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REFLECTIONS ON ENVIRONMENTAL ACCOUNTING ISSUES

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The paper studies how, in the future, certain environmental concerns could possibly be addressed in the central framework of the System of National Accounts. Considering only economic (market-type) valuation and not ecological valuation, the position is taken that a number of changes to the SNA central framework may be envisaged. For example, accounting for the depletion of both renewable and non-renewable natural resources. The issue of the degradation of natural resources due to their use for disposal services and the joint loss of consumption services is more complex, volume aspects should be considered rather than simple adjustments in current value.

INTRODUCTION

A partial version of this paper was prepared, under the title "Some Notes on Various Issues concerning Environmental Accounting", on the occasion of the special IARIW Conference on Environmental Accounting held in Baden (May, 1991), as a contribution to the discussion on the preliminary draft of the United Nations Handbook on Integrated Environmental and Economic Accounting. The paper was completed in March 1992 on the issue of the depletion of sub-soil and renewable natural assets and revised in the first half of 1994.

The 1993 SNA does not address environmental issues in its central framework, but rather in the context of satellite accounting. However, when proposing solutions for economic aspects of environmental satellite accounts, it seems very important to see how these solutions would or would not fit, if in the future they were to be introduced in the central framework of national accounts itself. This is the primary purpose of this paper: to see how it would be possible to address in a relevant way, in the central framework of a future SNA, basic environmental concerns. Such an approach would imply significant changes in the SNA and so I hope this paper will contribute suggestions for the next revision of the SNA.

These reflections do not necessarily present final conclusions. They are preliminary in nature, as a contribution to ongoing discussions.

1. DEGRADATION OF NATURAL RESOURCES (LAND, AIR, WATER) AS A RESULT OF RESIDUALS (MAINLY CHEMICALS) GENERATED BY PRODUCTIVE ACTIVITIES (INCLUDING RECREATIONAL ACTIVITIES OF HOUSEHOLDS)

The basic idea as to the monetary valuation of these resources is best illustrated by the case of air. As long as air is available to everybody in unlimited quantity and quality, it is useful (actually vital), but has no monetary value. When

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air in certain areas is polluted, polluted air remains unpriced, has no monetary value, but clean air begins to have an economic value due to its scarcity, if there is a potential economic demand for clean air. Similarly water is free as a gift of nature. It acquires an economic value when it is necessary to bring it from natural reservoirs to the user or to build up artificial reservoirs. If available water is polluted, clean water begins to have an increased economic value, if there is a potential economic demand for clean water. Air, water and land are polluted, in the instances considered here, because they are used for disposal purposes. These disposal services are provided free of charge by nature. Their availability is not unlimited because the regeneration capacity of nature is limited and the function of nature as providing disposal facilities to some users may compete with other functions of nature, such as providing clean water or clean air to other users. Consequently the disposal services acquire economic value due to their increasing scarcity, which results from the full set of functions of nature.

Maintenance costs may be considered as the upper limit of the monetary value of the natural resources in question when they become scarce. Maintenance costs are costs which are necessary for maintaining or restoring the initial level of natural resources.[1] However, economic agents may accept, within certain limits, a deteriorated level of quality of the natural resources they use or society may impose standards which do not correspond to full maintenance (voluntarily or involuntarily for example because of lack of knowledge of what the initial level was).

Due to the combined functions of nature, maintenance costs have two aspects. Firstly, they represent the cost of internalising (in a broad sense, inside the economy) the disposal services. Secondly, they also represent the costs for getting newly clean air, water and land. These costs have to be borne once, not twice (though, their amount may differ according to available technologies and the efficiency in using them).

The effects on Net Domestic Product of the introduction of actual or imputed maintenance costs are often addressed in general terms, without an explicit indication of the underlying economic assumptions and a precise reference to the recording of economic flows in national accounting. However, the internalisation of maintenance costs may have various impacts and be reflected in different accounting entries, depending on the way the maintenance functions is organised.

Let us compare various static cases. *In reference situation A*, there is no degradation of the natural environment and no maintenance costs.

Now, let us suppose that *situation B* is similar to situation A in that the total volumes of labour employed and capital used are the same in both situations, with the same levels of efficiency, for the economy as a whole. However, in situation B, there is *a pressure on the natural environment, totally balanced by actual maintenance costs.* For sake of simplicity, let us suppose that the maintenance function resulted in the development of a new set of activities with the same average productivity as ordinary activities (non-maintenance activities). Under the

[1]Note that we consider only costs for maintaining or restoring the initial state of natural resources, not costs for protecting oneself against the consequences of pollution. I use the expression "maintenance costs" in the broad sense given to it in the UN Handbook *Integrated Environmental and Economic Accounting*, referred to in this paper as the SEEA. It covers avoidance costs, prevention costs, etc.

assumption of equal volumes of factors of production employed, the means of production used in the maintenance activities are diverted from the set of ordinary activities. The obvious consequence is that the quantities of output for ordinary activities are lower in situation B than in situation A, whereas there now exists an output for maintenance activities.

What are the effects in current value and in global volume? We must distinguish various cases, depending on the forms taken by the maintenance costs:

(a) intermediate consumption by market producers in ordinary activities;
(b) internal consumption from own-account maintenance activities by market producers in ordinary activities;
(c) fixed capital formation by market producers in ordinary activities;
(d) intermediate consumption or fixed capital formation by non-market producers of government in ordinary activities;
(e) household final consumption.

This list covers the main cases. They are looked at in turn, supposing that only one case applies at any one time (see Appendix 1 for a presentation of the underlying accounting equations).

In *case* (a), value added in ordinary activities is reduced by the incomes of factors now engaged in maintenance activities, whereas a corresponding value added appears in maintenance activities. From the other side, there are new intermediate costs in ordinary activities. Analysing the direct and indirect consequences of these additional costs is a matter of modelling, similar to studying the impact of, for instance, an increase in the prices of energy. It is obvious that the introduction of a significant amount of new actual costs cannot leave the system of prices and quantities unchanged. However, especially in the context of environmental accounting, it is sometimes assumed that additional intermediate costs mean necessarily lower value added, more precisely operating surplus lower by the same amount. It seems totally unrealistic to assume that the elasticity of prices to costs is zero and that market producers would simply bear the new costs by accepting a reduced operating surplus. Moreover the above assumption implies that final users of ordinary products are not willing to pay for any part of the costs of maintaining the environment. This assumption seems in contradiction with the rationale behind the contingent valuation method which is advocated in the context of environmental accounting and more generally with the increasing concerns about environmental issues. In situation B, where a society has accepted diverting factors of production from ordinary activities in order to maintain the environment, it seems more realistic to suppose that producers raise their prices in relation to their costs and the final users' willingness to pay for the additional costs of maintaining the environment would result in prices adjusted to costs. Under the assumption of exact matching at the global level, gross and net domestic product would be equal in current value in situation A and B, both at market prices and at factor incomes (of course, there may be substitution effects inside the basket of goods and services produced by ordinary activities). Final uses would be the same in current value in both situations. However the volumes of gross or net final uses of ordinary products [there are no final uses of maintenance products by assumption in case (a)] would be prima facie lower in situation B and their prices higher. GDP and NDP are lower in volume in situation B (I assume for

the time being that quantities and volumes of ordinary products move in the same direction).

