclear fuel						
	DG	Manufacture of chemicals, man-made fibres						
	DH	Manufacture of rubber and plastic products						
	DI	Manufacture of other non-metallic mineral products						
	DJ	Manufacture of basic metals and fabrication of metal products						
	DK	Manufacture of machinery and equipment n.e.c						
	DL	Manufacture of electrical and optical equipment						
	DM	Manufacture of transport equipment						
	DN	Manufacturing n.e.c						
	41	Collection, purification and distribution of water						
	E*	Electricity, gas and water supply, except 41						
	F	Construction						
	75*	Public administrative services for water supply and sewage systems						
	90*	Sewage removal and treatment services						
	R*	Other services (G to Q, except 75* and 90*)						
Imports								
Total supply								

[1] *These flows of water correspond to the supply of "removal of waste water" service provided by NACE 90 industry.*
[2] *These flows of water correspond to the supply of "treatment of waste water" service provided by NACE 90 industry.*
The provision of "waste water treatment" service will also be recorded by corresponding pollutants flows tables (tables 10 and 11).

Table 6 - Physical flows of water corresponding to transactions recorded in table 2

(in thousands m^3)

		Products	**Irrigation water used**	Drinking water used	Non drinking water used	**Total drinking + non drinking**	**Waste water discharged in sewage networks**
Total intermediate consumption of industries							
	01*	Operation of irrigation systems					
	A*	Agriculture, hunting and forestry, except 01*					
	B	Fishing					
	CA	Mining and quarrying of energy producing materials					
	CB	Mining and quarrying except energy producing materials					
	DA	Manufacture of food products; beverages and tobacco					
	DB	Manufacture of textiles and textiles products					
Consuming	DC	Manufacture of leather and leather products					
	DD	Manufacture of wood and wood products					
Industries	DE	Manufacture of pulp, paper; publishing and printing					
	DF	Manufacture of coke, refined petroleum and nuclear fuel					
by NACE	DG	Manufacture of chemicals, man-made fibres					
	DH	Manufacture of rubber and plastic products					
subsections	DI	Manufacture of other non-metallic mineral products					
	DJ	Manufacture of basic metals and fabrication of metal products					
	DK	Manufacture of machinery and equipment n.e.c					
	DL	Manufacture of electrical and optical equipment					
	DM	Manufacture of transport equipment					
	DN	Manufacturing n.e.c					
	41	Collection, purification and distribution of water					
	E*	Electricity, gas and water supply, except 41					
	F	Construction					
	75*	Public administrative services for water supply and sewage systems					
	90*	Sewage removal and treatment services					
	R*	Other services (G to Q, except 75* and 90*)					
Final consumption							
	by government						
	by NPISH						
	by households						
Change in inventories							
Exports FOB							
Total uses							

[1] *These flows of water correspond to the use, by industries or households, of the "removal of waste water" service provided by NACE 90 industry.*
The allocation of the flows of waste water "treated" by NACE 90 seems difficult to obtain.

Table 7 - Total abstraction of water from the water bodies and total discharge of waste water directly into the water bodies (1)

(in thousands m^3)

			Abstraction from			Total abstractions	Discharge to			Total discharges
			Surface fresh water	Ground fresh water	Other water		Surface fresh water	Ground fresh water	Other water	
Total industries										
	01*	Operation of irrigation systems								
	A*	Agriculture, hunting and forestry, except 01*								
	B	Fishing								
	CA	Mining and quarrying of energy producing materials								
	CB	Mining and quarrying except energy producing materials								
	DA	Manufacture of food products; beverages and tobacco								
	DB	Manufacture of textiles and textiles products								
	DC	Manufacture of leather and leather products								
	DD	Manufacture of wood and wood products								
Industries	DE	Manufacture of pulp, paper; publishing and printing								
	DF	Manufacture of coke, refined petroleum and nuclear fuel								
by NACE	DG	Manufacture of chemicals, man-made fibres								
	DH	Manufacture of rubber and plastic products								
subsections	DI	Manufacture of other non-metallic mineral products								
	DJ	Manufacture of basic metals and fabrication of metal products								
	DK	Manufacture of machinery and equipment n.e.c								
	DL	Manufacture of electrical and optical equipment								
	DM	Manufacture of transport equipment								
	DN	Manufacturing n.e.c								
	41	Collection, purification and distribution of water								
	E*	Electricity, gas and water supply, except 41								
	F	Construction								
	75*	Public administrative services for water supply and sewage systems								
	90*	Sewage removal and treatment services								
	R*	Other services (G to Q, except 75* and 90*)								
Households (for final consumption)										
Total										

(1) Abstraction by NACE 41 for production of distributed water as well as direct abstractions by other industries for their ancillary activities have to be reported in this table. Similarly, discharges in water bodies by NACE 90 as well as direct discharges by other industries have to be reported here.