Let us keep the assumption of exact matching of additional costs by prices and examine the other cases.

Case (*b*) differs only formally from case (a). The results are the same.

In *case* (*c*) (*fixed capital formation by market producers in ordinary activities*), the costs of market producers in ordinary activities are increased by the amount of the new consumption of fixed capital, instead of a new intermediate consumption as in case (a) and (b). Let us suppose for sake of simplicity that gross fixed capital formation and consumption of fixed capital in maintenance products are equal. Under the same assumptions as in case (a) and (b), GDP in current value is increased by the amount of the new final use, whereas NDP on current value is unchanged (in practice, NDP unchanged on average could show a different time profile). The volume effects are more complex than in case (a) and (b). As in the latter cases, the volume of final uses of ordinary products is lower than in situation A and their prices higher. However, there is a new volume for the gross fixed capital formation in maintenance products. Consequently, GDP in volume may be unaffected, whereas NDP in volume is lower.

In *case* (*d*) (maintenance products used as intermediate consumption or fixed capital formation by a non-market producer of government in ordinary activities), the non-market output itself is, according to the 1993 SNA, valued at costs and always used for final consumption, either individual or collective.[2]

Let us consider firstly the case of an *additional intermediate consumption by government non-market producers* (*case* (*d.1*)). The difference with case (a) and (b), in volume, is that there is now a volume of final uses both gross and net, corresponding to the additional output of non-market services. In current value, the results are influenced by the way the additional government outlay is financed. When financed by indirect taxes on ordinary activities ("Other taxes on production" following the 1993 SNA)—case (d.1i)—or by taxes on products—case (d.1ii)—domestic product at market prices and final uses are higher than in case (a) and (b) and situation A. When financed by an additional tax on income (case (d.1iii)), domestic product at market prices and final uses are the same as in cases (a) and (b) and situation A. In effect, instead of having to pay additional prices for (a reduced volume of) market ordinary products for the costs of maintaining the environment, as in cases (a) and (b), final users have a lower disposable income permitting them to acquire the reduced volume of ordinary products (excluding the new amount of government output) at prices supposedly unchanged.

Let us turn now to the case of *additional fixed capital formation by government non-market producers* (*case* (*d.2*)). In volume, this case combines the results of case (c) (there is an additional gross fixed capital formation, no additional net fixed capital formation) and case (d.1) (there is a volume of final uses, both gross and net, corresponding to the additional output of non-market services due to a

[2]Part of government non-market services could be allocated to market producers, thus reducing GDP at market prices. I made a proposal in this direction during the elaboration of the 1993 SNA ("How to treat intermediate consumption of non-market services provided free of charge by government to market producers," 11 January 1989, unpublished).

higher consumption of fixed capital). Again, the results in current value are influenced by the way the additional government outlay is financed. They combine the results of case (c) and case (d1). It is not necessary to repeat them (see table below).

In *case (e)* (household final consumption in maintenance products), the aggregates in current value are the same in situation B as in situation A. In effect, under the assumptions concerning situation B, there is a shift of final consumption from ordinary products to maintenance products. In volume, final uses of ordinary products are lower than in situation A, whereas there is a volume for the new final use of maintenance products.

The *results* for the set of cases previously analysed are *summarized in the following table*. It is worth repeating that they come from static comparisons between a reference situation A in which there is no pressure on the natural environment and no maintenance costs and a situation B where maintenance costs totally balance the pressure on nature. The assumptions are made that the same volumes of labour and capital are used in both situations, with the same levels of efficiency reflected in equal nominal rates of return for the economy as a whole, and that additional costs are exactly matched by higher prices when relevant. Substitution effects are not analysed, except between ordinary activities/products and maintenance activities/products. Under these assumptions, the internalisation of maintenance costs *as such* does not automatically reduce GDP or NDP in current value, whichever form the maintenance costs take.

TABLE 1

DIFFERENCES BETWEEN SITUATION B AND SITUATION A

Aggregates Cases	GDP m.p.	NDP m.p.	GDP f.i.	NDP f.i.	Final Uses (Gross) in Current Value	Final Uses in Volume	
						Gross (= GDP)	Net (= NDP)
(a)	same	same	same	same	same	down	down
(b)	same	same	same	same	same	down	down
(c)	up	same	up	same	up	down, up	down
(d.1), (i) and (ii)	up	up	same	same	up	down, up	down, up
(d.1), (iii)	same	same	same	same	same	down, up	down, up
(d.2), (i) and (ii)	up, up	up	up	same	up, up	down, up, up	down, up
(d.2), (iii)	up	same	up	same	up	down, up, up	down, up
(e)	same	same	same	same	same	down, up	down, up

Reminder: the various cases refer to the forms taken by maintenance costs.

(a) intermediate consumption by market producers in ordinary activities.

(b) internal consumption from own-account maintenance activities by market producers in ordinary activities.

(c) fixed capital formation by market producers in ordinary activities.

(d1) intermediate consumption by non-market producers of government in ordinary activities.

(d1i) financed by additional other taxes on production (SNA 1993) on ordinary activities.

(d1ii) financed by additional taxes on products.

(d1iii) financed by additional taxes on income.

(d2) fixed capital formation by government non-market producers in ordinary activities.

(d2i) financed by additional other taxes on production (SNA 1993) on ordinary activities.

(d2ii) financed by additional taxes on products.

(d2iii) financed by additional taxes on income.

(e) household final consumption.

In current value, NDP is less sensitive than GDP. The latter changes when maintenance costs take the form of consumption of fixed assets instead of intermediate consumption or household final consumption expenditure and also when the additional government outlay is differently financed. This last feature makes a difference only to NDP in market prices.

The volume effects (and also price effects) are summarised in the last two columns of the table. Note that the volume effects are indicated separately for the various components of final uses: ordinary products, maintenance products according to whether they are used as gross fixed capital formation (cases (c) and (d2)) or household final consumption (case (e)), non-market services (cases (d1) and (2)). In the last column, the possible additional volume of gross fixed capital formation is balanced by an additional volume of consumption of fixed capital, thus leaving the volume of net fixed capital formation unchanged. The volume of final uses of ordinary products in case (a) and (b) (also (c) for NDP), where there is no other final use, is always reduced giving a lower GDP and NDP in volume terms. In the other cases where other final uses are present (gross fixed capital formation, government final consumption expenditure, or both, or household final consumption expenditure) the global volume effect is less simple. The volume of GDP is lower in case (a) and (b), possibly equal in cases (c), (d.1) and (e) and higher in cases (d.2). However, volume effects have other aspects when environmental consumption services are taken into account. These are examined later (see section on disposal services and consumption services).

These somewhat different pictures are linked to basic accounting rules concerning the distinction between producers and final consumers, intermediate consumption, fixed capital formation and final consumption, a topic which is considered later.

In *variants of situation B*, with other assumptions, the results could be different. If pressure on nature were lowered through reducing the scale of economic activities and employment or changing the structure of activities in favour of less efficient ones, GDP and NDP would be lower in situation B. On the other hand, if the volumes of labour and capital used in maintenance activities did not have to be diverted from other activities, GDP and NDP could be higher.

Let us consider now *situation C* which differs from situation A in that there is *a degradation of the natural environment*, as a result of residuals, but *no maintenance activities at all.* As in situation B the degradation is valued by the necessary maintenance costs which are now estimated (imputed).

It is sometimes proposed (for example, in the SEEA) recording simply additional costs in this case, as a use of natural assets, treated similarly to consumption of fixed capital when going from GDP to NDP. As everything else is supposed unchanged, net value added is reduced and a lower net domestic product is obtained (and implicitly a lower net operating surplus). However, as the previous discussion on the internalisation of maintenance costs showed, the assumption that everything else is unchanged does not seem acceptable. Depending on the types of situation in question, the internalisation of maintenance costs could result in various consequences on national accounts aggregates, in terms of both current value and volume. In any case, what has to be estimated in this context is a potential/sustainable domestic product or a potential/sustainable level of

consumption, under certain assumptions. It is a problem of modelling, not an issue of *ex post* accounting. What matters for analysis is the comparison between potential/sustainable domestic product(s) or final consumption level(s) and actual domestic product or consumption, not the replacement of the latter by potential estimates.

However, it is certainly desirable to record the non-market relations between nature and the economy. A reasonable procedure would consist in the creation of a linkage account between nature and the economy, just as there is an account between residents and non-residents (the rest of the world account). Such an account, called in short "Nature account" would appear as a sector account, even if it is a kind of "flow account," recording only relations between nature and the economy and the corresponding possible changes in natural assets (a proposal for a natural sector account has already been made by others (see for example, Peskin, 1989)). Nature would provide the economy with disposal services valued by potential maintenance costs. These services—imported from nature—have to be recorded in the accounts. The above analysis of the various cases in situation B shows it is not meaningful to allocate them simply as additional costs to polluting industries, without rebuilding the input–output table and the accounts as a whole in order to study the consequential effects of these additional imputed costs (the latter may not be deemed simply to reduce the value added and operating surplus of the industries concerned). As economic activities tend ultimately to final consumption, disposal services can be considered as increasing the latter. In order to simplify, they could be allocated in the first instance globally to the economy as a whole as an additional final use balanced by a capital transfer.[3]

The current accounts of nature would record an output of disposal services corresponding to a consumption of natural assets (no net value added). The accumulation accounts of nature would then show a capital transfer granted to the economy, balanced by this consumption of natural assets. In this approach, the balance sheet of nature shows a stock of natural assets with a negative monetary value corresponding to the unmatched potential maintenance costs.[4]

The current accounts of the economy would record *a new flow "Use of disposal services provided by Nature,"* balanced by a negative component under saving as there is no corresponding income. A capital transfer received from nature would then be recorded in the economy's accumulation accounts.

According to this analysis, the economy consumes a part of nature in addition to its final consumption out of the income resulting from economic activities. It seems both sound and meaningful to say that the value of our consumption is actually higher than the traditional measure, because the latter in conformity with market type valuation does not include the value of disposal services as measured by the potential maintenance costs of natural assets. Thus our consumption is higher than our income.

The above analysis holds even if one wants to include nature (only domestic nature of course) as a component of the national economy.

[3]Of course, complementary breakdowns of the disposal services consumed according firstly to their primary users and then to their final users are absolutely necessary for analysis.

[4]The SEEA, on the contrary, keeps the market value of water and air in its accounts for stocks of natural assets, through an item called "Adjustments due to market valuation."

Let us suppose now that there are no or not enough maintenance activities during a certain number of years, then regeneration activities—in addition to maintenance activities—are necessary later—if a country wishes to recover part of nature's functions. The regeneration costs incurred in *situation D*, are of a capital nature. However, they only compensate the previous consumption of natural assets corresponding to disposal services received from nature as capital transfers. It seems normal to treat them as symmetrically as possible with the recording in situation C. Let us suppose that the accumulated consumption of natural assets is equivalent to 10 times the annual necessary maintenance costs (AMC), then regeneration activities start at an annual rate equivalent to the necessary annual maintenance costs.

The accumulation accounts of the economy record changes in assets firstly as a positive entry for acquisition of capital goods (+1AMC), secondly a negative entry for capital goods transferred to nature (−1AMC). From the other side, the element of saving used in order to finance this acquisition of capital goods would be offset by a capital transfer granted to nature of the same amount. Thus, there would be neither gross nor net fixed capital formation due to the regeneration costs, because the latter would be balanced by an equivalent transfer in kind of capital goods to nature.

In the accumulation accounts of nature, a capital transfer received from the economy is recorded (1AMC). An equivalent amount of regeneration of natural assets is recorded under changes in assets. The balance-sheet of nature shows a monetary opening value of −10AMC for natural assets and a monetary closing value of −9AMC.

Until now, I considered that the natural assets in question (land, air, water) were not appropriated by economic agents. *At least in the case of land, the degradation may concern appropriated assets.* The owner of the land is then supposed to provide disposal services. Part of the account proposed for nature under situation C (a degradation of the natural environment, no maintenance activities at all) would become a part of the accounts of the land owners. This would also occur in situation D, where regeneration takes place, assuming the polluters or government pay for the regeneration costs. However, in this case, when combining the institutional sectors making up the total economy, gross fixed capital formation, compensating the previous consumption of natural assets, would appear at the global level of the economy in so far as regeneration is concerned with appropriated natural assets.

The analysis in this section does not refer explicitly to the degradation of natural resources as a result of *residuals generated by consumption activities of households.* The proposed treatment covers this situation. Households use disposal services provided by nature, directly in their consumption activities (transport, recreation, etc. . . .) or through the goods and services they acquire. This is recorded, although not separately, under the item "Use of disposal services provided by nature," which I suggest introducing in the account of the economy.

In this regard, the SEEA in some of its versions (IV.2 with environmental costs at maintenance values and IV.3 with environmental costs at market and contingent values) treats the degradation due to household activities as additional costs transferred to industries, thus reducing their value added. In addition to the

basic criticism made of the SEEA general approach as such, such a procedure is highly questionable without introducing a full treatment of household production, something that the SEEA only does when presenting possible extensions (versions V.1 to 3).

2. Degradation of Land as a Result of its Use in Agriculture or of Other Soil Erosion

I look first in this section at the degradation of agricultural land caused by improper agricultural practice.