Table 8 - Water abstracted from the water bodies for the preparing of drinking water

(in thousands m^3)

	Abstraction from					
	Surface water				Ground water	Other water
	Meeting public supply standards			Not meeting standards		
	A1	A2, not A1	A3, not A2			
Total industries						
01* Operation of irrigation systems						
A* Agriculture, hunting and forestry, except 01*						
B Fishing						
CA Mining and quarrying of energy producing materials						
CB Mining and quarrying except energy producing materials						
DA Manufacture of food products; beverages and tobacco						
DB Manufacture of textiles and textiles products						
DC Manufacture of leather and leather products						
DD Manufacture of wood and wood products						
DE Manufacture of pulp, paper; publishing and printing						
DF Manufacture of coke, refined petroleum and nuclear fuel						
DG Manufacture of chemicals, man-made fibres						
DH Manufacture of rubber and plastic products						
DI Manufacture of other non-metallic mineral products						
DJ Manufacture of basic metals and fabrication of metal products						
DK Manufacture of machinery and equipment n.e.c						
DL Manufacture of electrical and optical equipment						
DM Manufacture of transport equipment						
DN Manufacturing n.e.c						
41 Collection, purification and distribution of water						
E* Electricity, gas and water supply, except 41						
F Construction						
75* Public administrative services for water supply and sewage systems						
90* Sewage removal and treatment services						
R* Other services (G to Q, except 75* and 90*)						
Households (for final consumption)						
Total						

Table 9 - Balance of flows of water between economy and water system

(in thousands m^3)

			(+) Abstractions (table 7)	(-) Leaks and losses	(+) Urban drainage	(-) Economic transactions on water (table 5)	(+) Economic transactions on water (table 6)	(-) Economic transactions on waste water (table 6)	(+) Economic transactions on waste water (table 5)	(-) Discharges (table 7)	=	Balance (consumption)
Total industries												
	01*	Operation of irrigation systems										
	A*	Agriculture, hunting and forestry, except 01*										
	B	Fishing										
	CA	Mining and quarrying of energy producing materials										
	CB	Mining and quarrying except energy producing materials										
	DA	Manufacture of food products; beverages and tobacco										
	DB	Manufacture of textiles and textiles products										
	DC	Manufacture of leather and leather products										
	DD	Manufacture of wood and wood products										
Industries	DE	Manufacture of pulp, paper; publishing and printing										
	DF	Manufacture of coke, refined petroleum and nuclear fuel										
by NACE	DG	Manufacture of chemicals, man-made fibres										
	DH	Manufacture of rubber and plastic products										
subsections	DI	Manufacture of other non-metallic mineral products										
	DJ	Manufacture of basic metals and fabrication of metal products										
	DK	Manufacture of machinery and equipment n.e.c										
	DL	Manufacture of electrical and optical equipment										
	DM	Manufacture of transport equipment										
	DN	Manufacturing n.e.c										
	41	Collection, purification and distribution of water										
	E*	Electricity, gas and water supply, except 41										
	F	Construction										
	75*	Public administrative services for water supply and sewage systems										
	90*	Sewage removal and treatment services										
	R*	Other services (G to Q, except 75* and 90*)										
Households (for final consumption)												
Total												

Table 10 - Pollutants discharged by economic activities into the sewerage network

(in physical units: kg or a more adapated unit)

		Pollutants	Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Heavy metals								Phosphorus (total)	Nitrogen (total)
						As	Cd	Hg	Cu	Cr	Ni	Pb	Zn		
Total industries															
	01*	Operation of irrigation systems													
	A*	Agriculture, hunting and forestry, except 01*													
	B	Fishing													
	CA	Mining and quarrying of energy producing materials													
	CB	Mining and quarrying except energy producing materials													
	DA	Manufacture of food products; beverages and tobacco													
	DB	Manufacture of textiles and textiles products													
	DC	Manufacture of leather and leather products													
	DD	Manufacture of wood and wood products													
Industries	DE	Manufacture of pulp, paper; publishing and printing													
	DF	Manufacture of coke, refined petroleum and nuclear fuel													
by NACE	DG	Manufacture of chemicals, man-made fibres													
	DH	Manufacture of rubber and plastic products													
subsections	DI	Manufacture of other non-metallic mineral products													
	DJ	Manufacture of basic metals and fabrication of metal products													
	DK	Manufacture of machinery and equipment n.e.c													
	DL	Manufacture of electrical and optical equipment													
	DM	Manufacture of transport equipment													
	DN	Manufacturing n.e.c													
	41	Collection, purification and distribution of water													
	E*	Electricity, gas and water supply, except 41													
	F	Construction													
	75*	Public administrative services for water supply and sewage systems													
	90*	Sewage removal and treatment services													
	R*	Other services (G to Q, except 75* and 90*)													
Households for final consumption															
Total															

Table 11 - Pollutants discharged to water bodies by direct discharge of waste water[1]

(in physical units: kg or a more adapated unit)