Let us suppose first that the operator is also the owner of the land. Land, as a permanent asset, does not necessitate a consumption of capital to be recorded. Of course, permanent refers both to quantity and quality. Quality may be increased and improvement to land is actually treated in the SNA as gross fixed capital formation, subject later to the calculation of consumption of fixed capital if the improvement is not permanent. Quality of land may also be reduced by improper agricultural practice. In this respect, land may be considered no longer a fully permanent asset. Thus, if the quality of land diminishes as a result of its use in agriculture, consumption of land (consumption of natural assets) similar to the consumption of fixed capital for produced assets should be recorded and the net value added of agriculture reduced, and the reduced quality of land is reflected in a lower market price. Conversely, if the quality of land is increased by current agricultural practice, corresponding additional output and gross fixed capital formation should in principle be recorded. If the operator of the land is not the owner, the relations between the accounts of the two units have to be recorded (capital transfer from landowner to tenant if the decrease in the value of land is not compensated, disposal by the landowner of a part of the volume of land otherwise).

When the degradation of land is due to soil erosion resulting from cause other than agricultural practice, like past deforestation, an additional final use could be recorded, following a similar treatment to the one indicated in the case of degradation of natural resources as a result of residuals.

3. Defensive Expenditures

The deduction of defensive expenditures from final demand is advocated by some authors "in order to obtain a more welfare-oriented measure of economic welfare in the context of environmental accounting" (Stahmer 1991, p. 58). Suggestions made refer to environmental protection activities, which are directly or indirectly part of final demand, and actual damage costs caused by environmental deterioration (e.g. health expenditures of households).

The concept of defensive expenditures is wide and flexible. Defensive expenditures are identified for example in fields like traffic, housing, security. Some authors propose treating all expenditures by government in the fields of regrettable necessities (defence, justice, police essentially) as defensive expenditures and to deduct them from GDP because of "their intermediate nature." It is generally considered,

in the context of this kind of proposals, that none of these defensive expenditures add to welfare.

Such suggestions raise a number of problems as to the nature of the distinction in national accounting between intermediate and final consumption, the interpretation of market values in terms of welfare and the fundamental issue of "what is final?"

When goods and services are used to produce other goods and services, they enter either intermediate consumption or consumption of fixed capital, according to whether they "disappear" in the annual production process or they are used during more than one year. Consequently, in national accounts, intermediate consumption and consumption of fixed capital apply only to producers, and they depend on the boundary of production which is chosen. Goods and services which are acquired, other than for a process of production, are deemed to enter final consumption or, in the 1993 SNA, capital formation as valuables. Thus the concept of intermediate consumption has nothing to do with the distinction between a "bad" (to treat as intermediate consumption) and a "good" (to consider as final consumption). The distinction between producing activities and (final) consuming activities is not immutable. The boundary of production may be moved. If it is extended, additional processes of production are recorded, some goods and services leave final consumption to enter intermediate consumption or consumption of fixed capital (via an initial reclassification as fixed capital formation), new value added appears, a new output is created and . . . later enters final consumption, if it is not used for producing other goods and services, etc.

National accounts strictly follow a neutral interpretation of market values. They record economic activities and flows without any value judgment about the content of these activities and flows and their desirability from a moral point of view. It follows that subtracting something from final consumption because it would not add to welfare (in fact what people have in mind is a concept of well-being which is very different from welfare in economic theory) is a nonsense in national accounting. It would result in something uninterpretable. In effect it assumes implicitly that the non-removed part of final consumption correctly measures the contribution of monetary goods and services to well-being, an assumption which may not be accepted. Nobody would maintain that the contribution of aspirin to well-being is correctly measured in absolute terms by its monetary value.

The question "what is final?" may be addressed strictly in the framework of national accounts without changing their basic rules, but only—as already said above—by moving the boundary of production. As final consumption in national accounts refers fundamentally to goods and services *which are not used for producing other goods and services* either in the current period or in the future, one may try to extend as far as possible the sphere of productive activities.

One way to consider extending the production boundary to include, for example, health costs resulting from environmental damage as intermediate costs, would be to consider introducing the concept of human capital into the SNA. A moment's thought, however, reveals that what is presently treated as final consumption would have to be allocated between gross fixed capital formation, intermediate consumption and final consumption. This allocation would be far

from easy and involve many considerations other than purely environmental ones.

4. Disposal Services and Consumption Services

Disposal services are provided by nature, irrespective of whether natural resources are degraded or not. However if residuals are discarded only to an extent which allows for the function of regeneration by nature avoiding degradation of the natural environment, these disposal services are free goods and have no monetary value. They may acquire a monetary value if the emission of residuals exceeds this limit, when a degradation of natural resources occurs and maintenance costs become necessary. If no maintenance costs are introduced (see situation C in the section on degradation by residuals), the monetary value of the non-market disposal services provided by nature is at the limit equal to the full maintenance costs that are necessary and represent consumption of natural assets used by nature in the process of providing disposal services to the economy. When maintenance costs are introduced, some or all of the degradation of natural resources is avoided. The increase in actual maintenance costs offsets the monetary value of the disposal services provided by nature up to the point where no degradation occurs.

Exactly the same arguments hold for *consumption services*, so disposal services and consumption services may be considered jointly.[5]

Both are provided by the same types of natural assets. Complication arises from the fact that part of the natural assets affected by the services may be located outside the economic territory of a given country. For sake of simplicity, it is advisable to *suppose firstly the absence of external flows*, that is, *disposal services and consumption services are only provided by domestic nature to the national economy*.[6] Under this assumption, the necessary maintenance costs measure the actual or potential consumption of natural assets used by nature in the process of providing *both* disposal services and consumption services. The total value of consumption services cannot be higher than the total amount of maintenance costs involved because if this amount of maintenance costs were actually spent, the level of consumption services would be totally restored. Thus I do not share the view expressed in the SEEA (see paragraph 359 and 361 for instance) that the maintenance cost approach is relevant only for the valuation of disposal services (and productive services of land), whereas contingent valuation applies separately to consumer services. Even if contingent valuation is used, the maximum value of consumption services is still given by the total amount of maintenance costs, because potential demand must be confronted with potential costs for meeting it (I do not discuss here the difficulties involved in aggregating values

[5]Consumption services are the same as consumer services in the SEEA: "Consumer services of the natural environment encompass the elementary functions of the environment in providing for physiological as well as recreational and related needs of human beings" [SEEA 357 (c)].

[6]External flows are related to effects in other countries. For example, residuals originating in a given country may flow to other countries. In the latter, on one hand disposal services are provided to the country where the residuals come from, on the other hand the quality of available consumption services is lowered.

based on contingent valuation). If the aggregate willingness to pay for the maintenance or restoration of the quality of consumption services is higher than the maintenance or restoration costs involved, the difference represents a consumer surplus. In the analysis that follows, it is assumed that, in the absence of external flows, the total value of consumption services is equal to the total amount of maintenance costs when relevant.

When there is no pressure on the environment and no maintenance costs, as in *situation A* considered in the section on residuals, neither disposal services nor consumption services have a monetary value, but a certain volume in physical terms. In the accounts of nature, the output of disposal services and consumption services has a zero value and there is no consumption of natural assets. In the accounts of the economy, the uses of disposal services and consumption services provided by nature also have a zero value (see Appendix 2 for a presentation of the accounts of Nature and the Economy).

When there is a pressure on the natural environment, but no maintenance costs and consequently a degradation of natural resources (as in *situation C* above), there is an increase in the volume (quantity) of the disposal services and a decrease in the volume (essentially quality) of the consumption services provided by nature. The volume of disposal services and consumption services move in different directions. The market type value of total non-market environmental services provided by nature is equal to their cost for nature, the consumption of natural assets. This cost is incurred by nature in providing the disposal services, the pressure comes from them, not in providing the consumption services (conversely in this situation, the economy consumes natural assets when using disposal services, not when benefiting from consumption services).

Thus, in situation C, the monetary value of the disposal services may be taken equal to the consumption of natural assets, measured by the necessary maintenance costs, whereas the monetary value of the consumption services provided by nature remains zero.[7]

In the accounts of nature, these outputs are recorded. There is a consumption of natural assets and a capital transfer to the economy. Corresponding entries are made in the accounts of economy.

When moving from situation A to situation C, disposal services increase in volume and in current value and consequently there is no change in their implicit price component, whereas consumption services decrease in volume with no change in current value, which is equivalent to an increase in an implicit price component.

Let us look now at the introduction of maintenance costs. Moving from situation C to *situation B* (in which the pressure on the natural environment is totally balanced by actual maintenance costs) disposal services provided by nature to economy decrease in volume and in current value until reaching a zero value in situation B. As the degradation of nature is progressively reduced until there is no longer any uncompensated degradation, the consumption services increase

[7] I do not follow the approach in the SEEA according to which in such a situation there is a positive current value of disposal services and a negative current value of consumption services (see SEEA version V.4 and V.5). In the absence of external flows, it would mean that in total the monetary value of environmental services is zero, when there is a consumption of natural assets.

in volume until they reach their initial level as in situation A. However, they are costly now, not in terms of natural assets provided by nature, but in terms of maintenance costs incurred. Their value in situation B is equivalent to the full maintenance costs which are necessary every year. Consumption services are now a joint product of nature and the economy, in which the monetary value of nature's contribution is zero and the economy's contribution is equal to the internalised maintenance costs.

The results of the previous analysis can be summarised in the following way for nature.

ENVIRONMENTAL SERVICES PROVIDED BY NATURE

	Situation A → Situation C → Situation B		B/A
Disposal Services			
Current monetary value	up	down	same
Volume	up	down	same
Implicit price	same	same	same
Consumption Services			
Current monetary value	same	same	same
Volume	down	up	same
Implicit price	up	down	same

However, as explained above, consumption services (clean air, clean water, etc.) become a joint product of nature and the economy when going from situation C to situation B. Their current economic value increases from zero to the value of maintenance costs incurred by the economy. Does this increase in current value correspond to a volume change or a price change from the point of view of the economy?

Some analysts would probably say that it is not a volume change, but a price change, because this new expenditures simply compensate the loss of welfare incurred when the volume of consumption services was reduced as compared to situation A. In effect, in B, the quantity and quality of consumption services are, by definition, the same as in situation A. Coming back to the table presented in section 1 where differences between situation B and situation A are summarised, the logical implication of this position would be that the increases in volume shown in the last column of this table (rows d to e) must be deleted and replaced in some way with price increases. This would mean that maintenance products as such have no welfare content.

In my view however the new economic value in question corresponds to a volume change, not a price change. The defensive or compensating nature of these expenditures does not matter. What matters is the fact that from situation C to situation B the consumer's preferences and public choices have changed. They now take into account directly or indirectly maintenance products as representatives of clean consumption (environmental/economic) services. An economic good or service has a volume, a welfare content even if it replaces a previous free gift of nature performing the same function. Turning again to the table in section 1, the logical implication of this position would be that not only the increases in volume

shown in the last column are correct, but also the higher values paid in cases a to c have to be interpreted in terms of higher volumes, not higher prices. The assumption in situations extending from C to B is in effect that consumers give progressively higher preferences to environmentally clean products. Thus when calculating price indexes or national accounts at constant prices (in volume), the additional intermediate costs or consumption of fixed capital connected with the cleaning of products would have to be reflected in volume changes, not in price changes from the consumers' point of view, that is the cleaning of products represents an increase in quality of these products.

The introduction of external flows does not change the basic analysis, but it complicates the picture. First I consider direct external flows of disposal services. Then I look at indirect external flows of disposal services through the usual external transactions in goods and services.

Direct external flows of *disposal services* can be treated by adjusting the framework used in section 1 when analysing *situation C* (in which there is a degradation of the natural environment and no maintenance activities at all). In the accounts of the National Economy, the flow "use of disposal services provided by Nature" is broken down in three components according to the origin of the disposal services, that is, domestic nature (nature within the geographic territory of a country), foreign nature (within the geographic territory of other countries) and other nature (outside any geographic territory, as for example the ozone layer). Three capital transfers are then received by the national economy, coming from these three origins. A similar analysis is made for foreign economies. In between, separate accounts for each type of nature (domestic, foreign, other) record the provision of disposal services to the national economy under review and foreign economies respectively. Corresponding capital transfers are granted by each type of nature. All of these relations are shown in the following matrix, where M denotes maintenance costs, D domestic nature, F foreign nature and O other nature, small letters denote the destination of disposal services, national economy or foreign economies. Thus, MFn is an import from foreign nature by the national economy, MDf an export from domestic nature to foreign economies, etc. . . . All economies are supposed to be in situation C.

An economy may make *indirect use* of disposal services provided by foreign or other nature. This occurs when the production of imported goods and services in their countries of origin has been obtained by using disposal services provided by foreign nature or other nature. Disposal services can be allocated proportionately between domestic uses and exports and then between countries of

DIRECT FLOWS OF DISPOSAL SERVICES (SITUATION C)

	Use		
Source	National Economy	Foreign Economies	Total
Domestic nature	MDn	MDf	MD
Foreign nature	MFn	MFf	MF
Other nature	MOn	MOf	MO
Total	MDn + MFn + MOn	MDf + MFf + MOf	

DIRECT AND INDIRECT FLOWS OF DISPOSAL SERVICES (SITUATION C)

Source	Use		Total
	National Economy	Foreign Economies	
Domestic nature	$(1-\alpha_n^f)$ MDn + α_f^n MDf	$(1-\alpha_f^n)$ MDf + α_n^f MDn	MD
Foreign nature	$(1-\alpha_n^f)$ MFn + α_f^n MFf	$(1-\alpha_f^n)$ MFf + α_n^f MFn	MF
Other nature	$(1-\alpha_n^f)$ MOn + α_f^n MOf	$(1-\alpha_f^n)$ MOf + α_n^f MOn	MO
Total	$(1-\alpha_n^f)$ (MDn + MFn + MOn) + α_f^n (MDf + MFf + MOf)	$(1-\alpha_f^n)$ (MDf + MFf + MOf) + α_n^f (MDn + MFn + MOn)	

destination. The accounts and matrix referred to above may be adjusted accordingly. If α_n^f is the share of exports in the output of the national economy and α_f^n the share of exports to the national economy in the output of foreign economies, the matrix then reads as above (the possible subsequent use of imports in order to produce output is neglected here). Although the totals of rows are unchanged, their allocation is normally different.