		Pollutants	Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Heavy metals								Phosphorus (total)	Nitrogen (total)
						As	Cd	Hg	Cu	Cr	Ni	Pb	Zn		
Total industries															
	01*	Operation of irrigation systems													
	A*	Agriculture, hunting and forestry, except 01*													
	B	Fishing													
	CA	Mining and quarrying of energy producing materials													
	CB	Mining and quarrying except energy producing materials													
	DA	Manufacture of food products; beverages and tobacco													
	DB	Manufacture of textiles and textiles products													
	DC	Manufacture of leather and leather products													
	DD	Manufacture of wood and wood products													
Industries	DE	Manufacture of pulp, paper; publishing and printing													
	DF	Manufacture of coke, refined petroleum and nuclear fuel													
by NACE	DG	Manufacture of chemicals, man-made fibres													
	DH	Manufacture of rubber and plastic products													
subsections	DI	Manufacture of other non-metallic mineral products													
	DJ	Manufacture of basic metals and fabrication of metal products													
	DK	Manufacture of machinery and equipment n.e.c													
	DL	Manufacture of electrical and optical equipment													
	DM	Manufacture of transport equipment													
	DN	Manufacturing n.e.c													
	41	Collection, purification and distribution of water													
	E*	Electricity, gas and water supply, except 41													
	F	Construction													
	75*	Public administrative services for water supply and sewage systems													
	90*	Sewage removal and treatment services													
	R*	Other services (G to Q, except 75* and 90*)													
Households for final consumption															
Total															

p.m. fertilisers spread on soils by agriculture						

[1] *Pollutants can be discharged into the water bodies:*

** either directly by industries (all lines except 90) and households*

** or by activities of sewage removal and treatment services (line 90)*

Table 12 - Pollutants subtracted by economic activities

(in physical units: kg or a more adapated unit)

		Pollutants	Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Heavy metals								Phosphorus (total)	Nitrogen (total)
						As	Cd	Hg	Cu	Cr	Ni	Pb	Zn		
Total industries															
	01*	Operation of irrigation systems													
	A*	Agriculture, hunting and forestry, except 01*													
	B	Fishing													
	CA	Mining and quarrying of energy producing materials													
	CB	Mining and quarrying except energy producing materials													
	DA	Manufacture of food products; beverages and tobacco													
	DB	Manufacture of textiles and textiles products													
	DC	Manufacture of leather and leather products													
	DD	Manufacture of wood and wood products													
	DE	Manufacture of pulp, paper; publishing and printing													
	DF	Manufacture of coke, refined petroleum and nuclear fuel													
	DG	Manufacture of chemicals, man-made fibres													
	DH	Manufacture of rubber and plastic products													
	DI	Manufacture of other non-metallic mineral products													
	DJ	Manufacture of basic metals and fabrication of metal products													
	DK	Manufacture of machinery and equipment n.e.c													
	DL	Manufacture of electrical and optical equipment													
	DM	Manufacture of transport equipment													
	DN	Manufacturing n.e.c													
	41	Collection, purification and distribution of water													
	E*	Electricity, gas and water supply, except 41													
	F	Construction													
	75*	Public administrative services for water supply and sewage systems													
	90*	Sewage removal and treatment services													
	R*	Other services (G to Q, except 75* and 90*)													
Total															

Table 13 - Average purchaser's prices of some water related economic products

(in monetary unit per m^3)

		Products	Water distribution and treatment (CPA codes)							
			Part 01.41.11 Operation of irrigation systems	41.00.11 Drinking water	41.00.12 Non drinking water	41.00.20.01 Distribution services of drinking water	41.00.20.02 Distribution services of non drinking water	**41.00 Total distributed water**	**Part 75.12.13 Water related administrative services**	**90.00.11 Sewage removal and treatment**
Average price of intermediate consumption of industries										
Average price by consuming industries by NACE subsections	01*	Operation of irrigation systems								
	A*	Agriculture, hunting and forestry, except 01*								
	B	Fishing								
	CA	Mining and quarrying of energy producing materials								
	CB	Mining and quarrying except energy producing materials								
	DA	Manufacture of food products; beverages and tobacco								
	DB	Manufacture of textiles and textiles products								
	DC	Manufacture of leather and leather products								
	DD	Manufacture of wood and wood products								
	DE	Manufacture of pulp, paper; publishing and printing								
	DF	Manufacture of coke, refined petroleum and nuclear fuel								
	DG	Manufacture of chemicals, man-made fibres								
	DH	Manufacture of rubber and plastic products								
	DI	Manufacture of other non-metallic mineral products								
	DJ	Manufacture of basic metals and fabrication of metal products								
	DK	Manufacture of machinery and equipment n.e.c								
	DL	Manufacture of electrical and optical equipment								
	DM	Manufacture of transport equipment								
	DN	Manufacturing n.e.c								
	41	Collection, purification and distribution of water								
	E*	Electricity, gas and water supply, except 41								
	F	Construction								
	75*	Public administrative services for water supply and sewage systems								
	90*	Sewage removal and treatment services								
	R*	Other services (G to Q, except 75* and 90*)								
Average price for households' final consumption										
Average FOB price for exports										
Average purchasers's price										