Let us suppose now that all economies are in *situation B* (the pressure on the natural environment is totally balanced by actual maintenance costs). The monetary value of disposal services and consumption services provided by nature is zero. There is a monetary value of *consumption services* provided by the economy which corresponds to internalised maintenance costs and is embodied in the value of ordinary or specific (maintenance) products.

The value of consumption services acquired by an economy, when situation B is generalised, is of the same amount as the value of disposal services used by this economy, when situation C was generalised (see columns of the above matrices). This cost is borne either internally or through the prices of imports.

Let us suppose finally that the *situation* is of a *mixed* nature, for example the National Economy is in situation B, whereas Foreign Economies are in situation C, or intermediary between C and B, let us say C for sake of simplicity. We may suppose also that, in such a situation, the National Economy in question is not in a position to raise the prices of its exports. In order to be clean, the National Economy supports maintenance costs for a total amount of MDn + MFn + MOn + MDf, which measures the total environmental services provided by itself (not by the domestic nature which is keep clean). MDf represents the amount of disposal services provided by the National Economy to Foreign Economies, and MDn + MFn + MOn the cost of acquisition of consumption services by the National Economy. Also, though being itself in situation B, the National Economy continues to use imported disposal services, through its imports of goods and services from unclean Foreign Economies, for an amount of

$$\alpha_f^n \,(\mathrm{MDf} + \mathrm{MFf} + \mathrm{MOf}).$$

5. DEPLETION OF SUB-SOIL ASSETS

Sub-soil resources (oil, coal, metallic or non-metallic mineral reserves) are pre-existing assets which are not created by production activities. They may be transacted as such, before any actual exploitation, though, to be transacted, they

must be known. However, the discovery resulting from mineral exploration activities does not create the reserve itself. This is obvious physically. It is also true economically. The discovery of exploitable reserves makes the asset cross the boundary between the assets which are not included in the stock of assets of the SNA balance sheets, and the assets which are economic assets, in the somewhat narrow sense given in the SNA to the concept of economic assets, and are included in these balance sheets. As a consequence the discovery of new exploitable reserves must be recorded in the "Other changes in volume of assets" according to the accounting structure of the 1993 SNA, not in the production account.

When extraction takes place, the production activity consists in changing the location of the resource, from sub-soil to ground level, transporting it, trading it, etc. The sale value of the quantities which are extracted represents both the sale of an existing asset and the value of the output of the related production activities.

If a new approach were to be introduced in the future in the central framework of the SNA, how should the first component, that is the sale value of the existing asset, be recorded? Not as consumption of fixed capital, because the reserves may not be considered a fixed capital asset producing other goods repeatedly over a period of time; it is a part of the reserve itself which is physically extracted in each period. The correct treatment is as a withdrawal from inventories to be recorded as changes in non-produced inventories on the left-hand side of the capital account.[8] Now, what would be the influence on the production account of the extracting activity? Should the value of the decrease in inventories be added to its intermediate consumption, thus leaving unchanged the value of the output? Actually the activity in question does not use the raw material as an input into a process of physical transformation. What is done is similar to the type of transformation done in transport and trade industries: change of location, sorting, etc. Consequently, the relevant treatment seems to be to exclude the value of the decrease in inventories from the output of the extracting activities, thus reducing by this amount the value of the output as currently measured in national accounts and leaving the intermediate consumption of the extracting (mining) activities unchanged.

As a result of this way of recording, gross and net value added, gross and net domestic product would be reduced by the amount of the decrease in non-produced inventories recorded in the same period of time, as compared to their estimates in the 1993 SNA.

What value should be given to the sale of assets to be reflected in the withdrawals from inventories? An extended literature exists on the valuation of depletable resources (see Jonathan Levin, 1991, for a recent review). From a national account perspective, it makes sense to take the value of the rent, that is the excess of sale price of the extracted raw materials over the costs of extracting, trading, possibly transporting them and the acquisition costs of the resource (written off

[8]This change in inventories covers only the quantities which are extracted. The change in the quantities of exploitable reserves due to changes in technology or to changes in the prices of the raw materials in question must be recorded in the other changes in volume of assets account, whereas the change in the value of the total exploitable reserves due to the change in prices is recorded in the revaluation account.

exploration expenditures, both successful and unsuccessful, upon the total quantities acquired). These costs include the opportunity cost of the capital involved in the extracting activities.

This solution differs from the one advocated by El Serafy, 1989. The latter breaks down the rent element between two components, a component of income and a component of capital consumption (change in inventories according to El Serafy's analysis). The second component represents the amount that one should invest in order to be provided with a sustainable income. This breakdown depends on the life expectancy of the resource and the discount rate. This ingenious solution seems to provide for a nice rule of behaviour when spending the money obtained through the sale of a non-renewable resource rather than a procedure for calculating income itself. Take the following example. If I inherit a certain quantity of gold and wish to derive permanent benefits from it, even after having sold all this gold, it is certainly advisable for me to invest part of the value of the quantity of gold I choose to sell every year in income bearing assets. In the SNA, the sale value of the gold itself will be recorded in total as a disposal of valuables, an entry in the capital account according to the 1993 SNA. The part of this value which I decide to consume every year is not income, it is a mean of financing consumption expenditure out of a reduction in net worth. This is the general rule of the SNA. An asset, whatever its nature is, is withdrawn from the balance sheet of the seller at the full value of its sale, whatever use is made of the product of the sale. One may finally ask the question whether the income concept of the SNA—based also on the idea of maintaining capital intact—corresponds to the concept of sustainable income which El Serafy and others strictly following Hicks have in mind. For instance, we know that individuals or households must share their net current receipts between consumption and saving if they want to sustain their consumption capability after they retire. Nevertheless both their consumption and their saving are included in their disposable income. It is true however that various views may exist on the relation between income and capital in national accounting when taking a Hicksean perspective. El Serafy follows what could be called a strong Hicksean concept of income whereas national accounts apply a weaker one.[9]

Supposing the treatment explained above is followed in its general lines, there are consequences as to the way certain other flows must be classified and recorded. The reduction in value added and GDP/NDP implies that certain flows are no longer income flows to be recorded in the current accounts, they now must be recorded as capital transfers or in a way which is similar to capital transfers. A part of present current taxes on income, wealth, etc. and a part of dividends and other distributed property income should become transactions recorded in the capital account (on the right-hand side according to the accounting structure of the 1993 SNA). These consequences cannot be avoided. Continuing to record the disbursements/receipts in question as current flows would mean, firstly, keeping in the disposable income of the receiving sectors components which, according to

[9]See 1993 SNA, para 8.15, for a discussion of the links with economic theoretic concepts of income.

our analysis, are not income by nature, secondly having negative saving for the extraction/mining industries, a result which would not make sense.

The institutional sectors receiving dividends and other property income, taxes on income, from the extracting activities would receive part of them as a capital flow recorded in their capital account, no longer as a current flow recorded in their current accounts. Their income and saving is reduced accordingly.

6. Depletion of Renewable Natural Assets

Two types of renewable natural assets (forests, livestock, including fishstock, biota in general) are looked at in turn: those which are cultivated by human activity, those which are only exploited by human activity. Both may be used as sources of raw materials or as fixed assets providing ecological services.

6.1. *Cultivated Natural Assets*

The treatment decided upon for the 1993 SNA seems appropriate except in so far as ecological aspects are not taken into account.[10]

The growth of stocks of *cultivated natural inventories*—timber trees, animals for slaughter, etc., is included in the output of economic activities as entries in inventories (work-in-progress which is transformed into finished products at the time of sale). When sales take place, there is thus a withdrawal from inventories (of standing trees, animals etc.). Leaving aside possible secondary products, the output of a cultivated forest in each period of time for example is therefore, as far as only forestry activity is concerned—that is the growing of standing timber—the value of the entries in inventories (the cultivated natural growth). At maturity, the value of the withdrawal from inventories is equal to the value of the sales of standing timber.[11] This implies that the inventories of work-in-progress are regularly revalued. It also implies, as is stated generally by the 1993 SNA for the valuation of work-in-progress, that the net operating surplus, which is only realised at the time of sale, is recorded over the entire period of growth. Of course, as the process of production is a very long one in the case of a forest, any divergence between the expected rate of return and the actual rate of return will be reflected in a distorted figure for the net operating surplus of the final period unless the whole series of accounts in question is adjusted.

If the standing timber is sold well before maturity for immediate felling, an abnormal case under good forestry practice, the value of the sale will presumably be lower than the value of the inventory of work-in-progress. The difference will be recorded in the "other changes in volume of assets account" and the withdrawal from inventories will be equal, as usually, to the value of the sale.

Cultivated natural fixed assets are treated as other produced fixed assets. In their case, the natural growth of the fixed assets themselves (that is the trees yielding repeat products as opposed to the products themselves, or dairy cattle) is included in output as an own-account fixed capital formation. When these assets

[10]See however the section above on the degradation of land as a result of its use in agriculture.

[11]If the timber is felled before being sold, the value of the withdrawals from inventories of standing timber must be derived from the sales of timber after felling.

are at maturity, consumption of fixed capital should begin to be recorded. At the end of the productive life of the asset in question, when it is sold for felling or slaughter, the residual net value is transferred from stocks of fixed assets to stocks of inventories.

So far, *the ecological value of the cultivated natural assets* has not been considered at all; only the market value has been taken into account. It is most improbable that the ecological value will be introduced in the central framework of the SNA when the next revision takes place. This will probably remain an issue for satellite accounting. However, if ecological aspects are taken into account in satellite accounting, they should be introduced completely with the recording of both ecological assets, their changes and the ecological services provided by these assets. The loss of ecological value could not be simply deducted from domestic product, if the ecological services themselves are not included in the value of the output. In effect, these services are not reflected in the market value of the output of ordinary cultivated natural products. The market value of the cultivated natural assets does not cover the ecological aspects either. Thus, if we were able to estimate the ecological value of forests and the services provided by them in a way permitting aggregation at the total economy level, we would have to introduce a new type of asset, such as "eco-systems of cultivated forests," a new output of services (ecological services) and an increased income and final consumption.

Suppose now that a forest is converted into building land. A certain "eco-system of cultivated forests" would disappear. This disappearance would be recorded, in my view, as an "other change in volume of assets" in the corresponding account. Then everything else being equal, the output of ecological services, income and final consumption would be lower in the following years. If the destruction of the forest in question takes place in year t, the income would decrease from year $t-1$ to year t and this reduced level would persist in $t+1$, $t+2$, etc. . . . According to the suggestion just mentioned, the destruction of this eco-system would be treated in the same way as catastrophic losses in the 1993 SNA.

Of course, if one is not willing to follow this SNA approach and prefers a different concept of income, one may choose to record the consequences of exceptional events which the SNA includes in the other changes in volume of assets account as current flows. In this case, the value of the eco-system which is destroyed is deducted from income in the same period when the destruction occurs (in year t). One consequence of this treatment must be noticed however. Everything else being equal, the income in year $t+1$ (identical in absolute level with the level of income for this year when following the treatment described in the previous paragraph) would show a significant increase when compared with the level of income in year t. I am not sure this would be a more significant way of describing the phenomenon in question.

6.2. *Wild Natural Assets*

These assets are for instance virgin forests or sea fishstock. They are not treated as economic assets. They belong to nature. Juridically, they are normally in the public domain. The economy uses them as reserves of raw materials which

are provided free of charge to the economic agents extracting natural resources from wild assets.

Traditionally in national accounts the extraction is recorded, at the time it occurs, as output of the extracting activities (logging, fishing, hunting) both in physical and in value terms. Obviously, the extracting activities do not create the wild assets. Those assets are created by nature only, that is to say there is in their case no economic activity equivalent to forestry or fish or animal farming.

Physically, the harvest of wild biota corresponds to an equivalent withdrawal from natural non-produced assets. In value however, the story is more complex because, under certain conditions, the natural resources may be actually considered a free gift of nature, which means that no monetary value can be attached to the natural resource as such (the standing timber, the fish in the sea, etc.). This condition is, broadly speaking, that the *extraction* of a given resource, taking into account of course the different types of quality, *is in physical terms lower than or equal to the natural growth* of this asset. The process of harvesting may be reproduced indefinitely without reducing the level of the corresponding asset. It is as if the resources were unlimited. Under such circumstances the value of the output of the extracting activities is equal to the value of their sales. Their withdrawal from the natural non-produced inventories has a zero monetary value.

However, *when the harvest is greater than the natural growth*, the extracting activities then reduce the stock of natural non-produced assets and consequently the possibilities of future harvesting. Thus the withdrawal from these assets by the extracting activities no longer has a zero monetary value.

How should this withdrawal be valued? In accordance with the maintenance costs approach, it seems to be the cost of regenerating the natural assets to the level prior to this extraction in excess. Supposing, for sake of simplicity, that human activity may not directly contribute to the regeneration of the natural assets, in this case the only possibility for permitting the reconstitution of the assets by nature is by reducing the harvest below the level of natural growth during a certain period of time. The cost of regenerating the natural assets may thus be estimated in principle, as it has been already proposed by others, as the present value of the net value added which must be foregone during the period of reconstitution of the resource.

How to record the value of the depletion of renewable resources, that is, the extraction in excess over natural growth? To the extent that the value of the depletion is lower than or equal to the component of rent possibly existing in the sale price of the extracted resources (rent being, as for sub-soil, non-renewable assets the excess of the value of sales over the extraction costs widely defined), the value of the depletion is recorded as it is proposed above to treat rent for the depletion of sub-soil assets. The value of output, value added, primary income is lowered by the amount of the depletion, current transfers are reduced, additional capital flows are recorded in the capital account, as well as a negative change in non-produced inventories. A corresponding flow of non-produced inventories is recorded between nature and the economy in the other changes in volumes of assets account. The possible excess of the value of depletion over the rent should then be treated following a method similar to the one which has been proposed in the first section of this paper for the degradation of natural resources as a

result of residuals (see analysis of situation C). In the current accounts of the economy, an additional flow of final use is recorded (it may be called for instance "complementary value of the consumption of extracted renewable natural resources"), thus increasing final consumption. A capital transfer is then received from nature in order to balance the accounts. In the accumulation accounts of nature, a capital transfer is granted to the economy, corresponding to a consumption of natural assets.

In the balance-sheet of nature, the full amount of the (accumulated) depletion is recorded as a negative monetary value of the stock of natural assets. If later on, extraction is lower than natural growth, natural assets are regenerated through natural growth. This would be recorded as an output of nature, balanced by an addition to natural assets. In the balance-sheet of nature, the negative monetary value of the stock of natural assets in question would be reduced until it reaches again a zero monetary value.

The ecological value of the wild forests has not been considered at all in this section. It raises similar but more complex issues than in the case of cultivated natural assets. They are not considered in this paper.

Conclusion

As a preliminary conclusion, I would like to stress the following. There is the case for making some adjustments to Domestic Product when taking into account certain aspects of environmental phenomena. The most obvious case is the recording of the depletion of sub-soil assets. In such a case, value added would be lower than its measure according to the 1993 SNA.

However, not all adjustments to value added and domestic product which are proposed seem justified. In relation to the degradation of natural resources as a result of residuals generated by economic activities, there is a case for increasing final consumption by introducing an additional final consumption of environmental services provided by nature and leaving income unchanged. This additional final consumption corresponds to the consumption of natural assets resulting from the emission of residuals. According to this way of recording, adjusted final consumption is higher than final consumption in the 1993 SNA, whereas disposable income is unchanged and a capital transfer is received from nature. In the SEEA, the level of final consumption is not adjusted in this respect, whereas disposable income is lowered.[12] In the SEEA as well as in this paper, final consumption actually benefits from a reduction in natural assets (recorded in the SEEA as a use of non-produced natural assets similar to consumption of fixed capital). From the point of view of the significance of economic values, it seems more relevant to say that, when attributing a monetary value to factors of production which are provided free of charge, the value of the final products resulting from economic activities become higher.

[12]The SEEA does not for the time being include a full set of integrated accounts. Nevertheless, I suppose that this is what people have in mind in the context of version IV-2 of the SEEA. However, there are different views among supporters of the SEEA.

The difference made in this paper in the analysis of various phenomena relies basically on the fact that some of them are taken into account in the market economic values (the case of depleted sub-soil resources), whereas other are not taken into account in these values (case of degraded natural resources as an effect of the emission of residuals). The two types of cases require different treatment in environmental accounting.

Appendix 1

Accounting Equations

Notations:

O = output
IC = intermediate consumption
W = compensation of employees
D = consumption of fixed capital
P = net operating surplus
IT = other taxes on production
VAT = non-deductible value added tax
TI = additional tax on income
1 = ordinary activities/products
2 = maintenance activities/products
IC^1_2 = intermediate consumption of activity 2 in products 1
A = situation A

Situation A: no degradation of the natural environment and no maintenance costs

$O_{1,A} = IC_1 + W_1 + D_1 + P_1$
$GDP_A = W_1 + D_1 + P_1$
$NDP_A = W_1 + P_1$

Situation B: the pressure on the natural environment is totally balanced by actual maintenance costs

$O_2 = IC^1_2 + W_2 + D^1_2 + P_2$ in all cases
$O_{1,B} = [IC_1 - IC^1_2 + W_1 - W_2 + D_1 - D^1_2 + P_1 - P_2]$ in situation e
$+IC^2_1$ in case (a) and (b), with $IC^2_1 = O_2$
or $+D^2_1$ in case (c), with $D^2_1 = O_2$
or $+IC^2_1 + IT$ in case (d1i), with $IT = IC^2_1 = O_2$
or $+IC^2_1 + VAT$ in case (d1ii), with $VAT = IC^2_1 = O_2$
or $+IC^2_1$ in case (d1iii), with $IC^2_1 = O2$
or $+D^2_1 + IT$ in case (d2i), with $D^2_1 = O_2 = IT$
or $+D^2_1 + VAT$ in case (d2ii), with $D^2_1 = O_2 = VAT$
or $+D^2_1$ in case (d2iii), with $D^2_1 = O_2$

$GDP_{B,mp}$ = $W_1 + D_1 + P_1$ in case (a), (b), (d1iii), (e)
= $[W_1 + D_1 + P_1] + D^2{}_1$ in case (c)
or +IT in case (d1i)
or +VAT in case (d1ii)
or $+D^2{}_1$ + IT in case (d2i)
or $+D^2{}_1$ + VAT in case (d2ii)
or $+D^2{}_1$ in case (d2iii)

$NDP_{B,mp}$ = $W_1 + P_1$ in case (a), (b), (c), (d1iii), (d2iii), (e)
= $[W_1 + P_1]$ + IT in case (d1i) and (d2i)
or +VAT in case (d1ii) and (d2ii)

$GDP_{B,fi}$ = $W_1 + D_1 + P_1$ in case (a), (b), (d1i), (d1ii), (d1iii), (e)
= $W_1 + D_1 + P_1 + D^2{}_1$ in case (c), (d2i), (d2ii), (d2iii)

$NDP_{B,fi}$ = $W_1 + P_1$ in all cases

Reminder: the various cases refer to the forms taken by maintenance costs:

(a) Intermediate consumption by market producers in ordinary activities.

(b) Internal consumption from own-account maintenance activities by market producers in ordinary activities.

(c) Fixed capital formation by market producers in ordinary activities.

(d1) Intermediate consumption by non-market producers of government in ordinary activities.

(d1i) Financed by additional other taxes on production (1993 SNA) on ordinary activities.

(d1ii) Financed by additional taxes on products.

(d1iii) Financed by additional taxes on income.

(d2) Fixed capital formation by government non-market producers in ordinary activities.

(d2i) Financed by additional other taxes on production (1993 SNA) on ordinary activities.

(d2ii) Financed by additional taxes on products.

(d2iii) Financed by additional taxes on income.

(e) Household final consumption.

Appendix 2

Accounts with Environmental Services in Current Value

Nature	
Current Accounts	
Gross value added	Disposal services
Consumption of natural assets	Consumption services
Net value added	

Capital Account

Consumption of natural assets	Net saving
	Capital transfers granted (−)

With:
Disposal services = zero (situation A, B) or annual maintenance costs (AMC) (situation C)
Consumption services = zero (A, B, C)
Consumption of natural assets = zero (A, B) or AMC (C)
Capital transfers = zero (A, B) or AMC (C)
Gross value added = zero (A, B) or AMC (C)
Net value added, net saving = zero (A, B, C)

ECONOMY

Use of Income

Disposal services
Consumption services
Net saving

Capital account

	Net saving
	Capital Transfers received (+)

With:
Disposal services = zero (A, B) or AMC (C)
Consumption services = zero (A, C) or AMC (produced by the Economy and embodied in other goods and services, in B)
Capital transfers = zero (A, B) or AMC (C)
Net saving: unchanged (A, B) or reduced by AMC (C)

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